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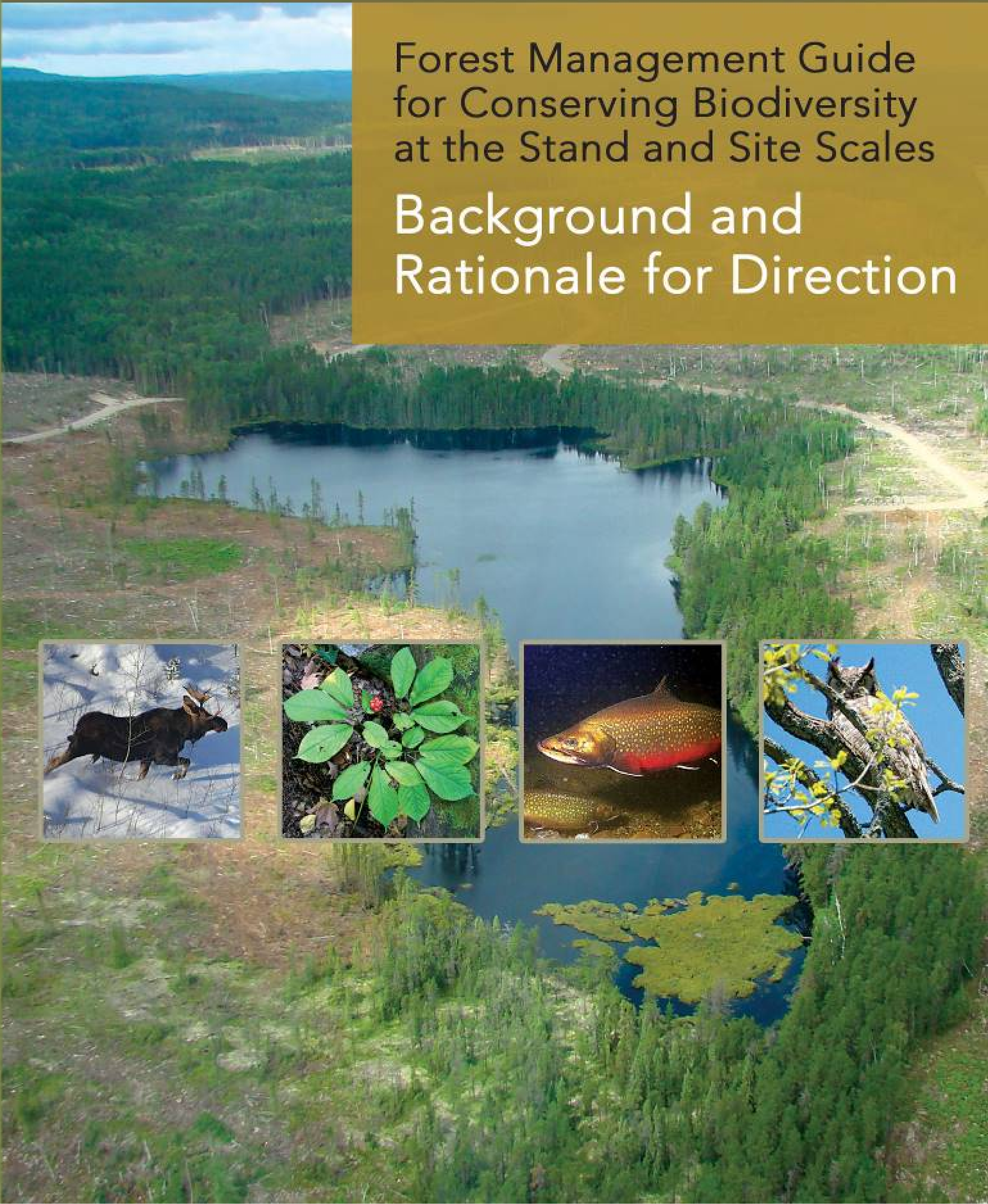
# Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales

# Background and Rationale for Direction



# Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales – Background and Rationale for Direction

## 2010

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**PREFACE**

This document presents background information on the many topics discussed within, and the rationale for direction contained within, the *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales* (OMNR 2010[1]) (hereafter referred to as the Stand and Site Guide).

The numbering of sections in this document parallels that found in the Stand and Site Guide.

References to the *Landscape Guide* refer to the following documents:

OMNR. 2010. Forest management guide for Great Lakes - St. Lawrence landscapes. OMNR, Queen's Printer for Ontario, Toronto, ON.

OMNR. In prep. Forest management guide for boreal landscapes. OMNR, Queen's Printer for Ontario, Toronto, ON.

Throughout this document, the following abbreviations are used in place of commonly-used terms:

AHA – allowable harvest area

AOC – area of concern

AOU – area of the undertaking

BA – basal area

CFSA – *Crown Forest Sustainability Act* (1994)

CRO – condition on regular operations

FMP – Forest management plan

FMPM – *Forest Management Planning Manual* (2009)

FTG – free-to-grow

GLSL – Great Lakes-St. Lawrence

LTMD – long term management direction

MU – management unit

NRVIS - Natural Resource Values and Information System

OMNR – Ontario Ministry of Natural Resources

SRNV - simulated ranges of natural variation

[1] OMNR. 2010. Forest management guide for conserving biodiversity at the stand and site scales. OMNR, Queen's Printer for Ontario, Toronto, ON.

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## 1.0 INTRODUCTION

Section 1 presents an overview of:

- the purpose of the Stand and Site Guide,
- the organization of the guide,
- definitions of terms used,
- MNR's philosophical approach to conserving biodiversity,
- the legislative and policy context for the guide,
- the pilot testing conducted,
- the socio-economic impact analysis conducted, and
- OMNR's statement of environmental values

No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

## 2.0 INTEGRATION AND IMPLEMENTATION

Section 2 presents an overview of:

- how the Stand & Site Guide is integrated with other direction,
- the implementation schedule for the guide, and
- previous guides that are replaced by the Stand & Site Guide.

No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

## 3.0 CONSERVING BIODIVERSITY – Management at the Stand, Multi-stand, and Meso-landscape Scales

### 3.1 Introduction and Linkage to Landscape-level Direction

Section 3.1 introduces the content of Section 3 and provide some background and context. No *Standards*, *Guidelines*, or *Best Management Practices* are presented. The examples used in this section are not intended to suggest the correct course of action.

### 3.2 Applying the Coarse Filter

#### 3.2.1 Composition

**Background**

A basic principle of applying the coarse filter is to “keep all the pieces”. In the context of forests, that concept can be translated as providing for a desirable amount and variety (age/structure and cover type) of forest conditions over time. Composition is an ecological term used to describe the pieces. More specifically, composition refers to the different elements, or groups of elements, represented in an ecosystem, and their relative abundance.

To be able to keep all the “pieces” (i.e., forest conditions) it is first necessary to describe those pieces. Rather than attempting to describe the almost infinite number of combinations of species, age, and site types occurring in a forest, a classification is employed. The FMPM directs the creation of a specific classification, *forest units* (refer to the FMPM for a description), for use in forest management planning. Other sources of composition direction (*Landscape Guide*, indicators handbook, etc.) typically rely on a coarser classification that is based on a grouping of forest units and/or ages. The direction in this section is intended to provide composition direction at the forest unit and sub-forest unit level that will be compliment with any grouped forest unit targets.

**Rationale for direction**

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - When developing long-term management direction, develop an objective and desired level for each individual forest unit. The sum of desired levels for all forest units will be consistent with any grouped composition targets (e.g., upland conifer). | The only *Standard* in this section requires that, for each forest unit identified in the forest management plan, an objective and desired level be set. The purpose of this is to ensure some forethought on the desirable level for the range of conditions within a grouped (i.e., grouped forest units) composition class. For example, at the strategic level, the forest management plan may include a grouped composition objective for the area of intolerant hardwood forest (assume intolerant hardwood forest is a grouping of a poplar and a birch forest unit). If only the grouped composition objective was implemented, there is no specific consideration for the desirable level of each individual forest unit. It would be possible to satisfy the grouped objective while significantly altering the proportion of each forest unit. For example, the entire area of the birch forest unit could be converted to the poplar forest unit, and the desirable level for the intolerant hardwood group achieved.<br><br>The *Standard* in this section requires that a desirable level be identified for each forest unit. It further qualifies that the desirable level must be |

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| | consistent with any grouped composition targets. This means the combination of desirable levels for individual forest units will add up to the desired level for the grouped objective. In this example, it may be acceptable and indeed desirable to convert a significant amount of the birch forest unit into the poplar forest unit. The standard simply requires a conscious decision to do so be presented in the plan. |
| *Guideline* - Where there is not a strategic decision to do otherwise, select harvest, renewal, and tending treatments that maintain existing tree species diversity at the forest unit level. | Forest units are aggregations of forest stands with similar composition. However, even though stands are of similar composition, there is a diversity of tree species included within. For example, the poplar forest unit may include pure poplar, poplar-birch mixes, and poplar-conifer mixes. Some species (e.g., white spruce) may only occur as a minor component of other forest units and rarely, if ever, form a pure condition. This guideline requires that the combination of harvest, renewal, and tending treatments maintain the species diversity within each forest unit, unless a change in diversity can be linked to a strategic decision to do otherwise. This guideline ensures that naturally occurring species in a forest unit are included in the future forest. This guideline is applied at the forest unit and not the site level. Change in species diversity and abundance at the site level is often consistent with emulation of natural disturbance and in many cases is desirable.<br><br>Included in the *Guideline* is a qualifier that a change in diversity is acceptable if linked to a strategic decision to do so. This qualifier is included to acknowledge that there may be some species that have been introduced or eliminated compared to the expected natural condition. This may have occurred for a variety of reasons such as previous management, insect/disease outbreaks, or active fire suppression. For example, on a particular forest, white pine may have formed a minor component of the jack pine forest unit in the past, and it may be desirable to re-introduce this association through management. Re-introduction or elimination of a species within a specific forest unit is not required, nor excluded by the guideline.<br><br>It is important to note that the diversity guideline relates to species diversity (i.e., count), not area, and is not to be construed as requiring an assessment of the area occupied by individual species. |
| *Guideline* - Develop *conditions on regular operations* to maintain S1, S2, and S3 Natural Heritage Information Centre vegetation communities, or other uncommon vegetation communities identified by MNR, which are likely to occur in areas of planned operations. A list of any additional uncommon vegetation communities will be provided by MNR prior to completion of the long-term | This *Guideline* relates to maintaining known occurrences of S1, S2, or S3 communities as defined by the Natural Heritage Information Centre (NHIC) or other uncommon vegetation communities identified by MNR. The NHIC uses a ranking system that considers the provincial rank of a community type as a tool to prioritize protection efforts. **These ranks are not legal designations.** The provincial (=sub-national) rank is known as the SRANK. These ranks have been assigned using the best available scientific information, and follow a systematic ranking procedure developed by The Nature Conservancy (U.S.). The ranks are based on the estimated number of occurrences, estimated community extent, and estimated range of the community within the province. The provincial ranks are explained below.<br><br>S1 - Extremely rare in Ontario: usually 5 or fewer occurrences in the province, or very few remaining hectares (e.g., Dry Oak - Pitch Pine Mixed Forest Type).<br><br>S2 - Very rare in Ontario: usually between 5 and 20 occurrences in the province, or few remaining hectares (e.g., Basswood - White Ash |

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| management direction. | - Butternut Moist Treed Limestone Talus Type).<br><br>S3 - Rare to uncommon in Ontario: usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with some extensive examples remaining (e.g., White Cedar Treed Limestone Cliff Type).<br><br>Many of the known occurrences of S1, S2, and S3 communities are either located outside the AOU, within protected areas, or in areas where forest management activities would not typically occur (e.g., cliffs).<br><br>Subject to data sharing and sensitivity requirements, the location of known occurrences can be acquired through the NHIC. The decision to include or not include known occurrences of S1, S2, or S3 community types within areas of planned operations is a separate decision made during forest management planning that is not addressed by the guideline. The guideline requires that *conditions on regular operations* be developed for any communities known to exist within areas of planned operations. If there are no known occurrences, *conditions on regular operations* are not required. The *conditions on regular operations* may or may not include active management of some or all of the species that comprise the community. The *conditions on regular operations* may or may not include modifications to normal harvest adjacent to known occurrences. The purpose of any active management, within or immediately adjacent to the community, would be to maintain the community on the land base.<br><br>The option for additional vegetation communities to be identified by MNR recognizes that S1, S2, and S3 vegetation communities have not been assessed for many ecoregions within the AOU. Any additional vegetation communities to be considered must be provided before completion of the LTMD. This timing ensures the planning team has adequate opportunity to consider and develop appropriate *conditions on regular operations*. |
| *Best management practices* | This *Best management practice* is an extension of the first *Guideline* and provides examples of how to achieve it. The first example encourages consideration of species diversity at the prescription level. If a given prescription is known to shift species composition in an undesirable direction (e.g., increased balsam fir), it may be appropriate to modify the prescription or use it sparingly. The second example simply ensures that an approved silvicultural tool is included in the plan to cover the range of known/desirable conditions. The third example is intended to avoid bias in the selection of stands for harvest. Selecting stands for harvest that are predominantly from one part of the range of the forest unit condition may lead to a substantive change in the average composition over time. This *Best management practice* (and three examples) is not intended to suggest that a decision for an individual stand cannot move species composition away from the pre-treatment composition, or the forest unit average. Rather, that the sum of decisions for all stands being treated ads up to a desirable condition. |

### 3.2.2 Pattern

No *Standards*, *Guidelines*, or *Best Management Practices* are presented. The text directs the reader to the relevant section based on the management intent of a specific area.

#### 3.2.2.1 Defining residual forest

A definition of *residual forest* was required to ensure consistent interpretation and usage of the term. This definition was developed to be used in Section 3 for pattern considerations as well as Section 4 when maintaining suitability of site-specific habitats. Due to the frequent references to residual forest and the importance of its definition to many pieces of direction, it was placed in its own sub-section to make for easy reference and to draw the reader's attention to it as early as possible.

As a cautionary note, the use of the term *residual* has changed from that described in the *Forest Management Guide for Natural Disturbance Pattern Emulation* (OMNR 2001). As well, Section 3.3 includes further direction on the provision of cover for specific animals. Habitat that provides cover as described in Section 3.3 will normally meet the definition of residual forest but the reverse is not always true.

The conceptual definition of residual forest is provided to help the reader understand what residual forest is and isn't. Most importantly it must be made clear that residual forest is not necessarily old, old growth, overmature, or mature. As well, the term residual only has a loose connection to natural disturbance events. For example, residual forest may include areas where disturbance skipped, but may also include areas where the intensity of the disturbance was low enough for some trees to have survived.

The technical definition is an attempt to draw a logical split between younger forest and older forest (not to be confused with old forest or old growth – "older" is meant as a relative term). The technical definition has been based on development stage definitions and the expected response of wildlife (i.e., function).

There are 7 development stages commonly used in the non-spatial habitat suitability models in use in Ontario (e.g., Holloway et al. 2004). A hierarchical cluster analysis of wildlife affinities for these development stages was undertaken to determine which development stages met the conceptual definition of older forest (example provided in Fig. 3.2a). The cluster analysis suggests a clear separation between the *presapling* and *sapling* development stages and the *mature, old, selection,* and *uniform shelterwood* development stages. The *immature* development stage falls between the two groups but was more similar to the older cluster. Based on this analysis the line between functionally younger and functionally older forest was determined as the onset of the immature development stage.

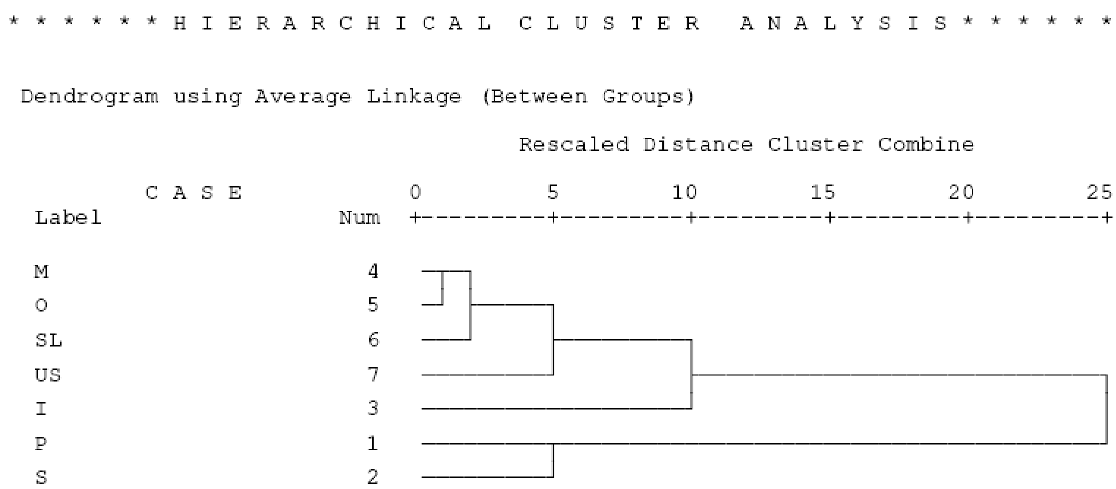


**Fig. 3.2a. Clustering of development stages based on the habitat affinities described for 67 species in the Great Lakes – St. Lawrence forest by Holloway et al. (2004). Development stages are sapling (P), sapling (S), immature (I), mature (M), old (O), mature but selection-cut (SL), and mature but shelterwood-cut (US).**

The criteria used to define residual forest (Table 3.2b) are described (with rationale) in the following table.

| Criteria | Description and Rationale |
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| *Condition* - Crown productive forest and free-to-grow | Ownership does not theoretically influence the functional value of forests to wildlife. However, since operations on patent forest land are not governed by forest management plans, residual forest must be crown land. The footnote is intended to clarify that although an area may not be available for harvest (e.g., park) it may still contribute to residual forest if all other criteria are met. In the case of a park, it may be necessary to consult the park management plan before utilizing park areas as residual forest.<br><br>The productive forest requirement is a simple way to ensure there is enough tree cover to describe a given stand as forested (i.e., 30%) rather than open habitat with some trees. In practice, this condition requirement will only be applied to forest areas that have not been harvested in the last 20 years. If an area has been recently harvested, or planned for harvest, additional canopy closure requirements are prescribed (see below).<br><br>The free-to-grow requirement is included to ensure that the forest has been regenerated to an acceptable standard, and that the forest being evaluated for residual is indeed the intended future forest. |
| *Age/Height* – ≥35 years **<u>or</u>** ≥10m | The definition of the *immature* development stage used in Ontario is based on age and varies by forest cover type (e.g., ecosite), and geographic region. Some of the regional variability can be attributed to conceptual differences in the definitions. In general, the onset age for lowland sites is generally older than upland sites. Despite the longer time frame to reach the immature stage, lowland sites tend to be shorter in height at the onset of the immature stage than upland sites (Holloway et al. 2004). It was determined that adopting the variable definitions |

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| | (including regional differences) of the immature development stage as a definition of residual forest would be too cumbersome for practical implementation and not consistent across regions.<br><br>Various approaches to simplifying the definition of immature for application to residual forest were examined. The goal was to find a simplification of the definition without compromising the integrity of the result. It was determined that a combined age and height definition of 35 years <u>or</u> 10 m would adequately capture the variability in site types, growth rates, and geographic regions represented in the various definitions of the immature development stage. The specific values were derived from an analysis of stand age and predicted height at onset of the immature development stage for the range of forest cover types across the AOU. Thirty-five years is the approximate age of onset for immature development stage for slower growing forest types. Ten meters is the approximate height achieved at the onset of the immature development stage for faster growing forest types. Ten meters also corresponds to the value used to define thermal cover for moose and deer in Section 3.3, which is based on expected wildlife response (i.e., functioning as older forest). Based on testing, it is expected that the paired age/height criteria will provide a similar result to the more complex and variable definitions of the immature development stage for each ecosite and region. |
| *Minimum patch size* – 0.1 ha | The minimum patch size of 0.1 ha was selected to provide flexibility in implementation and ensure that the majority of trees left unharvested will contribute to either an individual tree or patch target. Section 3.2.3.1 includes direction that clumps of more than 10 trees can only count as 10 individual trees. The combination of the 10 tree and 0.1 ha direction means that a clump of 50 trees that is less than 0.1 ha in size will count as 10 trees for individual tree targets but no area for patch targets. While the additional 40 trees do not count toward a specific guide target, they do still fill an ecological roll. The potential existence of these “extra” trees have been taken into consideration in the development of individual tree and patch direction.<br><br>When you consider fires, residuals (trees and forest) are a continuum from individual trees to small partially burned patches, to larger unburned patches. Any definition of patch versus concentration of individuals is somewhat arbitrary in terms of minimum size and % burned within. Both pieces of direction (i.e., trees and forest) are designed to ensure some trees are left behind. Early drafts of this section included a minimum patch size of 10 or more trees to ensure any trees left in the harvest area would count as either an individual or a patch. Advice from practitioners was that this was too small for practical management of patches of forest and would create too many difficulties for implementation.<br><br>The size of 0.1 ha was chosen to correspond to the approximate size of a patch with a radius equal to the height of the uncut forest. This represents the smallest patches that are intentionally left in the harvest area. For example, a tree length reserve may be left to protect a value or to address a safety concern.<br><br>A larger minimum area was considered (e.g., 0.25 ha) but it was felt that this was unnecessarily restrictive. Although relatively small, a 0.1 ha patch is still expected to function differently than the surrounding forest for some organisms. There is no expectation that all residual patches, |

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| | particularly the smaller ones, will be mapped or tracked as a separate polygon in the inventory. If the minimum patch size of 0.1 ha is too small for local circumstances, planning teams can elect to use a larger minimum patch size as this would still be consistent with the definition of residual forest. |
| *Canopy closure* – ≥50% based on dominant/codominant trees | In addition to the height/age criterion, it was necessary to consider an acceptable canopy closure for residual forest. Recall that the conceptual definition of residual forest is forest that functions more like older forest than younger forest. At some point along a gradient of more to less canopy closure in a mature forest stand, conditions will become so open that the stand begins to function more like younger than older forest. As a complicating factor, a forest with low canopy closure due to recent harvesting has a different structure, and is typically more similar to young forest, than a naturally low stocked stand of similar canopy closure.<br><br>Consistent with typical application of habitat suitability models, and previous application of the *Natural Disturbance Pattern Emulation Guide* (OMNR 2001), unmanaged stands that meet the condition criteria (productive forest and free-to-grow) are considered to have adequate canopy closure to be residual forest. Typical inventories at the time of preparing this guide require ≥30% canopy closure to be considered productive forest.<br><br>The value of 50% for stands managed in the last 20 years, and stands planned for harvest, was derived from a variety of sources including literature, the cluster analysis of the non-spatial habitat suitability models, and field experience implementing partial harvest in Ontario.<br><br>Clustering of the non-spatial habitat suitability models suggested that wildlife communities in selection-cut and early stage shelterwood-cut habitat are more similar to those in mature and old stage habitat than to those in presapling or sapling stage habitat. Selection-cut habitat typically has a residual canopy closure ≥60% and shelterwood-cut habitat (regeneration cut) typically has a residual canopy closure ≥50%. Thus, forest stands with a canopy closure ≥50% should provide at least some of the functions of older forest.<br><br>The value of 50% is further supported by a meta-analysis of 54 bird studies conducted by Vanderwel et al. (2007) which suggested that retention of ≥65% of trees results in “relatively minor reductions in species abundance” and that retention of >50% of trees “are not expected to cause critical reductions in abundance for any species”. Many of the studies cited by Vanderwel et al. (2007) involved GLSL-type forest conditions. However, the conclusions are also consistent with work from boreal Alberta. For example Tittler et al. (2001) suggested that retention of 10-40% of trees (in clumps) was not adequate to maintain all forest-dependent bird species in clearcuts; Harrison et al. (2005) found that retention levels of 50 or 75% were needed to maintain mature forest-dependent bird species in the EMEND study.<br><br>Further, MacDonald et al. (2003) suggested that partial harvests that retain <40% canopy closure may provide insufficient shade to mitigate effects on water temperature of small streams. This is relevant since the definition of residual is used for both pattern and maintenance of aquatic values in Section 4.0.<br><br>The majority of the work on effects of partial harvest has been done in |

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| | tolerant hardwood or white pine forest. For example, in tolerant hardwoods, selection cutting that reduces canopy closure to <70% can reduce habitat suitability for some old forest species like red-shouldered hawks (Naylor et al. 2004), pileated woodpeckers (Annand et al. 1997), and ovenbirds (Jobes et al. 2004), while increasing habitat suitability for young forest species such as chestnut-sided warbler, mourning warbler, and white-throated sparrow (Jobes et al. 2004). Rodewald and Yahner (2000) found that clearcuts in tolerant hardwood forest in Pennsylvania where about 40 dominant/codominant trees had been retained/ha tended to be dominated by early successional/edge species (~80 % of birds detected – in uncut stands these species represented only 20% of birds detected) suggesting that first removal shelterwood harvests may not function like older forest.<br><br>The habitat requirements for featured species in Ontario were also considered in determining the appropriate stocking levels for residual forest. American martens (a species associated with older forest) use forest with canopy cover of at least 30% but preferably 50-70% (Thompson and Harestad 1994). Pileated woodpeckers (also associated with older forest) had an average canopy closure within home ranges in Missouri of 75-96% (Renken and Wiggers 1989); canopy cover ≥60% appears to be optimal in both Oregon and Ontario (Bull et al. 1992, Kirk and Naylor 1996).<br><br>In his review of the effects on thinning and spacing on wildlife, Telfer (1991) suggested that thinning had little effect on wildlife unless it changed stands from a 'dense' to 'open' condition, where he defined open as <50% cover. For small mammals, Carey and Wilson (2001) found that reducing BA by 24-30% in immature Douglas fir stands did not result in a reduction in the abundance of species associated with old forest. Similarly, Suzuki and Hayes (2003) suggested that moderate intensity thinning (about 60% BA retention) in immature Douglas fir appeared to "maintain or improve habitat quality for most species". Heavier thinning (about 40% BA retention) was suggested to benefit species of younger forest (e.g., deer mice) and appeared to have a short-term negative effect on western red-backed voles (a mature-forest species), although differences between moderately and heavily thinned stands were not statistically significant.<br><br>There is a difficulty in directly comparing all of the above literature relevant to canopy closure and old versus young forest as the studies represent a variety of forest conditions (including those outside Ontario) and do not necessarily address canopy closure directly (e.g., some studies measured BA reductions). Further, some of the stocking references represent the optimal stocking for a particular species and as such are not necessarily useful in determining a threshold of older versus younger forest. However, they have been included in this rationale for context.<br><br>In summary, the cluster analysis, supported by a review of the literature, suggests that managed stands with 50% or more canopy closure are generally more similar to older forest than younger forest. For this reason managed stands with less than 50% canopy closure are not considered residual forest. |
| *Sub-stand pattern* - The sub-stand pattern will resemble an older | A criterion for sub-stand pattern is included as part of the canopy closure direction. This direction applies to areas planned for harvested only. As stated in Table 3.2b, the intent of this part of the definition is to |

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| forest with small gaps, rather than a mixture of discrete young and old forest patches. Ideally trees will be uniformly spaced. However moderate concentration to facilitate operations is acceptable. | ensure that the size and arrangement of openings produce a forest that resembles an older forest with small gaps, rather than a mixture of discrete younger and older forest patches. This direction provides some bounds on what area the 50% canopy closure is to be achieved over. Diagrams are provided to further described the required distribution of canopy closure but no metrics have been included. Specific metrics such as maximum opening size, trail width and spacing, degree of concentration will be dependent on local circumstances such as tree crown size, width of the area managed for residual (e.g., narrow strips vs. larger polygons), other objectives for the site, and available harvest and/or renewal machinery.<br><br>Depending on local circumstances, it may not be possible to conduct a harvest treatment that retains residual forest with an acceptable sub-stand pattern. This determination should be made early in the planning process as silvicultural options are defined and reflected in the long-term management direction. |
| *Composition* - Unless otherwise specified in the FMP (e.g., SGR for the general harvest area, prescription for the AOC, *conditions on regular operations*), harvested residual forest will normally have a species composition, average stem diameter, and average stem quality similar to that found in the stand before harvest. | The composition portion of the direction is included to communicate the general composition principles for harvesting to maintain residual forest as well as provide a default prescription. The default prescription requires a proportionate removal by species, quality, and diameter. This reflects the conceptual definition of residual forest, and the requirement to maintain functionally “older” forest characteristics. It is possible to alter the default prescription through the forest management plan. There are no specific bounds on what may be an acceptable reason for altering the default prescription but the intent is that the alteration is either silviculturally appropriate, or directly linked to achieving a plan objective or future forest condition. The minimum requirement is that the result meets the conceptual and quantifiable definition of residual forest. An example may be that balsam fir and other thin barked species will be preferentially removed over other species to emulate the effects of a partial burn. |

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### 3.2.2.2 Coarse filter pattern emulation and finalizing the harvest area boundaries during operational planning

**Background**

The principles of the *Crown Forest Sustainability Act* (CFSA) (1994) require that forest management “emulate natural disturbances and landscape patterns while minimizing adverse affects on [other values]”. Further, the EA declaration order (condition 39) requires clearcut harvesting be based on emulating natural disturbance patterns. Emulating natural disturbances implies a consideration for the pattern created by these disturbances at many scales. Emulating natural disturbance is intended as an efficient means of conserving “Large, healthy, diverse and productive Crown forests and their associated ecological processes and biological diversity” (CFSA – principle 1).

To be able to fully apply the Stand and Site Guide, a planning team will have already developed long-term management direction (LTMD). At the time of preparing the Stand and Site Guide, the LTMD included 10 years of proposed operations that have been selected with consideration for a desired landscape scale pattern. If the LTMD was developed prior to the landscape guide being developed, the broad pattern associated with the LTMD considered the suite of forest management guides applicable at that time. Otherwise, the LTMD will have been developed with consideration for the Landscape Guide, and includes a strategic landscape map. In both cases the broad landscape pattern (large areas of harvest and retention) is set and some of the context for stand and multi-stand pattern may also be provided.

The next step for the planning team is to perform detailed operational planning within the context of the LTMD and the preferred harvest areas. Detailed operational planning involves the delineation of the precise harvest boundaries which defines a finer scale pattern than the LTMD and associated preferred harvest areas. Detailed operational planning requires the consideration of many factors (e.g., AHA, AOCs, access) of which pattern is but one.

The order of events described above is a simplification of the actual task. In practice, some aspects of detailed operational planning may occur to support the development of the LTMD and selection of preferred and optional harvest areas. The approach is typically iterative, rather than linear, with the LTMD providing context to detailed planning and vice-versa.

In developing the Stand and Site Guide, it was necessary to consider the need for additional pattern direction at finer scales (i.e., the stand, multi-stand, and meso-landscape scales) than considered in the development of the LTMD (i.e., large landscape scale). Section 3.3 provides this direction when the management intent is specific to the maintenance or creation of habitat for a specific species. Refer to Section 3.3 for the specific direction and rationale. Section 3.2.2.2 provides this direction for all other harvest areas.

It was determined that a natural pattern, including expected variability, would be achieved without the need for highly specific pattern targets in this section after careful analysis of:

- current practice,
- the intrinsic pattern of Ontario’s forests within the AOU,
- direction provided in other guides (e.g., Landscape Guide),
- direction provided in other sections of this guide (e.g., Section 4), and
- planning required to develop the LTMD.

Instead, the direction took a more efficient approach by reducing the complexity of the requirements from previous (e.g., OMNR 2001) guides. Guideline effectiveness monitoring will be carried out to further test the implementation of this approach.

The introductory text includes clear direction for where the standard and guidelines apply. Specifically,

> *The guidelines in this section (Table 3.2c) only apply to areas harvested using the clearcut silviculture system. Clearcut harvest areas where the forest immediately following harvest is greater than 3m and FTG are exempt. Where the inventory does not contain sufficient data to assess the applicability of this exemption, verification will be required prior to completing the harvest.*

This statement excludes shelterwood and selection areas from the specific pattern guidelines. Further, clearcut harvest areas that immediately result in a free-to-grow (FTG) stand greater than 3 m tall are excluded. **Excluding these specific harvest treatments does not mean that pattern will not be provided, just that there is no explicit direction required to achieve it.**

Areas harvested under the selection silviculture system have been excluded from the guidelines in Section 3.2 because stand level pattern is irrelevant when a mature canopy is maintained. Implementation of the shelterwood silviculture system can result in young (sapling or immature) development stages for short periods of time but rarely results in the presapling conditions associated with clearcuts. The nature of the broader forest area where shelterwood silviculture is currently practiced is very heterogeneous and the result is typically a mixture of selection, shelterwood, and occasionally clearcut silviculture in intimate relation to each other. The intimate nature of this mosaic combined with the specific guidelines for any clearcuts that are intermixed, normally results in a reasonable pattern and likely one that approximates the natural disturbance pattern for that area. Further, the exact location of each system is not known until detailed information is collected on the ground. As a result, planned patterns are unlikely to be realized as the pattern that is implemented is adjusted to match the actual conditions. This is not necessarily due to errors in the inventory, rather a lack of resolution.

In addition to pattern considerations at the stand and multi-stand level discussed above, sub-stand pattern direction, which may be more important in partial harvest scenarios, is provided for in Section 3.2.3. Further, the stand level pattern will be controlled in part by landscape level requirements (see the Landscape Guide for details).

Clearcut harvest areas that immediately result in a FTG stand greater than 3 m tall are normally stands where the overstory, and therefore correct stand description, is a clearcut forest unit, but there is sufficient understory (and management intent) that the immediate post-harvest result is a FTG stand greater than 3 m. A common example is a stand with an overstory of poplar with a well stocked understory of hard maple or white pine that is carefully logged. Essentially these are clearcuts (due to the overstory forest type) that look and act like a final removal in a shelterwood. The FTG requirement was included to ensure the result matches the objectives for the site and forest conditions meet a regeneration standard. Three meters was chosen to roughly match the onset of the sapling development stage and to correspond with the temporal height definition of a clearcut.

It may appear that having these types of clearcuts excluded on a case-by-case basis will be relatively meaningless considering most inventories do not include understory information. In fact, since the guidelines allow the flexibility to make residual forest adjustments during operations, additional on-the-ground information will be available prior to making these adjustments, and can be implemented appropriately. As these clearcuts are expected to function like final removal cuts in the shelterwood system, refer to the rationale for excluding shelterwood areas (see above).

The introductory text also includes the statement,

> *Section 3.2.2.2 will only be applied in areas where a species-specific emphasis has not been identified. When operating within a defined area with a species-specific emphasis*

*(caribou mosaic, deer yard, moose LLP, etc) the guidelines in this section do not apply. Refer to Section 3.3, or other approved direction, for additional operational planning direction in these areas.*

This statement is provided to direct managers to the appropriate section based on specific circumstances. Section 3.2.2.2 provides direction that is intended to be applied only to those portions of the management unit where a generic emulation of natural disturbance approach is applied. Through development of the LTMD, other portions of the management unit may have had a fine filter emphasis assigned (e.g., deer winter concentration area) where an adjustment to the generic emulation requirements may be needed to minimize adverse effects resulting from emulating natural disturbances and landscape patterns (CFSA – principle 2). That is not to say that emulation principles will be excluded from these areas.

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* - Implementation of the guidelines in this section will be consistent with the achievement of biodiversity objectives. | This is a statement of principle that is already implied in the planning system. This *Standard* simply states the principle explicitly in relation to this section. As a forest management plan progresses, a great deal of effort goes into developing the LTMD and demonstrating that implementation of the LTMD will result in an acceptable level of objective achievement over time. Included in the development of the LTMD is an assessment of the sustainability of the landscape pattern. If detailed operational planning were to deviate significantly from the LTMD (e.g., biodiversity objectives), it would call into question the validity of all the previous work that led to the acceptance of the LTMD. If, during detailed operational planning, new information arises which suggests it is not possible for detailed operational planning to be consistent with the LTMD, the FMPM indicates the LTMD will be re-examined. The guideline related to this standard provides further clarification (see below for further explanation). |
| *Guideline* - Operational planning will normally follow stand boundaries and/or natural features. | This *Guideline* is intended as a simple (i.e., parsimonious) way of achieving a more complicated objective (i.e., natural pattern). Stand boundaries are appropriate in that they are based, in part, on the underlying landforms and the previous disturbance history. It is recognized that there are several artificial artifacts included in the stand boundaries of typical inventories, but the underlying landforms and natural disturbance history still show through and are a reasonable proxy of natural pattern.<br><br>In relatively homogenous forest areas, with simple landforms/topography, stands tend to be larger, with simple boundaries, as would be expected with natural disturbances in these areas. In relatively heterogeneous forest areas, with complex landforms/topography, stands tend to be smaller with complex boundaries, as would be expected from natural disturbances in these areas. Even the cases where somewhat artificial stand boundaries are included (i.e., the interpreter was a “splitter”), the FMP process of selecting stands for harvest tends to aggregate similar stands and reduce the presence of artificial boundaries.<br><br>It is recognized that in areas where the stand boundaries are highly |

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<tr><td></td><td>controlled by human constructs such as ownership boundaries, highways, and utility corridors, the use of stand boundaries will not likely achieve a pattern that emulates natural disturbance. It could be argued that due to the fragmented use patterns, these areas are inherently unnatural anyway, and an FMP decision at the operational stage has limited ability to change this. If the LTMD indicates it is appropriate to harvest in these areas, the associated landscape level pattern created would have been expected and already rationalized as appropriate and consistent with objectives.<br><br>Natural disturbances, particularly fire (both ground and crown), tend to follow natural features. Smaller wind disturbances may be associated with landforms (e.g., ridges, hilltops) and insect outbreaks may follow previous disturbance patterns of host species. While stand boundaries do tend to align with natural features, there are many natural features within a stand that may also be a logical boundary from a disturbance emulation point of view. In these cases a natural pattern will still be developed.</td></tr>
<tr><td>Guideline - Operational planning will ensure that any point within a planned clearcut harvest area will have at least 25 ha of mapped residual within a 500 ha circle (or hexagon) about that point.</td><td>The area within a circle approach is a way of describing natural pattern that avoids the arbitrary determination of a patch or disturbance boundary.<br><br>To determine the appropriate minimum amount of residual forest to retain in clearcuts, the amount of unburned forest within 500 ha circles randomly overlaid on the 42 fire database (OMNR 1997) used to support the development of the Forest Management Guide for Natural Disturbance Pattern Emulation (OMNR 2001) was measured. The selected value of 25 ha represents the 25th percentile of observed values (i.e., 75% of circles had > 25 ha of unburned forest). Five-hundred hectares was selected as a reasonable size class to consider multi-stand pattern and to correspond with the smallest pattern scale used in the Landscape Guide.<br><br>This Guideline will not be applied in isolation and is intended to augment all of the other sources of pattern (i.e., Landscape Guide requirements, AOCs, ineligible stands, bypass, intermixing of silviculture systems, wildlife habitat considerations) to ensure a minimum level of residual is provided (25 ha equates to at least 5% residual – more if there is any non-forest). Coupled with the other sources of pattern noted above, a range of residual (from 5 to >50%) approximating natural variability is expected.<br><br>Utilizing an area within a circle approach, as opposed to the previous percentage within a disturbance approach (as required by the Forest Management Guide for Natural Disturbance Pattern Emulation (OMNR 2001)) provides several advantages:<br>• ensures residual along relatively straight boundaries is not excluded,<br>• ensures residual between two disturbances is not excluded,<br>• avoids arbitrary determination of disturbance boundaries,<br>• avoids convoluted multi-plan disturbance scenarios,<br>• integrates with the conceptual approach to pattern in the Landscape Guide (i.e., texture not patches), and provides a simple approach to distribution of residual across a disturbed area.<br><br>This Guideline is meant to be complimentary, not additive, with the</td></tr>
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| | subsequent guideline to leave 0.5 ha in every 50 ha patch. For example, a 1 ha residual patch will satisfy the 50 ha guideline and contribute 1 ha toward meeting the 500 ha guideline.<br><br>The direction includes the option to assess achievement using either a circle or hexagon. Hexagons are a reasonable approximation of a circle that can be arranged into a regular lattice. Hexagons are included to allow managers to take advantage of innovative analysis techniques based on hexagons that may provide advantages over traditional circular (e.g., grid moving window) approaches. |
| *Guideline* - Mapped residual forest includes: i) unallocated stands or portions of stands that meet the definition of residual forest, ii) stands or portions of stands scheduled for harvest that will retain residual forest, and iii) residual forest within AOCs associated with known values. | This *Guideline* simply clarifies that any habitat that meets the criteria in Table 3.2b can potentially be considered residual forest. |
| *Guideline* - Normally, additional mapped residual forest that is required during operational planning will be preferentially retained so it is connected to the shoreline of a lake, pond, river, or stream that is within, or directly adjacent (<200m) to, the planned harvest area with a preference for areas of hydrological linkage (e.g. ephemeral streams, springs, seeps, groundwater discharge, etc.). Otherwise, additional mapped residual may be connected to known values, located to encompass uncommon forest types, or located consistent with expected disturbance | This *Guideline* is included to capitalize on the multiple purposes that residual forest patches can serve. A single residual patch could be connected to an aquatic AOC, comprised of an uncommon forest type, and adjacent to a nest and seepage area.<br><br>Connection to shorelines and overlap with hydrological linkages is intended to complement direction in Section 4.1. Past practice when operating in proximity (30-90 m) to lakes, ponds, rivers, and streams was to either undertake a partial harvest, or to leave a slope dependent 30-90 meter “donut” of uncut forest as a reserve. This typically resulted in an unnatural pattern. In a naturally disturbed landscape, we would expect more variation with donuts of varying widths (including those narrower and wider than 30-90 m), half or semi-circular donuts, and even no donuts (see Section 4.1 for further discussion). The direction in Section 4.1 includes options to allow for some of the “donut” to be harvested which can create narrow and semi-circular donuts. The requirement in Section 3.2.2.2 for additional residual will ensure that the “donut” will also be thicker than the minimum 30-90 m in some places, thereby providing a more natural pattern. By further specifying a preference for areas of hydrological linkage, the disturbance of these susceptible areas is minimized and the utility of adding a residual patch is maximized.<br><br>Connecting residual to special habitat features will further increase the utility of the residual patches and provide enhanced protection for the habitat feature to which it is connected. Habitat features that are dependent on some level of disturbance (e.g., beaver ponds) should not be selected for overlap with a residual patch.<br><br>Connecting residual to uncommon forest types, particularly those that will remain unharvested, will help to maintain that uncommon forest type on the landscape by reducing the risk of blowdown and helping to |

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| behaviour. | maintain the site characteristics (e.g., hydrological regime) that caused it to occur in that location to begin with.<br><br>When shorelines, special habitat features, and uncommon forest types are not an option for adding residual, the guideline requires that expected disturbance behavior is considered when locating additional residual patches. For example, the amount of non-forest in the local area, distance from the edge of the recently disturbed area, forest composition, topography, and soil moisture can influence the likelihood and location of residual in natural disturbance events. This is a basic principle of emulating natural disturbance.<br><br>It is important to note that this guideline refers to the placement of <u>required</u> residual (when there is less than 25 ha at the 500 ha scale) and does not imply additional residual is required over and above the 500 ha guidelines when adequate residual already exists. |
| *Guideline* - A minimum of 5 ha of the mapped residual within any 500 ha circle (or hexagon) will belong to a patch greater than 5 ha. | It is expected that the natural arrangement of forest types, AHA limitations, AOCs, and unplanned retention will normally provide for a natural range of residual patch sizes. This *Guideline* is intended to ensure there are at least some medium-sized patches after implementing the harvest treatment. It is expected that small patches will be created through AOC prescriptions and small bypass areas while large patches will be created through unallocated stands, intermixing of silviculture systems, and Landscape Guide direction. The size of 5 ha was selected in part to be complimentary with moose cover guidelines in areas where moose habitat is emphasized (see Section 3.3) as well as a consideration for the following factors:<br><br>• the average and range of patch sizes observed in natural disturbances (OMNR 1997, Lee 2002),<br>• the size of unplanned residual patches expected to be created through normal operations,<br>• relative operational costs of leaving different size patches (Pavel 2006),<br>• the minimum patch size where edge effects would be minimized for a variety of plants, lichens, and insects (Schmiegelow 1997, Schieck et al. 2000, Fisher and Wilkinson 2002, Nelson 2003, Rheault et al. 2003, Luoma et al. 2004, Gandi et al. 2004, Hannon 2005),<br>• relative susceptibility to blowdown (Navratil 1995, Ruel 1995, Crites 2000), and<br>• typical mapping standards for minimum polygon size.<br><br>The minimum patch size wording was selected carefully and a footnote provided to further elaborate on possible scenarios that will satisfy the direction. As well, examples are provided in the “selected appendices” section to provide further interpretation of the direction. |
| *Guideline* - Implementation of the harvest plan will ensure that any point within a new clearcut harvest area will have at least 0.5 ha of residual within a 50 ha | Much of the discussion and rationale for the 500 ha guideline applies to this *Guideline*. Fifty hectares was selected as an order of magnitude smaller than the 500 ha scale and to roughly correspond with the scale of an individual stand. As in the case of the 500 ha guideline, the value of 0.5 ha corresponds to the 25$^{th}$ percentile of the amount of unburned forest observed in a random sample of 50 ha circles overlaid on the 42 fire data set. There is no requirement to map the 50 ha scale residual as the individual pieces will likely be quite small. As well, relative to the |

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| circle (or hexagon) about that point. Develop a *condition on regular operations* for areas where this residual is not mapped in advance. | 500 ha scale, locating any additional residual to satisfy the 50 ha guideline will be simple and can easily be implemented in the field. For this reason a condition on regular operations is required to enforce the creation of these patches where the planned operations do not include sufficient area. The condition on regular operations for patches can be thought of as similar to the condition to leave wildlife trees. Wildlife trees are not mapped, and may not be marked in advance, but the result after harvest will include sufficient trees.<br><br>The flexibility to locate the 50 ha scale patches during operations does not preclude mapping in advance if that is advantageous for local operational implementation and agreed to by the planning team.<br><br>There are no explicit patch size requirements associated with the 50 ha scale requirements, but it is anticipated that a range of patch sizes from very small to very large will be used to satisfy this guideline. The only minimum patch size restriction is 0.1 ha which comes from the definition of residual forest. Patches smaller than this are considered clumps of wildlife trees. |
| *Guideline* - Mapped residual that is not serving any other purpose (AOC, specific habitat function, etc), and would otherwise be available for harvest, can be moved during operational implementation provided … | This *Guideline* is intended to recognize that it is not possible to foresee all operational realities during operational planning. The location of planned residual may be adjusted based on numerous factors such as new or changing values, changes in the silviculture system, economic realities, and physical site conditions. |
| *Guideline* - In the event that any of the guidelines in this section will compromise achievement of geographically specific (e.g. habitat) or broad landscape level (e.g. pattern) biodiversity objectives, the achievement of biodiversity objectives will take priority over the guidelines. Any required modification of these guidelines to ensure consistency with biodiversity objectives will be described in the FMP. The degree and geographic scope of modification will be | This *Guideline* is meant to address unique situations on a case-by-case basis where implementing the guidelines in this section will compromise the achievement of the LTMD or more specifically the achievement of targets set for biodiversity indicators of objective achievement. The guidelines in this section, including the referral to other sections when operating within a specific geographic zone with a fine filter intent, are designed to minimize potential conflicts. One example where this exception process may apply is a site that was degraded due to poor management in the past where rehabilitation has been planned. Requiring the maintenance of residual forest could limit the amount of area available for rehabilitation. This will compromise the stand level objective, but may also limit achievement of forest level objectives if the planned rehabilitation was to an important future forest type.<br><br>The requirement to limit the geographic scope and/or degree of modification is meant to place some bounds on the extent of modification. The requirement to document the modification in the plan is to ensure the modification is adequately communicated to the interested parties, and that adequate compliance measures are included in the plan. |

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| limited to that required for consistency with biodiversity objectives. | |
| *Guideline* - **Additional direction for forest management plans written without the Landscape Guide:**<br><br>Operational planning will ensure the area of residual forest averaged over all planned harvest areas where 3.2.2.2 applies, using a 500 ha moving window assessment, is greater than or equal to 20% of the crown forested area. | This *Guideline* only applies to plans written without the benefit of the Landscape Guide. The pattern direction in the Landscape Guide provides a high-level control on the amount of residual forest at the stand level. This becomes a check and balance that tests the assumption that the amount of residual left in harvested areas will have a range similar to that expected in naturally disturbed landscapes.<br><br>In the absence of the Landscape Guide, a minimum of 20% has been included to ensure a natural range of residual forest is maintained. The value of 20% was derived using the same base data and logic as the 25 in 500 ha and 0.5 in 25 ha direction (see discussion above). In combination, this direction ensures that no clearcut harvest area will have less than 5% residual in any 500 ha area (25 in 500) and that at least 20% will be left in enough clearcut harvest areas to ensure a minimum average of 20% over all planned clearcut harvest areas. This combination of a specified minimum and average is intended to provide an efficient method of achieving a natural pattern. |

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### 3.2.2.3 Catchment considerations

**Background**

Aquatic ecosystems, and the biotic communities inhabiting them, are shaped by characteristics of the aquatic feature itself (e.g., morphometry, water chemistry), the adjacent riparian ecosystem, and the mosaic of ecosystems comprising the associated watershed or catchment (e.g., Richards et al. 1997, Zorn et al. 2002, Wang et al. 2003, Brazner et al. 2005, Cyterski and Barber 2006).

In this section we provide a brief overview of how the characteristics of catchments, and disturbances within catchments, affect aquatic ecosystems and their biota, with special emphasis on calcium and mercury. We conclude with a discussion of the approach proposed in this guide to mitigate any undesirable effects of forest management.

The influence of riparian vegetation on aquatic ecosystems and their biota, and direction to mitigate undesirable effects of forest management activities in riparian areas, is discussed in 4.1.

*Catchment-scale effects*

A catchment is simply the area that drains into a water feature. Numerous characteristics of catchments influence water yield and water chemistry in both disturbed and undisturbed states. For example, in boreal lakes, characteristics such as catchment area relative to lake volume, catchment slope, and % area in wetlands appears to influence parameters such as the level of DOC, TP, Ca, Mg, and TN (D’Arcy and Carignan 1997, Carignan et al. 2000, Prepas et al. 2001).

Removal of forest cover by wildfire, timber harvest, blowdown, insects, or disease may increase water flux by temporarily altering evapotranspiration, infiltration, overland flow, and sub-surface flow (Putz et al. 2003). Altered hydrological regime, in concert with increased mineralization, may result in increased movement of DOC, heavy metals (such as MeHg), cations, and plant nutrients into lakes, streams, and groundwater (Carignan et al. 2000, Lamontagne et al. 2000, McEachern et al. 2000, Steedman 2000, Allen et al. 2003, Prepas et al. 2003).

Changes in the quantity and quality of water following disturbance may result in changes in the biota of lakes and streams. For example, changes have been noted in pelagic and benthic algae (Planas et al. 2000), periphyton (Desrosiers et al. 2006), zooplankton (Patoine et al. 2000), and benthic macroinvertebrates (Scrimgeour et al. 2000, Martel et al. 2007, Kreutzweiser et al. 2008a). However, effects on fish communities are generally reported as minimal (St-Onge and Magnan 2000; Steedman and Kushneriuk 2000; Tonn et al. 2003, 2004).

The magnitude of hydrological, chemical, and biological effects following catchment disturbance is influenced by many factors including climate, watershed physiography, pre-disturbance vegetation, and type and intensity of disturbance (Steedman et al. 2004). Magnitude of effects is generally related to the percent of catchments disturbed (Carignan et al. 2000, Prepas et al. 2003, Martel et al. 2007). Effects on water flux and element export are generally not detectable unless 25-50% of the forest cover on small catchments is removed (Steedman et al. 2004). However, changes in the communities of some biota, such as benthic invertebrates, have been detected in streams associated with <25% catchment disturbance (Martel et al. 2007, Kreutzweiser et al. 2008a).

The effects of catchment disturbance are generally transitory. Water flux and nutrient export peak in the 1st and 2nd year after disturbance and both typically recover to pre-disturbance levels 5 to 10 years after disturbance as vegetation re-establishes (Steedman et al. 2004). For example, water yield in streams typically returns to pre-disturbance levels within 3 to 7 years (Putz et al. 2003, Nitschke 2005). Total suspended sediments return to pre-disturbance level within 3 years (Macdonald et al. 2003). Mobile ions such as K and Cl are rapidly flushed from lakes by the 3rd year after disturbance; other parameters such as DOC, TP, Ca, and Mg take longer (Carignan et al. 2000). Biological effects are also relatively short-lived. For example, pelagic algae and zooplankton communities returned to reference levels by the 2nd and 3rd year, respectively, after catchment disturbance (Patoine et al. 2000, Planas et al. 2000). Moreover, effects on benthic invertebrates are most apparent < 5 years after disturbance (Martel et al. 2007).

*Comparison of harvesting and natural disturbance*

Timber harvest and wildfire generally produce similar catchment-scale effects. However, the magnitude of some effects does differ between the two types of disturbance. For example, timber harvest may have a greater effect on water flux because roads and ditches may enhance drainage efficiency (Steedman et al. 2004). In 5 case studies reviewed by Nitschke (2005), streams running through burns and clearcuts were associated with 70 and 150% increases in summer flow, respectively, and stream flow recovered more quickly (mean of 5.3 versus 7.5 years) in burned catchments.

Wildfires and harvesting can differ in their effects on chemical changes in lakes and streams. For example, lakes and streams within clearcut catchments typically exhibit greater increases in the concentration of DOC, MeHg and Na; lakes and streams in burned catchments typically exhibit greater increases in the concentration of NO3, SO4, and Mg (Garcia and Carignan 1999, Carignan et al. 2000, Nitschke 2005).

Differences in water yield and water chemistry may translate into differences in lake or stream biota. For example, response of zooplankton, pelagic algae, and littoral benthic invertebrates to catchment disturbance differed between lakes within burned and harvested catchments (Patoine et al. 2000, Planas et al. 2000, Scrimgeour et al. 2000). However, response of fish communities to catchment-scale disturbance appears to differ little between lakes in burned and harvested catchments (St-Onge and Magnan 2000, Tonn et al. 2003).

*Calcium and catchment-scale effects*

Catchment-scale export of calcium from forest soils to adjacent aquatic ecosystems occurs in both disturbed and undisturbed catchments. Export of calcium may be temporarily but significantly elevated following both wildfire and forest harvesting; exports from burned catchments are typically about twice those from harvested catchments (e.g., Carignan et al. 2000, Lamontagne et al. 2000, Nitschke 2005).

Export of base cations has important biological implications for receiving aquatic ecosystems. For example, calcium is required by aquatic organisms such as crustacean zooplankton and other invertebrates that play key roles in aquatic food webs (Keller et al. 2001). Recent research suggests that calcium concentration in many lakes on the southern shield has declined to levels that may have adverse consequences for crustacean zooplankton, and consequently for other members of these food webs (Jeziorski et al. 2008). Declining calcium level in lakes appears to be linked to reduced export from surrounding catchments, which in turn appears to be a consequence of reduced exchangeable calcium concentration in forest soils (Houle et al. 2006). Numerous factors may have contributed to this decline, but much of the decline appears to be linked to acid precipitation which has apparently accelerated base cation leaching from forest soils across eastern North America (see references in Kreutzweiser et al. 2008b).

A number of recent studies suggest that removal of calcium in tree boles associated with forest harvesting and calcium uptake by regenerating forest vegetation may potentially result in a long term decline in watershed calcium levels and the rate of export to aquatic systems (Watmough and Dillon 2002, Watmough et al. 2003, Watmough and Aherne 2008). However, empirical evidence that harvesting, at the intensity and scale normally conducted, is likely to have a widespread biologically significant effect is generally lacking. Moreover, not all research suggests that forest harvesting results in reduced exchangeable calcium concentration in soils (see review in Kreutzweiser et al. 2008b) or long term reductions in the export of calcium to streams and lake ecosystems (e.g., McLaughlin and Phillips 2006). Thus, there is currently insufficient evidence to warrant inclusion of additional mitigative direction specifically for catchment-scale effects of harvesting on calcium exports to aquatic ecosystems. Furthermore, the variability in catchment-scale effects of forest harvesting on exports of calcium and the lack of research documenting how forest management operations may interact with other factors (e.g., catchment geology, drought, acid precipitation) would make it difficult to quantitatively define appropriate mitigation (if needed). However, the studies by Watmough and others do make a compelling case to further investigate this topic. The growing body of information on this topic, and the potential requirement for (and nature of) mitigative direction, should be carefully considered during the 5-year review of this guide.

*Mercury and catchment-scale effects*

Mercury is a natural element occurring in air, water, soil, and biota in the boreal forest. Mercury, which exists in several inorganic or elemental forms and as organic methylmercury (MeHg), alternates between forms and cycles among different components of the ecosystem as part of a complex biogeochemical process. Natural levels of mercury are spatially variable depending on geology, soil, and forest characteristics. However, the global atmospheric pool of mercury has increased 2 to 5 fold over pre-industrial times (Lindberg et al. 2007). Mercury derived from industrial activity, primarily the burning of fossil fuels, may increase mercury levels in the immediate area of such activities, but increased mercury levels in remote areas, such as the Arctic, indicate the importance of the global atmospheric mercury pool as a source of contamination. Although mercury emissions in North America and Europe have been dramatically reduced in the last few decades, the global atmospheric pool of mercury has not decreased, partly due to increases in emissions from developing countries (Lindberg et al. 2007). Current estimates are that approximately half of the mercury deposition in the boreal forest comes from anthropogenic sources, although such estimates are highly uncertain (Grigal 2002, Lindberg et al. 2007).

In the boreal forest, existing mercury, and mercury deposited from the atmosphere, is primarily stored bound to humic particles in the upper few centimetres of the soil profile (Grigal 2002, Povari and Verta 2003). The soil mercury pool is relatively stable and experimental additions of mercury indicate that most newly deposited mercury is held in the soil (Hintelmann et al. 2002). Hintelmann et al. (2002) further suggest that their observations indicate that the primary source of mercury in aquatic systems away from point source discharges is direct deposition from the atmosphere with terrestrial runoff contributing relatively less mercury. However, disturbance to forest areas, including forest management activities (Povari et al. 2003) and natural disturbances including fire (Kelly et al. 2006), severe storm events (Munthe et al. 2007b), and drought (Grigal 2002), can result in the release of mercury from the soil pool and subsequent volatilization to the atmosphere or entrance into surface runoff or groundwater, bound to dissolved or particulate organic carbon (Grigal 2000). Waterborne mercury moving into aquatic systems may then be methylated, primarily by sulphur-reducing bacteria in low oxygen environments within wetlands and lake sediments (Morel et al. 1998). The capacity of aquatic systems to form MeHg depends on a number of factors, including the proportion of wetlands associated with lakes or streams (Grigal 2002). However, methylation in aquatic systems is the principal mechanism by which mercury is made available for incorporation and biomagnification in aquatic ecosystems.

There is a developed body of research on the process by which water impoundment releases mercury stored in the soil and may accelerate the production and bioaccumulation of MeHg in flooded areas, particularly those with high proportions of flooded organic material such as wetlands (Bodaly et al. 2004, Hall et al. 2005). There has been much less research on the impacts of other types of disturbance. Studies in Finland have shown that forest management activities can lead to an increase in the concentration of total mercury and MeHg in groundwater and surface waters (Munthe et al. 2007a, Povari et al. 2003, Povari and Verta 2003). Recent research conducted in Quebec has shown that mercury levels in periphyton, plankton, and fish in lakes within watersheds that have been disturbed by forest management activities or fire are higher than in undisturbed lakes (Garcia and Carignan 1999, 2000, 2005; Desrosiers et al. 2006). These results have raised concerns over the impact of forest management activities on mercury levels in aquatic systems and the potential risk this may pose to wildlife and humans consuming fish.

**Implications for direction in this guide**

Removal of trees from catchments by timber harvest or wildfire is associated with generally similar changes in the hydrology, chemistry, and biota of lakes and streams. Moreover, effects are generally transitory and most do not appear to translate to higher biotic levels (but see discussion on *Mercury and catchment-scale effects*).

It is anticipated that the cumulative effect of applying the coarse and fine filter direction in the Landscape Guide and Stand & Site Guide will result in a level of catchment-scale disturbance that is within the range of that associated with natural disturbances. Thus, there is no additional fine filter direction prescribed to mitigate the general catchment-scale effects of timber harvest. However, since the response of some variables may differ between harvested and burned catchments, catchment-scale effects are identified as one of the high priority questions for evaluation during effectiveness monitoring of the guide (see Section 7.0).

This conclusion was reached after undertaking a comparison of the extent of disturbance in catchments resulting from the actual harvest pattern from the previous 25 years of harvesting, the expected future harvest pattern directed by forest management guides, and the estimated pattern resulting from a natural disturbance regime. This comparison demonstrated that past and expected future harvests result in catchment level disturbance patterns within the range expected on a naturally disturbed landscape.

There is fairly compelling evidence that timber harvest (and wildfire) results in an increase in the movement of mercury from terrestrial to aquatic environments where it may be converted to MeHg (see above). Associated with this, there is a growing concern about the associated potential risk to wildlife and human health. Kolka et al. (1999, 2001) suggest that most terrestrial mercury is transported bound to particulate organic matter and thus recommend management practices that limit site disturbance and particulate transport to aquatic features, such as use of buffer strips and erosion control devices. There is also growing evidence that specific locations within catchments may be ‘hotspots’ for mercury methylation (Branfireun and Roulet 2002, Mitchell et al. 2008). These sites may be associated with areas of flow accumulation that focus movements of water, mercury, and sulfates from surrounding uplands into areas of saturated soils (anoxic conditions), thus facilitating increased levels of methylation by sulfate-reducing bacteria. Operations that result in disturbance of these ‘hotspots’ or disrupt the hydrologic flow to them could potentially affect the rate of methylation or the subsequent transport of methylated mercury to aquatic features (Porvari et al. 2003, Munthe and Hultberg 2004).

While there is no direction explicitly labeled as ‘catchment-scale’ in the guide, there are many pieces of direction in the guide that will address these concerns. Section 5.2 provides general direction to minimize site disturbance within upland areas which will reduce the creation/mobilization of particulate matter as well as maintain hydrological function. Sections 4.1 and 5.1 provide comprehensive direction to minimize the subsequent risk of particulate matter transport to aquatic features. Sections 3.2 and 4.1 also provide direction to specifically minimize site disturbance, and preferentially retain residual forest, in areas that are hydrologically connected to aquatic features and that may be linked to or function as potential methylation ‘hotspots’ (i.e., ephemeral streams, springs, seeps, and other areas of groundwater discharge). Thus, there is no additional fine filter direction prescribed to mitigate the catchment-scale effects of timber harvest on mercury export. However, given the growing concern expressed by stakeholders, mercury export is specifically identified in Section 7.0 as a priority for effectiveness monitoring.

**Previous direction**

The *Forest Management Guide for the Protection of the Physical Environment* (OMNR 1997) included a rule of thumb that no more than 50% of a second order watershed be harvested in a 10 year period. Second order watersheds typically range from 10s to 100s of hectares but can be several thousand hectares with significant variation in average size between management units. This direction was considered for inclusion in the Stand and Site Guide but deemed ineffective, and more importantly unnecessary.

Second order watersheds are an arbitrary response unit for assessing catchment scale effects with limited scientific basis. By varying the definition of catchment/watershed, a single township could have anywhere from a few to dozens or even hundreds of catchments. Devito et al. (2005) argue that response units are not the same everywhere and there are many factors at many spatial scales that influence what an appropriate unit might be. There does not appear to be a defensible method of deriving an appropriate geographic response unit.

There is limited scientific basis for setting a threshold of percent disturbed in a geographic response unit. While 50% is a reasonable generalization of how much of a catchment can be disturbed before seeing a measurable hydrologic response, some studies show a response at levels as low as 15% while others show no response at 100% (e.g., Stednick 1996). Further, a hydrological response is not necessarily negative as the response (e.g., increased water yield) is often consistent with a naturally disturbed system.

In addition to being ineffective, the second order watershed direction is no longer necessary. Landscape level pattern direction, coupled with stand level retention requirements, is expected to produce a natural pattern of disturbance (and retention) at multiple scales. This level of sophistication in pattern direction did not exist at the time the *Forest Management Guide for the Protection of the Physical Environment* (OMNR 1997) was developed. The 2$^{nd}$ order watershed direction was originally included without the benefit of this context and is now considered unnecessary and further has the potential to be contradictory to the CFSA's principle of emulating natural disturbances and landscape patterns.

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### 3.2.3 Structure

#### 3.2.3.1 Wildlife trees

**Background**

Wildlife trees are standing individual trees or stems, or small clumps of trees or stems, within areas of operations (in this guide, a clump of wildlife trees is <0.1 ha in size; clumps with more than 10 trees or stems can be counted as contributing no more than 10 to the wildlife tree requirements). Wildlife trees may or may not be of commercial importance, but are valuable in the maintenance of ecological function and require special attention in managed forests (e.g., Backhouse and Lousier 1991).

In the past, wildlife trees were often referred to as 'residuals' or 'residual trees', which sometimes led to confusion, as mappable stands of trees are usually referred to as 'stand level residuals' (see Section 3.2.2.2). The direction for management of wildlife trees and residual trees applies to regular harvest areas, and may be included in some area of concern prescriptions (see Section 4).

To qualify as a wildlife tree, a tree can be a standing, healthy, dead or dying tree, or a tree killed by stubbing or tending operations. Normally, a wildlife tree is only the main trunk or 'stem' of a tree. Some specific types of wildlife trees have certain characteristics or attributes as described in this section.

Wildlife trees are retained to provide habitat for wildlife both while they stand and after they have fallen and become downed woody material (see Section 3.2.3.2).

*Residual trees, cavity trees, and stubs*

Although the literature is often unclear as to what exactly is being referred to, and the definition differs among authors (Perera et al. 2004, 2007), the live and dead trees that remain standing after a disturbance in fire-origin forests, as well as in forests harvested using the clearcut silvicultural system, have been generally referred to as residual trees and snags, or residual 'structures'. It is believed that the retention of residual structures following tree harvesting operations, if similar to forest composition and structure created naturally by wildfires, will help sustain ecological processes and conserve biodiversity (Hunter 1990).

Some residual structures may become 'chicots', although 'chicots' are not necessarily fire-origin products.

In boreal northeastern Ontario, the terms "snag" and "cavity tree" have in the past been used interchangeably to include dead, dying, or live trees with cavities or the potential to develop cavities, and are larger than 10 cm dbh and taller than 3 m (Watt and Caceres 1999).
While Perera et al. (2004) identified a number of studies that examined post-fire residual structures in North American forested landscapes (e.g., Lee and Crites 1999, Haeussler and Bergeron 2004), the primary focus of most studies was the abundance of post-fire residual live trees, snag trees, and downed wood. None described the process of delayed tree mortality or the fall rate of post-fire residual live trees.

Site effects are believed to have an influence on snag occurrence (e.g., McCune et al. 1988). However, a recent assessment of boreal wildfires in Ontario, found no evidence of associations between the number of residual snags and site conditions, including soil moisture, percent slope, aspect, distance to water, and distance to wetland (Perera et al. 2008). In addition, fire size did not affect the number of residual snags. However, as fire intensity increased, the number of snags also increased (but there were fewer living trees). For three years following fire, living trees died and both living trees and snags fell to the ground, although more snags were created (trees dying) than fell.

Some information on the fall rate of fire-origin snags suggests there is substantial snag fall 2-7 years following a fire (Lyon 1977, Schaeffer and Pruitt 1991). Apfelbaum and Haney (1981) reported most snags had fallen within 15 years after fire, while Everett et al. (1999) reported snag fall to be most rapid within the first 15 years after fire. Everett et al. (1999) also evaluated factors that could contribute to the fall rate of fire-origin snags, including species, tree diameter, aspect, and slope. The amount, distribution, and type of residual trees which form the post-fire residual structure of a forest landscape is highly variable (Perera et al. 2004).

In addition to fire, other major disturbances that result in pulses of tree mortality, which produce residual structures, include ice storms (Rebertus et al. 1997), insect outbreaks (Fleming and Freedman 1998), and windstorms (Roovers and Rebertus 1993).

In the absence of major disturbances, trees still die and form snags. Trees die from a wide variety of causes, such as lightening strikes, pathogens, and environmental stress (McCune et al. 1988). Trees also differ in mortality rates based on species and, once dead, trees differ in how long they persist as snags (Moorman et al. 1999, Goodburn and Lorimer 1998).

Snags and cavity trees are important for wildlife, including high value/high profile species like the marten and pileated woodpecker. Some species of wildlife excavate their own cavities and are termed primary cavity users, while others, called secondary cavity users, rely on cavities formed by primary cavity users or those cavities that form naturally (Tubbs et al. 1987).

Bellhouse and Naylor (1997) and Naylor (1998a,b) estimated that in tolerant hardwood and conifer stands in the GLSL forest, about one-quarter of all birds and mammals use holes or cavities in trees for denning, roosting, resting, feeding or hibernating. In boreal northeastern Ontario, snags and cavity trees provide critical habitat for more than 40 species of wildlife, as well as habitat for mosses, fungi, insects, and other invertebrates (Watt and Caceres 1999).

OMNR (2004) provides an excellent description of how cavity trees are formed and their value to wildlife in the GLSL forest. In summary, cavities are generally found in either standing dead trees (snags) or in living trees that are declining (Fig. 3.2b). The type of cavity and the kind of tree a cavity occurs in varies. Cavities are usually formed by woodpeckers, branch mortality, or wounding. Cavity formation rate and cavity longevity is dependent on a number of factors including the species of tree, its size and vigour.

In boreal forests of northern Ontario, the density and diversity of cavity-users is thought to be related to large-diameter snag density (Spytz 1993).

In managed forests, the ‘stubbing’ of live trees is increasingly being used to emulate natural snag and cavity tree formation (Fig. 3.2c). Stubbing is done by cutting (and killing) a live tree well above the normal stump height (i.e., 3-5 m high).

Stubbing is recommended when the objective is to emulate some of the physical properties of a tree that died quickly during a catastrophic natural event (e.g., wildfire). In addition to enhancing windfirmness of the tree (i.e., stubs are less likely to be blown over than a canopied tree following clearcutting), stubbing of conifers has been found to benefit specialized species such as the three-toed and black-backed woodpeckers (which forage on recently killed conifers) and olive-sided flycatchers, as well as other more common species (Gyug and Summers 1995). Nappi et al. (2003) confirmed that black-backed woodpeckers prefer larger snags, and 5 m high stubs were preferred over shorter stubs.

**Fig. 3.2b. Examples of trees with existing cavities (Illustrations by Mandy Saile, photos by MNR).**

Stubs can also be actively used by cavity nesters, but Harris (2001) only observed nesting in reworked holes (existing cavities below the stub); no new nest holes were excavated in stubs he observed.

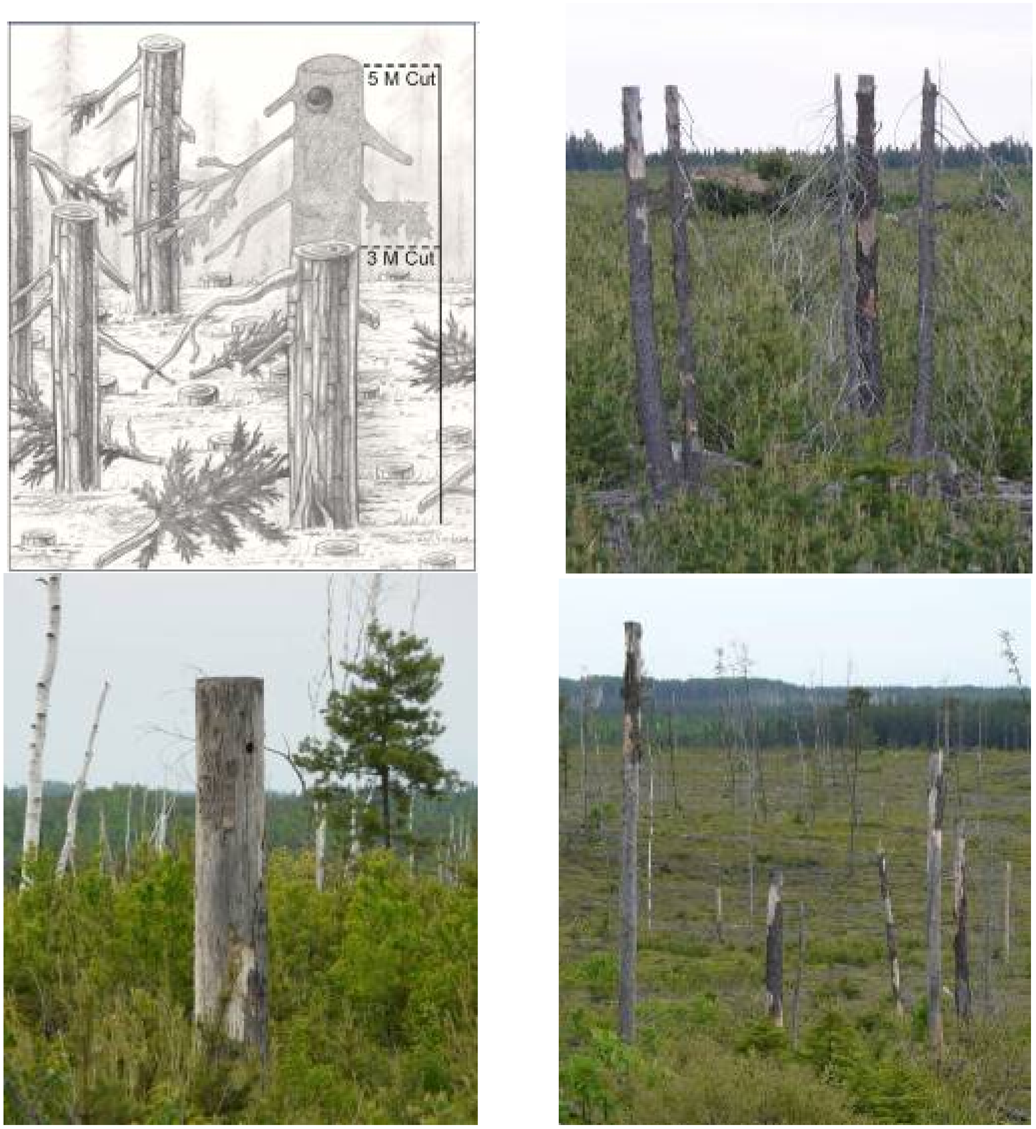


**Fig. 3.2c. Examples of stubbed trees (Illustration by Mandy Saile, photos by MNR).**

*Mast trees*

Mast trees (Fig. 3.2d) are trees that produce edible fruits. Mast is usually differentiated as hard mast (e.g., acorns, beechnuts, and hazelnuts) or soft mast (e.g., blueberries, black cherries, and wild raisins). Hard mast tends to always be of high importance, in part simply because of the size and volume of individual fruits and, in some instances, its greater seasonal longevity.
Mast is important food for the many species of small and large mammals and birds. Acorns are arguably the most important food resource for birds and mammals in a hardwood ecosystem (Martin et al. 1951). Fruit and seed production can be used to predict furbearer (especially marten) abundance (Fryxell et al. 1999), although seeds from coniferous trees are usually not included as mast. The abundance of hard and soft mast influences weight gain, reproductive rate, and cub survival in black bears (Rogers et al. 1988). Mast is also important to deer (Duvendeck 1962, Pekins and Mautz 1987).

In GLSL forests, Naylor (1998a,b) estimated that about 25% of the birds and animals consume tree mast. Species of tree, the size of tree, the position and condition of the crown, evidence of mast production, and use by wildlife are some of the variables that influence the importance of mast trees (OMNR 2004).

**Fig. 3.2d. Examples of red oak (left) and American beech (right) mast trees (Photos by MNR).**

*Supercanopy and veteran trees*

Supercanopy trees are large living trees that emerge above the main canopy of a stand (OMNR 2004) (Fig. 3.2e). Veterans are trees that survived a stand initiating disturbance such as a fire and eventually became supercanopy trees as the new stand regenerated (OMNR 2004) (Fig. 3.2e). In a managed forest, veterans are healthy dominant or co-dominant trees belonging to long-lived species (e.g., white pine, red pine, hemlock, red oak) that are retained at the time of harvest and are expected to grow for all or most of the next rotation, ultimately becoming supercanopy trees (or at least large snags and downed woody material).

Supercanopy trees create vertical structure in the forest and are important for a number of wildlife species, including bears and large raptors (DeGraaf et al. 1992, Rogers and Lindquist 1992). Supercanopy trees are also aesthetically desirable, and are often viewed as 'character' trees (OMNR 2004).

Supercanopy trees provide benefits to wildlife, and are thus considered for retention, in all silvicultural systems. Veteran trees, however, are only specifically addressed in shelterwood and clearcut silvicultural systems since a relatively continuous supply of healthy dominant and co-dominant trees is maintained as a regular outcome of the application of the selection system. Veteran trees may also function as mast trees (see above) or scattered conifers (see below). In unmanaged forests, veteran trees are likely to have scars or other injuries (because they are survivors of a catastrophic event such as fire or blowdown). However, when selecting veteran trees in managed forests, healthy relatively defect-free trees are preferred.

**Fig. 3.2e. Examples of veteran trees (conifers in top images) and supercanopy trees (conifers emerging from the hardwood-dominated canopy in the bottom image) (Photos by MNR).**

*Trees that contribute to species diversity and canopy structural diversity*

Scattered conifer trees in hardwood stands and scattered hardwood trees in conifer stands (Fig. 3.2f) are important components of habitat for 5-10% of the vertebrate species that inhabitat these forest types (Naylor 1998a, b). For example, in the GLSL forest, scattered conifers provide nest sites for black-throated green warblers and sharp-shinned hawks in tolerant hardwood forest (Naylor 1998a). Scattered hardwoods typically provide the best nest sites for pileated woodpeckers and northern goshawks in pine-dominated conifer forests (Naylor 1998b). Similar benefits are likely in boreal forest areas.

The number of wildlife species using a stand may be influenced by the vertical and horizontal structure of the tree canopy (MacArthur and MacArthur 1961, Roth 1976). Vertical structure describes the structure from the ground (e.g., herbs) through the understory layer (e.g., shrubs), through various mid-canopy layers (e.g., trees) to the upper reaches of the canopy (e.g., supercanopy trees). Horizontal structure describes the spatial arrangement (i.e., patchiness) of the vertical structure as you move through the stand (e.g., distribution of canopy gaps, residual patches, wildlife trees).

Trees that occur infrequently or are uncommon for the forest type of the area not only contribute to species diversity because of their presence, they also have an influence on the vertical and horizontal structure of the tree canopy in the stands they occur in. In this guide, trees retained as wildlife trees that occur infrequently or are uncommon for the forest type are referred to as ‘diversity trees’.


**Fig. 3.2f. Examples of a scattered conifer (hemlock) in tolerant hardwood forest (left) and a scattered hardwood (containing a stick nest) in conifer forest (right) (Photos by MNR (left) and Kandyd Szuba (right)).**

### Effects of forest management

Perera et al. (2004) found few studies that identified the causal factors and the contribution of potential factors which could help explain the observed variability in post-fire residual stand structure. However, their review did identify a wealth of literature documenting that tree mortality varies with fire intensity and tree characteristics, and that fire intensity seems to be the dominant factor contributing to post-fire residual tree mortality. Regardless, the number of residual trees (a combination of live, dead, and dying trees) left following a fire is generally large, often hundreds or even thousands of stems/ha.

Unlike a fire, forest management has the potential to remove (and historically, often did) most of the trees from a site (i.e., traditional clearcut logging), or change the structure of a natural forest as a result of selection cutting. In red pine forests in the Great Lakes states, Duvall and Grigal (1999) found clear-cutting virtually eliminated residual vertical structure, although the amount of coarse woody material was highly variable as a result of thinning schedules in individual stands. In northern hardwood forests, where selection or shelterwood silvicultural systems are used, the abundance of large snags, and the amount of downed woody material, tends to be much less than in comparable unmanaged stands (Goodburn and Lorimer 1998, McGee et al. 1999). Similar findings are reported as a result of forest management when the area in old growth forest is reduced (Fisvoll and Prestø 1997) and when comparing mature and old growth forests to intensively managed stands (Freedman et al. 1996).

A review of the biodiversity aspects of retaining living trees in clearcuts, as compared to traditional clearcutting, revealed no negative responses, and a number of positive responses by both plants and animals, with birds and ectomycorrhizal fungi benefiting most (Rosenvald and Lohmus 2008). The tree species retained and tree density helped contribute to the benefits that the retention of trees provided.

In the Pacific Northwest, the number of residuals (wildlife trees) and how quickly these trees become downed woody material has been found to vary as a result of many factors, including tree species, size, cause of death, soil type, climate, and disturbance regime (Morrison and Raphael 1993, Bull et al. 1997). Typically, snag fall rates in that region are initially low following mortality, then increase for a period of time before leveling off (e.g., Bull 1983, Landram et al. 2002). Interestingly, in red and white pine forests of the GLSL forest, Carleton (2003) found mid-successional stands to have the greatest abundance of snags and downed woody material.

NCASI (2005) did a literature review of old-growth forest definitions, including the relationship between wildlife species and old-growth stands in the boreal forest, and concluded that in the boreal forest, older stands provided maximum fitness for some wildlife species, with one of the factors contributing to the superior habitat fitness being the presence of dead and downed woody material on the ground. The presence of large-dimension material in later decay stages was also found to be related to old forests (e.g., Duvall and Grigal 1999, Kuuluvainen et al. 2001). In a Danish beech forest study, Heilman-Clausen and Christensen (2004) found the number of species of wood-inhabiting fungi increased significantly with increasing tree size and the majority of red-listed species (i.e., rare species) were only on trees with a dbh >70 cm.

Modifications to forest practices to influence structural changes at the stand level can result in a managed forest which more closely resembles a natural forest (Goodburn and Lorimer 1998). Although the actual number of residual trees in managed forests may be less than in natural forests, it may be possible to achieve desired ecological functions. For example, leaving 1 large residual tree/ha will allow hawk owls to effectively hunt any size of clearcut (as they would in a natural burn), whereas cuts with no residuals can be searched only within about 70 m of the forest edge (Sonerud 1997).

Retention of uncommon (for the stand type) or infrequently occurring trees can also help address ecological function. For example, by selectively retaining scattered conifers in hardwood forest, important refuge and bedding sites of black bears are provided (Rogers and Lindquist 1992) and bird diversity within the stand is increased (Naylor 1998a).

Residual trees, large dead and dying trees, trees with cavities, and wildlife trees in general, are important for martens, a species that requires large logs, stumps, and dead or declining trees during winter as resting sites (Lofroth and Steventon 1990). A suite of bird species depend on snags, particularly the high snag numbers which occur following wildfire (e.g., Schulte and Niemi 1998, Hobson and Schieck 1999, Hannon and Drapeau 2005). In Finland, populations of threatened saproxylic beetles benefited from the retention of live and dead aspen trees in clearcuts (Martikainen 2001).

The retention of individual trees or small clumps of trees within areas of operations during all stages of forest management is necessary to provide both short and long-term benefits for wildlife. When standing, trees may be used for cavities as well as perch, roost, and nesting sites for a wide variety of species. As trees die, fall down, or are blown down, and decay, they continue to provide habitat for wildlife. How long trees left for wildlife purposes stay standing may depend on a number of factors, including species of tree, tree diameter, stand density, agent of mortality, and silvicultural treatment (Garber et al. 2005). Managing for wildlife trees is also necessary to achieve objectives for downed woody material (Section 3.2.3.2).

Careful choosing of wildlife trees to achieve the ecological function(s) identified is important, especially since the number of such trees will usually be much less following harvest operations than after a natural disturbance. It appears the dissimilarities related to snag abundance and bird communities between post-harvest and post-burn forests tend to diminish after about 30 years (Hobson and Schieck 1999, Imbeau et al. 1999), but across many ecoregions, distinct differences remain with respect to species associated with snags (Zimmerling and Francis, in prep.).

Management and maintenance of wildlife trees is an important aspect of conserving biodiversity. In Sweden, where intensive forest management has a long history, leaving trees in post-harvest boreal forests for fungi and insects, has been recommended to address biodiversity concerns (Ehnström 2001). The retention of dead and dying trees is now being used there to help achieve new biodiversity-oriented silvicultural practices and certification requirements, although modeling suggests it may take 100 years in that country to achieve residual (wildlife) tree and downed woody material objectives (Ranius and Kindvall 2004).

The careful management of wildlife trees is an important part of maintaining a healthy forest ecosystem. Wildlife trees can help to achieve short and long term ecological functions of the forest, including the management of transient components such as the nests/dens of small birds and mammals. Considerations and decisions as to which trees to choose and use to achieve the objectives that have been identified for any particular forest stand is important regardless of the area or forest cover type where operations occur.

**Rationale for direction**

The retention of wildlife trees is largely to provide specific habitat attributes many wildlife species are known to require. However, wildlife trees can also be used to achieve general biodiversity objectives, which can help contribute to forest and ecosystem health. To help achieve these goals and objectives, the direction on how to manage for wildlife trees is arranged by silvicultural system and/or stage of management as follows: 1) conventional cuts in the clearcut silvicultural system, 2) cuts in the selection silvicultural system and preparatory and regeneration cuts in the shelterwood silvicultural system; and 3) removal cuts in the shelterwood silvicultural system and white/red pine seed tree cuts in the clearcut silvicultural system. Direction for each category has unique, but sometimes similar or identical *Standards, Guidelines,* and *Best Management Practices*. In areas where tree markers are used to select specific trees for harvest and retention, the direction is generally more complex than elsewhere. It should be noted the direction in the areas and silvicultural systems where tree markers are used was developed to complement (and in some cases update), rather than replace, direction found in the *Ontario Tree Marking Guide* (OMNR 2004).

In general, the silvicultural system used to manage a forest is a reflection of the major forest cover types, and this in turn is related to stand structure and stand dynamics. While some wildlife species can and do live in a broad array of forest types, others are much more specific as to their needs. The direction on wildlife trees is an attempt to recognize the different forest types of Ontario in concert with the needs of the species of wildlife found in those forests. The direction also strives to address the needs of habitat generalists as well as those species that have much more specific habitat requirements. Geography, as reflected by some species ranges, was also a consideration.

Wildlife trees are frequently retained based on their functional value as cavity trees, mast trees, scattered conifers, veterans, or supercanopy trees (see above for definitions). Whenever possible, trees that provide multiple benefits should be the trees chosen for retention (OMNR 2004). For example, oaks frequently have multiple values. In addition to being a mast tree (the maintenance of large dominant and co-dominant oaks is the best way to ensure mast production; McShea et al. 2007), a large healthy oak tree might be a veteran tree in a shelterwood removal cut.

When available, wildlife trees will need to meet minimum size and height requirements. In areas where selection or shelterwood silvicultural systems are used (i.e., GLSL forests), wildlife trees will generally be ≥25 cm dbh, reflecting the size at which cavity, mast, scattered coniferous, and veteran trees become most valuable to a range of wildlife species (see Tubbs et al. 1997, OMNR 2004, Holloway et al. 2007). Wildlife tree size requirements are generally smaller (i.e., ≥10 cm dbh) in areas where clearcut silvicultural systems are used (or where shelterwood removal cuts are planned), reflecting the smaller tree sizes normally found in the boreal forest and the catastrophic events these types of cuts are emulating.

When wildlife tree direction cannot be met with trees of the specified size range (i.e., available trees providing habitat functions such as cavities, mast, or conifer cover are smaller than the minimum size specified), use of smaller sized trees to achieve the direction is permissible. Availability will be based on the trees available on an individual hectare, within a harvest block, or in any given 20 ha sampling unit of a harvest block when the harvest block is ≥ 20 ha, dependent upon the direction.

Many of the requirements to retain wildlife trees (in all silvicultural systems) are based on a sampling unit of 20 ha. This is intended to recognize the natural variability that occurs in the forest, provide for flexibility during forest operations, ensure wildlife trees are reasonably well distributed, and can be accounted for during inspection.

Wildlife tree direction allows for the total number of wildlife trees retained on any given hectare, under any silvicultural system, to vary (minimums, however, do apply). Variation is encouraged in recognition that specific numbers of wildlife trees or patterns of wildlife trees do not appear to be correlated to site conditions or other factors.

Regardless of the silvicultural system or stage of management, no direction pertaining to the maximum number of wildlife trees to be retained following harvest has been provided, although large numbers of trees that sometimes remain following clearcutting have been a concern in some areas of the province. The reason no upper limits as to the number of wildlife trees are provided, is based partly on studies that show high numbers of post-fire snags. Ferguson and Elkie (2003), for example, reported a post-fire snag density of 263/ha (10 years post-fire). A more recent study in the boreal forest of Ontario and Quebec reported 600-2400 snags/ha, but at < 5 years post-fire (Harper et al. 2005). Both studies are not dissimilar to other studies of post-fire snag/density in Canadian boreal forests. As such, acceptable upper limits of the number of wildlife trees per hectare retained on sites following harvest operations are not provided in this guide. Instead, upper levels of trees left post-harvest should be related to direction in appropriate silvicultural guides (e.g., so as to allow for proper silvicultural practices).

**Clearcut silvicultural system**

| **Direction** | **Rationale** |
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| *Standard* - Retain an average of ≥25 stems/ha. | Wildfires leave hundreds to thousands of standing live and dead trees per hectare (see review in Perera et al. 2007). Reproducing the structure of post-fire stands is not economically viable or practically feasible. However, retention of some trees within harvested areas may reduce differences in animal and plant communities between harvested and burned areas (see above). Unfortunately, no studies identify a definitive threshold.<br><br>In the absence of a definitive threshold, an average of ≥25 stems/ha is prescribed based on the *Forest management guide for natural disturbance pattern emulation* (OMNR 2001). Some information suggests this number is likely reasonable. For example, Perera et al. (2008) found an average of 28 live trees/ha in recent burns in boreal Ontario. Moreover, the similarity of bird communities on clearcuts and burns in boreal Ontario was greatest when clearcuts had 20-30 live trees/ha (Zimmerling[1], unpubl. data). |

[1] Ryan Zimmerling, Bird Studies Canada, Port Rowan, ON

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| *Standard* - Retain an average of ≥10 large stems or large stubs/ha with a minimum of 5 large living trees on each hectare. | Since direction prescribed will retain far fewer stems/ha in harvest areas than would typically be found after wildfire (see above), it is imperative to ensure that trees retained provide the desired structure and function to help achieve biodiversity objectives. For example, retention of an average of at least 10 large, living trees or large stubs per hectare with a minimum of 5 large, living trees on each hectare will help achieve structural diversity and function, should increase the probability of retaining potential cavity trees, and will help provide a source of future downed woody material. Large stems are defined as ≥25 cm dbh based largely on the minimum diameter requirements of medium- and large-bodied cavity users (see Kirk and Naylor 1996, Watt and Caceres 1999). |
| *Standard* - Except in extraordinary circumstances, wildlife trees that fall to the ground, or are purposely felled for worker safety reasons, become downed woody material. | Regardless of the type of silviculture practised, once trees have been identified for retention, they will not be harvested or 'salvaged' if they fall down post-harvest. One of the reasons wildlife trees are retained is to provide a source of downed woody material. Martens, for example, require large logs, stumps, and dead or declining trees during winter as resting sites (Lofroth and Steventon 1990). It is recognized that some wildlife trees (and occasionally, most wildlife trees) will fall down naturally soon after harvesting, while others may stay standing for decades. |
| *Guideline* - Large wildlife trees will be a mix of living cavity trees, stubs, supercanopy trees, veteran trees, mast trees, diversity trees, and safe dead trees. The appropriate mix of large wildlife trees will be identified in the forest management plan and will be consistent with objectives established for the planning unit or area (e.g., management unit, LLP). | The direction, as provided, attempts to be flexible, effective, and efficient by permitting planning teams to identify the appropriate mix of large trees to be retained within a planning unit or area (i.e., living cavity trees, stubs, supercanopy trees, veteran trees, mast trees and diversity trees). Which trees are chosen will depend on availability and objectives for the area. For example, supercanopy trees like white pines and hemlocks are important for some species such as the black bear, that uses these trees for refuge, bedding, or escape and hiding cover for its cubs (Rogers et al. 1988). Large birds like eagles, hawks, and ravens also use supercanopy trees for nesting, perching, and roosting (DeGraaf et al. 1992, Rogers and Lindquist 1992, Grier et al. 2003). However, in some areas, supercanopy trees may not be generally.<br><br>Planning teams should retain a mix of wildlife trees that will emulate those aspects of stand structure and function associated with naturally-disturbed sites. For example, retention efforts might focus on stubs and safe dead trees in forest units that would typically have been severely burned and living trees in forest that would have been less severely burned. |
| *Guideline* - When the number of large wildlife trees averages <25/ha, additional wildlife tree requirements may be met by retaining small safe standing dead trees, small stubs, or any other living trees. | While large stems are likely most valuable to wildlife, any living or dead stems ≥10 cm dbh and ≥3 m tall provide potential nesting, perching, and feeding sites and a potential source of downed woody material within the regenerating stand. Small stems are defined as ≥10 cm dbh based on the minimum diameter used by small-bodied cavity-users (Tubbs et al. 1987). |
| *Guideline* - Wildlife | Some clumping of trees can be beneficial for some wildlife species. For |

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| trees will generally be well dispersed. Retain an average of at least 15 individual stems/ha; the remaining stems may occur in clumps. | example, clumps of trees as small as 0.25 ha appear to enhance bird density and species richness in cutovers (Gyug and Summers 1995). Gullion (1984) recommended leaving a small patch (0.1 to 0.2 ha) of undisturbed mature aspen trees for every 3 to 8 ha of clearcut to enhance ruffed grouse populations. Small clumps of trees in aspen clearcuts may also enhance overall bird populations on regional and landscape scales (Merrill et al. 1998).<br><br>However, other species, such as hawk owls, benefit from well-spaced individual trees that provide perches for hunting within recently disturbed habitats (Sonerud 1997).<br><br>Direction for retention of residual forest in large patches (≥0.1 ha in size) is provided in Section 3.2.2.2. Section 3.2.3.1 permits wildlife trees to be retained in both small patches (clumps) and as individual well-spaced stems.<br><br>A clump of wildlife trees consists of individual stems or coppice growth within an area <0.1 ha. If the number of trees in a clump exceeds 10, no more than 10 trees can be counted towards the wildlife tree requirement of 25 stems/ha. Groups of trees ≥0.1 ha may also contribute as many as 10 wildlife trees, provided the area does not meet the definition of residual forest (Section 3.2.2.2).<br><br>To encourage the retention of wildlife trees in both clumps and as individual well-spaced stems, at least 15 of the 25 wildlife trees/ha will be individual stems. |
| *Guideline* - Reasonable efforts will be made to avoid knocking down standing wildlife trees during renewal and tending treatments. | As standing trees have specific values (e.g., as perching habitat), it is important that reasonable efforts are made during renewal and maintenance activities (in all areas and under all silvicultural systems) to avoid prematurely knocking wildlife trees over.<br><br>To minimize the potential for early fall-down of wildlife trees, operators are encouraged to consider windfirmness when leaving any tree which is intended to be a wildlife tree. |
| *Best management practices* | *Best Management Practices* suggest a number of factors, such as species, size, and distribution pattern, that should be considered when deciding on which trees are to be left as wildlife trees. Generally, these BMPs are based on information which has been demonstrated as valuable to a particular species, or group of wildlife species, in particular areas (e.g., Rogers and Lindquist 1992, Naylor 1998a).<br><br>*Stubbing*<br><br>One way to minimize the amount of blowdown among wildlife trees - which often occurs shortly after harvesting - and extend the usefulness of a standing wildlife tree, is to practice ‘stubbing’. Hobson and Schieck (1999) noted the main difference between post-fire sites and post-harvest sites was the amount of standing dead and live trees. Stubbing will help minimize this difference (i.e., trees that are stubbed die quickly, similar to what occurs following wildfire). Stubbing is recommended as a BMP, although trees retained as mast trees, scattered conifers, veteran trees, or supercanopy trees, should not be stubbed. In general, stubbing of cavity trees should also be avoided. However, stubs with cavities low on the bole may continue to function as cavity trees.<br><br>Stubbing is encouraged when objectives include retention of standing |

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| | dead trees, and may be particularly beneficial when applied in clearcuts dominated by jack pine and black spruce. In addition to enhancing the wind firmness of these trees, the stubbing of conifers has been found to benefit an array of specialized species, such as the black-backed and three-toed woodpeckers. High stubs (5 m tall) are preferred over low stubs (3 m tall) because they provide higher perches, larger foraging surface area, are more likely to have cavities below the stub, and will contribute a greater volume of downed woody material.<br><br>The amount of stubbing needs to consider silvicultural objectives in addition to wildlife habitat objectives. Duckert[1] (pers. comm. 2008) suggested some shading from the forest canopy is desirable to provide for a better microclimate for seedlings and enhance soil microbial activity, particularly on very dry and sandy sites. This suggests site-specific objectives (which include those related to post-harvest silviculture) should be an integral factor when determining the relative number of living and dead (e.g., 'stubbed' trees) trees to be left as wildlife trees.<br><br>Another reason to practice stubbing is for safety reasons. Stubbing can help reduce the potential hazards to forestry workers and other people who use managed forests during and following harvest operations, as stubbed trees are short, do not have a crown, and generally have few if any large branches. These characteristics reduce the potential of the stem falling during strong winds or any other reason, and harming a person who might be in the vicinity.<br><br>Recently, Perera and Buse[2] (pers. comm. 2008) analyzed data on the patterns of occurrence and distribution of post-fire live tree residuals from burns in northwestern Ontario. In general, they found that there was tremendous variability in numbers of post-fire residuals as well as where post-fire residuals were found. In general, the numbers of standing post-fire residuals tended to be less in the centers of the burn as compared to near the perimeter, likely a reflection of fire intensity.<br><br>However, when leaving mostly jack pine and spruce stubs, try to have them scattered throughout the cutover to provide long-term roosting and perching sites, as stubs are likely to persist for extended periods of time. Where a mix of stubs and living wildlife trees are retained in clearcuts, a distribution pattern that 'clumps' areas with stubs somewhat separate from the living wildlife trees areas, may emulate wildfire intensity, and help provide some added diversity.<br><br>A wildlife tree can be killed by stubbing or tending operations (e.g., a live tree may be left on-site, but later killed as a result of herbicide application). This possibility is intended, in part, to reconcile the direction which requires retention of 5 large living trees on each ha with silvicultural decisions, particularly in areas where clearcutting is practised. Although aspens are often the large, living trees left in cutovers, these trees often experience breakage, and often die relatively soon after harvest operations have finished. But regardless of how they die, the main bole often remains windfirm and can continue to provide valuable habitats for a variety of wildlife. Further, early post-harvest mortality of aspens is consistent with observations of what occurs post-fire. Despite its thick bark, aspens are unlikely to survive |

[1] Dan Duckert, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON
[2] Ajith Perera and Lisa Buse, OMNR, Ontario Forest Research Institute, Sault Ste. Marie, ON

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| | more than a year after a fire (Hély et al. 2003). Aspens that do survive a fire tend to be large trees near the edge of the burned area (Haeussler and Bergeron 2004).<br><br>*Tree species selection*<br><br>Conifers are representative of the boreal forest and it is desirable that many of the wildlife trees retained be conifers. Spruces and pines, for example, can be expected to have a relatively long effective life-span as wildlife trees, compared to some common boreal hardwoods such as white birch.<br><br>In all forest types, but particularly in the boreal forest, trembling aspen is a preferred species to retain as a cavity tree. They grow large, are widespread in terms of distribution and a common tree in many areas. They are also favoured by a wide array of cavity-nesting birds (including pileated woodpeckers), as well as by bats and flying squirrels (Crampton and Barclay 1995, McDonald 1995, Peck and James 1983).<br><br>Lee (1998) found white birch snags, which in the past have commonly been used in the boreal forests of Ontario to help achieve much of the residual [wildlife] tree requirements, do not stay standing for very long, and therefore do not function as a snag or perch tree for long, as compared to other (conifer) tree species. Sturtevant et al. (1997) reported that most white birch trees that are left standing following harvest soon die due to rapid change in site water balance, and are vulnerable to wind throw. They thought white birch could serve as an important reservoir of coarse woody material during the early stages of stand development. However, they also observed both standing and fallen white birch trees as long as 60 years after disturbance. All observations combined suggest some wildlife trees, at least where clearcutting is practised, could and should be white birch.<br><br>Some tree species can have a particularly long-lasting forest legacy. Hemlock trees, for example, have been found to die, fall down, and become downed woody material at one-third the rate of other trees in old-growth hemlock-hardwood stands, while decaying at a rate of only one-half that of similar sized sugar maples (Tyrell and Crow 1994).<br><br>Some tree species may not have attributes that are known to be desirable, but such a tree may still be acceptable as a wildlife tree. For example, balsam poplar is thought to be the most fire resistant boreal tree species (Lutz 1956, Scotter 1972), although it is not generally recognized or identified to be a tree species particularly important for wildlife. However, retention of balsam poplar and other species with attributes that are not known or are poorly understood can still provide valid components of wildlife habitat and can help achieve biodiversity objectives, in part because any species of tree is a reflection of the stand in which it occurs. In concert with other attributes, any tree of any species can make a valuable contribution as a component of the suite of wildlife trees retained on any given site; for example, if the tree retained is large, regardless of the species, it will at the least have value as a roosting or perching tree, and in the future as downed woody material (and provide value as feeding or denning habitat). |

**Selection silvicultural system; shelterwood silvicultural system (preparatory and regeneration cuts)**

There is no requirement to retain a minimum of 25 stems/ha (as per direction for the clearcut silvicultural system) since normal silvicultural practices will leave many more than 25 stems/ha.

| Direction | Rationale |
|---|---|
| *Standard* - Retain an average of ≥10 living cavity trees or large stubs/ha with a minimum of 5 living cavity trees on each ha. | An average of at least 10 living cavity trees or large stubs will be retained per hectare to provide nest, roost, and feeding sites for cavity-using wildlife, and future dead standing trees and downed woody material (see above).<br>OMNR (2004) recommended retention of 6 living cavity trees/ha. This target was increased to 10 stems/ha based on a number of recent studies (Naylor[1], unpubl. data; Bavrlic 2008; see also Tozer 2010). Cavity trees can be a mixture of living trees and stubs to meet the diverse habitat requirements of cavity-using wildlife (see above). |
| *Standard* - Except in extraordinary circumstances, wildlife trees that fall to the ground, or are purposely felled for worker safety reasons, become downed woody material (see Section 3.2.3.2). | See rationale provided above for the *clearcut silvicultural system*. |
| *Guideline* - Wildlife trees will generally be well dispersed. Retain at least half as individual stems; the remaining wildlife trees may occur in clumps. | See rationale provided above for the *clearcut silvicultural system*. |
| *Guideline* - Retain an average of ≥10 mast trees/ha. | There is little information to suggest how wildlife respond to varying levels of mast tree retention. OMNR (2004) prescribed retention of 8 mast trees/ha based largely on the recommendation of Tubbs et al. (1987). This target was increased to 10/ha for consistency with other wildlife tree retention targets (cavity trees, scattered conifers, and veterans) used by tree markers in selection and shelterwood harvests. |
| *Guideline* - Retain an average of ≥10 scattered coniferous trees/ha. | OMNR (2004) prescribed retention of 10 scattered coniferous trees/ha based on research in Algonquin Park that suggested the diversity of songbirds, and in particular the abundance of blackburnian warblers and black-throated green warblers, was related to the number of large (≥40 cm dbh) conifers/ha in tolerant hardwood stands (see Naylor 1998a). As the density of conifer dropped below 10/ha, the abundance and diversity of songbirds declined noticeably, and declined precipitously when there were fewer than 5/ha. |

[1] Brian Naylor, OMNR, Southern Science & Information Section, North Bay, ON

| | |
|---|---|
| | Note - In conifer stands, scattered hardwoods provide important benefits for a number of species of wildlife (OMNR 2004). However, because hardwood trees are likely to be retained in most stands as either cavity trees, mast trees, nest sites, or 'diversity trees', there is no specific direction for scattered hardwood trees. |
| *Guideline* - Retain an average of ≥1 supercanopy tree/4 ha. | OMNR (2004) prescribed retention of 1 supercanopy tree per 4 hectares based on refuge tree requirements of black bear sows with cubs. |
| *Guideline* - Reasonable efforts will be made to avoid knocking down standing wildlife trees during renewal and tending treatments. | See rationale provided above for the *clearcut silvicultural system*. |
| *Best management practices* | In areas where the selection silvicultural system is used, in all phases of shelterwood management, and during white/red pine seed tree cuts, stubbing of some sound trees is encouraged (see rationale for the *clearcut silvicultural system*).<br><br>Large trees are generally more valuable to a diversity of wildlife species than are small trees. Thus, living cavity trees, large stubs, mast trees, and scattered conifers should be ≥38 cm dbh whenever possible. Supercanopy trees are generally most valuable when ≥60 cm dbh. See OMNR (2004) for detailed information on the characteristics that make trees good choices for retention as living cavity trees, mast trees, scattered coniferous trees, and supercanopy trees. Further to the direction in OMNR (2004), large hollow trees (especially those that could be used by nesting or roosting chimney swifts) are also to be considered high priority for retention as living cavity trees. |

**Shelterwood removal cuts; white/red pine seed tree cuts**

| Direction | Rationale |
|---|---|
| *Standard* - Retain an average of ≥25 stems/ha. | See rationale provided above for the *clearcut silvicultural system*. |
| *Standard* - Retain an average of ≥10 living cavity trees or large stubs/ha with a minimum of 5 living cavity trees on each ha. | See rationale provided above for the *selection silvicultural system*. |
| *Standard* - Retain an average of ≥10 veteran trees/ha; a minimum of 5 veteran trees will be retained | OMNR (2004) prescribed retention of 10 veteran trees/ha based on the number of trees that typically would have survived stand replacing disturbances in the GLSL forest (see Pinto et al. 1998).<br><br>See OMNR (2004) for detailed information on the characteristics that |

| | |
|---|---|
| on each ha. | make trees good choices for retention as veteran trees. |
| *Standard* - Except in extraordinary circumstances, wildlife trees that fall to the ground, or are purposely felled for worker safety reasons, become downed woody material (see Section 3.2.3.2). | See rationale provided above for the *clearcut silvicultural system*. |
| *Guideline* - Wildlife trees will generally be well dispersed. Retain an average of at least 15 individual stems/ha; the remaining wildlife trees may occur in clumps. | See rationale provided above for the *clearcut silvicultural system*. |
| *Guideline* - Retain an average ≥1 supercanopy tree/4 ha. | See rationale provided above for the *selection silvicultural system*. |
| *Guideline* - When the number of large living cavity trees, large stubs, veteran trees, and supercanopy trees averages <25/ha, additional wildlife tree requirements may be met by retaining safe standing dead trees, small stubs, or any other living trees. | See rationale provided above for the *clearcut silvicultural system*. |
| *Guideline* - Reasonable efforts will be made to avoid knocking down standing wildlife trees during renewal and tending treatments. | See rationale provided above for the *clearcut silvicultural system*. |
| *Best management practices* | See rationale provided above for the *selection silvicultural system*. |

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### 3.2.3.2 Downed woody material

**Background**

Downed woody material has many important ecological functions. It influences nutrient cycles through the storage of nitrogen and carbon, provides micro-sites for regeneration, contributes to soil formation, helps prevent erosion, provides horizontal habitat structure for wildlife, and helps maintain biodiversity (Harmon et al. 1986, Jurgensen et al. 1992, Bellhouse and Naylor 1996, Newmaster and Bell 2002, Zobrist et al. 2005). Downed woody material consists of both 'coarse' and 'fine' material.

In general, coarse woody material includes sound and rotting logs and stumps, while fine woody material includes branches and twigs. However, these categories are somewhat arbitrary and loosely defined. A literature review by Perera et al. (2004) found 12 reports on aspects of downed woody material in boreal forest landscapes in North America; these reports used an array of terminology and had varied size-definitions with little consistency or consensus as to the subject matter.

Maser et al. (1979) defined material larger than 7.5 cm in diameter as down woody material, which is the same size Hayden et al. (1995) identified as coarse woody material for use by MNR's Growth and Yield program. In addition to the diameter requirement, Hayden et al. (1995) defined coarse woody material to be above the soil, with or without foliage, and not attached to a standing live or dead tree. It could be lying on the ground, or have one or both ends suspended above the ground (e.g., supported by rocks, stumps, or branches of the piece itself). The definition of downed woody material used for this guide follows the general principles and description of MNR's Growth and Yield program.

Sources of coarse woody material include tree mortality and branch or top loss from live trees (Garber et al. 2005). The amount and characteristics of coarse woody material are a result of a number of environmental factors, which include habitat type, forest structure, site quality, site productivity, stand density, climate, geography, disturbance agents (e.g., fire, blowdown, insects, disease), decay organisms, and tree fall-down dynamics (Harmon et al. 1986, Feller 2003). One of the most important factors influencing short and long-term coarse woody material dynamics in Ontario's forests is a stand-replacing fire. Wright et al. (2002) described the typical succession of coarse woody material following a stand-replacing fire as follows:

> "During a stand-replacing fire, large amounts of biomass are converted from live to dead matter. While some biomass is consumed in a fire, much more is converted from live to dead and is carried into the subsequent stand. CWD [coarse woody material] is therefore highest just after such a fire. This material persists as the regenerating stand develops and usually is the dominant source until the live trees begin to provide woody material of a large size. As the pulse from the fire begins to decompose, CWD in the stand decreases, reaching its lowest level in the mature stand. CWD rises again in late succession as mortality from the regenerated stand increases. It levels off when mortality and decomposition reach a "steady-state.""

Following a wildfire, the amount, distribution, and kind of downed woody material (mostly coarse woody material) is a reflection of fire behaviour; fire behaviour itself is influenced by the weather, site conditions, and stand characteristics at the time of the fire (Johnson 1992, Whelan 1995). Fire regime (e.g., frequency and severity of fires) also has an effect on coarse woody material (Wright et al. 2002). While fine woody material is normally consumed by wildfires, nutritional elements such as potassium, magnesium, and calcium remain in significant quantities (OMNR 2001).

In managed forests, modifications to forestry practices are required to maintain an adequate supply of downed woody material (Bellhouse and Naylor 1996). In general, downed woody material in managed forests will result from forest practises that leave wildlife trees (which are a future source of downed woody material; see Section 3.2.3.1 for further information), and from activities discussed in this section which direct practitioners on management of existing downed woody material already present, or resulting from, forest operations.

**Effects of forest management**

In forests that experience stand replacing fires, there are periods with very high and periods with relatively low accumulations of downed woody material (Spies and Cline 1988). Compared to a fire, clearcutting tends to leave less downed woody material and fewer dead or dying standing trees, the major contributors to future downed woody material (Pedlar et al. 2002, Brassard and Chen 2006). Similarly, more downed woody material has been found in blowdown sites as compared to sites following clearcut logging (Price et al. 1998). In areas that have been clearcut, there is almost always less production and availability of downed woody material over time than in fire origin forests (Sippola et al. 1998). Managed forests that are 30-60 years of age tend to be structurally simpler than older stands, with lower levels of coarse woody debris (Andruskiw et al. 2008).

Brassard and Chen (2006) believed coarse woody material was the slowest forest component to recover following harvest so as to resemble a natural forest, although Frelich and Reich (2003) believed that if young harvested stands had the same structure as young natural stands, they likely could develop to resemble a natural stand. A number of studies have reported that over time (i.e., the time line starting at the time of the disturbance through to the old-growth stage), the amount of downed woody material in a forest is U-shaped when plotted against time since disturbance (e.g., Spies et al. 1988*,* Krankina et al*.* 1999). This pattern is supported by theory (Feller 2003). However, Ter-Mikaelian et al. (2008) in an analysis of coarse woody material data collected from permanent sample plots in boreal and mixedwood forests of Ontario, failed to find this U-shaped pattern of downed woody material accumulation. Real-world variables (e.g., weather events, particularly storms) were believed to blur the predicted pattern. Hély et al. (2000) found previous attempts to relate living basal area to the amount of coarse woody material yielded poor results.

While the ecological function of downed woody material is important, including the pattern of accumulation over time, for some aspects of biodiversity the amount and quality of downed woody material may be more important than the spatiotemporal distribution (Rolstad et al. 2004). Although Ter-Mikaelian et al. (2008) found downed woody material volume and mass to be highly correlated, the relationships between the volume of downed woody material and stand age, site index, and stocking were weak or nonexistent. Perera et al. (2008) reported the post-fire volume of downed wood did not appear to be associated with any of the site factors they considered (soil moisture, percent slope, aspect, distance to water, distance to wetland), and the variability in downed wood abundance was high for all site factors.

In areas where selection harvest is practised (e.g., tolerant hardwood forests where stand replacing disturbances are uncommon), downed woody material tends to occur in 20 year pulses (i.e., harvest operations occur in a stand about every 20 years). During the intervening periods, though, recruitment can be greatly curtailed if snags are knocked down (which commonly occurs) during the timber harvest (Bellhouse and Naylor 1996). In addition, Naylor[1] (unpubl. data) found there was a greater volume of downed woody material in recent and old cuts, as compared to old forest, again attributed to the input of slash and the knocking down of snags during selection harvest operations. However, in white pine-dominated forests managed using shelterwood harvest, the greatest volume of downed woody material occurred in old forests (and not in recent cuts), likely because of the relatively high utilization of conifer tree crowns. Vanderwel (2005), using simulation modelling, suggested that the pattern of recruitment of downed woody material

[1] Brian Naylor, OMNR, Southern Science & Information Section, North Bay, ON

in white and red pine forests differs between burned stands and stands managed using shelterwood harvesting.

In boreal forests, tending, is apt to lower the overall volume of downed woody material, decrease the number of large downed logs, and increase decomposition rates (Brassard and Chen 2006).

The availability of large downed woody material in the early stages of stand development is mostly dependent on stand history (Spies et al. 1988). As the stand ages, the contribution of standing forest structure, stem growth, and tree mortality become increasingly important (Harmon et al. 1986). However, the length of time any particular log lying on the forest floor retains its ecological value will depend on a number of factors, including the size of the log, the species of tree, and the microsite it lays on (e.g., Tyrell and Crow 1994, Heilmann-Clausen and Christensen 2004).

In much of the boreal forest, mechanized full-tree logging is the preferred harvesting system. Typically, this involves roadside delimbing, which produces large quantities of slash at roadsides and landings, often resulting in loss of productive forest land (for further information, see Section 5.2.4 Loss of Productive Land) and creating a significant fire hazard (Luke et al. 1993). As such, slash piles are generally perceived as undesirable. In the boreal forests of Ontario, attempts to re-distribute the slash to the forest have generally produced unsatisfactory results, and usually, excess slash piles are burned. The growing interest in use of slash as biofuel could have a substantial impact on slash and downed woody material management if operationalized. In Swedish clearcuts, Rudolphi and Gustafsson (2005) reported that approximately 70% of the slash volume is presently removed, as well as one of six naturally fallen logs >15 cm in diameter, primarily for use as biofuel.

To minimize differences between managed and natural forests, retention of existing downed woody material and the future recruitment of downed woody material from wildlife trees will be required to achieve downed woody material objectives.

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Stems retained as wildlife trees (Section 3.2.3.1) that fall down, or are felled for worker safety reasons, become downed woody material and, except in extraordinary circumstances, will be left on site. Moving such trees for silvicultural purposes is permitted. | In managed forests, wildlife trees (Section 3.2.3.1) are likely to be one of the most important factors in the provision of continual supply of downed woody material. For this reason, any tree that was retained as a wildlife tree during any stage of forest operations will normally be left on site, regardless of when it falls down. Although the management of downed woody material is closely associated with maintenance and management of wildlife trees, managing downed woody material itself during all stages of forest operations is also required.<br>Downed woody material plays a major role in ecological processes including nutrient cycling, carbon storage, accumulation of soil organic matter, erosion control, and the maintenance of biodiversity (e.g., Maser and Trappe 1984, Harmon et al. 1986, Maser et al. 1988, Pedlar 2002, Janisch and Harmon 2002). Vanderwel (2005) summarized the wide variety of organisms that used downed woody material, which included micro-organisms, fungi, an array of invertebrates, reptiles, amphibians, birds, and mammals.<br>Numerous avian and mammalian species, ranging in size from shrews to bears, use downed woody material for such purposes as display, |

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| | nesting, denning, hiding, and feeding (e.g., Bellhouse and Naylor 1996). Pileated woodpeckers spend up to half their foraging time on downed woody material (Bull and Holthausen 1993). Coarse woody debris is believed to provide marten with sensory cues which help them locate small mammals, their primary prey (Andruskiw et al. 2008). None of these ecological functions provided by downed woody material should be adversely affected by the provisions that allow for movement of downed trees during harvest, renewal, and tending. |
| *Guideline* - Downed trees (or pieces of trees) present prior to harvest will be left on site (moving such trees for silvicultural purposes is permitted); where windstorms or other natural events (e.g., snow, ice) have recently caused damage to stands, trees leaning and downed by the recent disturbance, which normally would have been available for harvest, may be harvested and utilized. | Traditional logging practices leave proportionately more horizontal structure (i.e., downed woody material) than vertical structure (i.e., wildlife trees), but when compared to fire, the amount of downed woody material is still less (Lee et al. 1997).<br><br>The direction to leave downed wood (trees and pieces of trees) already present on the site will: help retain important sources of organic material and nutrients; provide a measure of protection regarding erosion; and, provide important habitats for some species of wildlife, plants (e.g., cryptogams), and insects (e.g., see Ehnström 2001). There is also evidence that harvesting of dead wood is not cost effective. Nader (2007) reported the harvesting of sound deadwood in an overmature stand reduced machine productivity, increased harvesting costs, and may have introduced undesirable decayed wood into the wood production system. As a general practice, leaving downed woody material addresses both ecological and economic concerns.<br><br>Notwithstanding the direction to leave downed wood (trees and pieces of trees) already present on-site, at the site, harvest or movement off-site of leaning and downed trees is acceptable in stands that are scheduled for harvest and have recently been subjected to substantial damage from a natural event, such as a windstorm or an ice storm. The intent is not to provide for the harvest of an individual or a few trees that have died or blown over, but to provide for management of downed wood that would normally have been available for harvest, being mindful of operational realities and wasteful practices, and to address forest health considerations. These situations (e.g., non-salvage harvest following ice-storm damage) will be assessed on a case-by-case basis. In areas identified for salvage harvest, the direction in Section 6.1 will apply. |
| *Best management practices* | By considering how forest operations at any stage of management may affect the amount, volume, and kind of downed woody material, maintenance of the ecological role of downed woody material can be addressed. For example, by avoiding the crushing, windrowing, or smothering of large, downed woody material during all phases of forest operations, the value of the downed woody material will less likely be concentrated temporally or spatially and areas suitable for tree regeneration will be retained. Leaving unmerchantable logs, or unmerchantable portions of logs on site, at the stump, rather than piling them in slash piles or roadside where they may be available for fuelwood (or other purposes) is desirable, as the downed woody material can continue to have value over time as the stand grows and matures. Leaving downed woody material on site is also a suggested operational practice to be followed when standing dead trees are lowered to the ground for safety considerations. While these trees will normally be left on site, it is recognized that some dead trees in some types of harvest situations (e.g., when using feller bunchers) will be |

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| | brought to landings. The ability to identify recently dead trees that may show little or no signs of decay is limited in mechanical harvest operations. Difficulty increases when visibility is reduced during night and winter operations.<br><br>By providing breaks in long windrows of material where they do occur, access and ease of movement for large mammals, humans, and equipment operators across the right-of-way to forest lands is accommodated.<br><br>Downed woody material at roadside that cannot be re-distributed, or otherwise utilized (e.g., the material may be targeted for biofuel production), may be burned (see Luke et al. 1993 for details), releasing some nutrients and providing for prime tree growing space. Some slash may be beneficial to some types of wildlife. Small brushpiles have been used as a technique to provide habitat on private lands such as orchards, where ground cover may be lacking (OMNR 1986). In these types of habitats, it has been suggested that retention of 2-10 brushpiles/ha is appropriate. |

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### 3.3 Fine Filter Adjustments

Background information and rationale for the management of habitat for species requiring fine filter adjustments at the landscape scale are provided in this section. Where identified, further direction and information regarding these species at the site level is provided in Section 4 and related appendices and/or background information and rationale. The species with specific, landscape level direction in this portion of the guide are white-tailed deer, moose (Fig. 3.3a), and 'other'. The direction for species not addressed in this section, but requiring landscape level direction, is provided elsewhere (see Sections 3.3 and 4.3. for details and explanations). It is anticipated that direction for woodland caribou will be provided in the *Boreal Landscape Guide.*

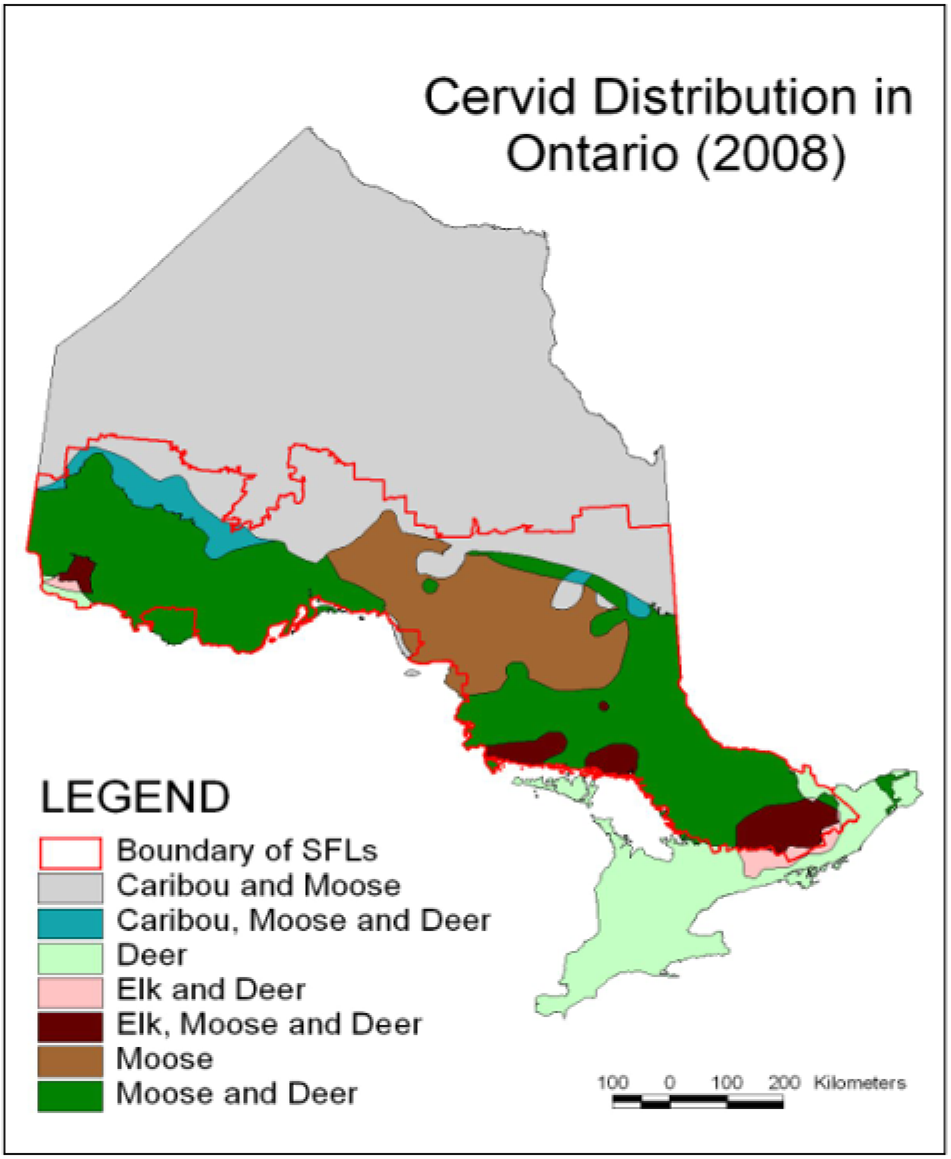


**Fig. 3.3a. Distribution of elk, moose, white-tailed deer, and woodland caribou in Ontario. (Adapted from OMNR 2009[1])**

[1] OMNR. 2009. Cervid ecological framework. OMNR. Queen's Printer for Ontario. Toronto, ON.

### 3.3.1 Marten and pileated woodpecker

At the stand level, martens require habitat that provides dens, resting sites, foraging habitat, abundant prey, and protection from the elements and predators (Watt et al*.* 1996). Maternal dens are usually associated with cavities in dead or living trees or fallen logs (Martin and Barrett 1983, Hargis and McCullough 1984, Wynne and Sherburne 1984). During summer, martens typically rest in the crowns of large conifer trees in mature conifer forest (Wynne and Sherburne 1984). During winter, resting sites are typically beneath the snow (Thompson 1986). Winter dens are usually associated with large logs, stumps, and dead or declining trees (Lofroth and Steventon 1990). The abundance of downed woody material may also influence marten hunting success and habitat suitability; large logs, hummocks, and stumps are critical components of habitat for small mammals such as red-backed voles (Gunderson 1959, Raphael 1988) and also provide access to subnivean space for hunting (Corn and Raphael 1992, Sherburne and Bissonette 1994).

Pileated woodpecker stand level habitat requirements include attributes which provide feeding, nesting, and roosting sites (Kirk and Naylor 1996). Pileated woodpeckers feed on a variety of insects (primarily carpenter ants and the larvae of wood boring beetles) throughout the year, and on fruits and nuts in the autumn (Bent 1939, Martin et al. 1951, Kirk and Naylor 1996). Pileated woodpeckers forage for insect food on or in dead trees, trees in declining health, and downed woody material by gleaning, bark pecking, and making excavations into sapwood or heartwood (Bull et al*.* 1990). A new nest is excavated each year in a dead tree or a living tree with advanced heart rot (Conner et al. 1976). Although trees and logs representing a range of sizes are used for foraging, large diameter material (≥25 cm) is preferred (Kirk and Naylor 1996). Large diameter trees are also used for nesting; trees ≥40 cm dbh seem to be preferred (Kirk and Naylor 1996). Roost sites, used to conserve energy and avoid predation, are generally in large diameter (≥40 cm dbh) hollow trees with multiple entrances (Naylor et al*.* 1996).

Landscape level requirements of martens and pileated woodpeckers are addressed by the coarse filter direction in the Landscape Guide. Stand level requirements are addressed by the coarse filter direction in Sections 3.2.3.1 and 3.2.3.2 of this guide. Thus, there is no fine filter direction for either species in this guide.

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### 3.3.2 Wolverine

At the time of writing this guide, the wolverine is listed as a *threatened* species in Ontario.

Large, remote landscapes with abundant prey populations (mainly woodland caribou and/or moose) are primary considerations for managing viable populations of wolverines. Wolverines have low reproductive potential and are sensitive to human disturbance, especially with respect to den site selection. Natal and maternal dens are selected, in part, to avoid humans and predators during the denning and kit-rearing periods. In general, there is a lack of information and knowledge regarding specific wolverine habitat requirements in Ontario.

Ontario has the most eastern viable wolverine population in Canada, believed to be concentrated in northwestern Ontario, roughly from Red Lake – Sioux Lookout north to Fort Severn – Peawanuck. The habitat needs of wolverines, including their need for large remote wilderness areas and abundant food supply, will be addressed in forest management planning primarily by: providing appropriate landscapes through application of landscape level guides; implementing the appropriate fine filter ungulate habitat adjustments found in landscape level guides and this guide; and, applying fine-filter protection to known denning sites. For additional background and rationale related to the protection of individual den sites see Section 4.3.7.1.

### 3.3.3 White-tailed deer

#### Background

| | |
|---|---|
| S-rank | S5/G5 |
| Status | Game Mammal (Schedule 2) in the *Fish and Wildlife Conservation Act 1997* |
| Trend - CDN | Increasing |
| Trend - ON | Increasing; rate of increase locally variable |
| Distribution | White-tailed deer are widely distributed in Ontario (see Fig. 3.3a). They are common throughout the GLSL forest region and much of the southern edge of the boreal forest region. They are less common to absent in the northern boreal, including the deep snow regions north of Lake Superior. During periods of successive mild winters, populations can increase dramatically and occupied ranges can expand far into the boreal forest region. Population crashes and range retraction typically occur after a series of harsh winters. |
| Habitat and biology | This section is largely a summary of a more thorough discussion on deer habitat requirements in Ontario by Voigt et al. (1997).<br>*General*<br>Although the habitat needs of deer can be listed simply as food, cover, and water, interactions with habitat are very complex. In brief, energy derived from plant food is required for movement, survival, growth, and reproduction. Cover also plays a key role in determining energy costs, and provides access to food resources and protection/escape from predators. During the summer months, deer use energy for antler development, lactation, and body growth. Deer will eat up to 4 kg (dry weight) of green plant material each day (Holter et al.1977). Even with an abundance of green food, deer are extremely selective, choosing high protein, high energy, highly digestible food types (Nudds 1980). Deer have physiological constraints for food digestion and consume only a small percentage of the total quantity of plant biomass (Hanley et al.1989), usually the growing tips and succulent shoots of herbaceous plants and forbs (Swift 1948).<br>For efficient digestion, deer switch diet continually as different plants grow, develop, and flower. Grasses are usually not well digested except in the spring and fall, when they are quite palatable and are heavily consumed, along with legumes and other fresh greenery (McCaffery and Creed 1969, Rogers et al.1981).<br>In the fall deer begin to accumulate fat reserves to help supply energy during the winter months (Verme and Ozoga 1980, Severinghaus 1981, Hobbs 1989). High energy, high carbohydrate food sources are sought. Green plants, such as clovers that grow even after heavy frosts are important as are high carbohydrate mast crops like acorns and beech nuts. Accumulations of fat on deer reflect the length of the fall season and the quality and quantity of fall food (Mautz 1978). During the rut, from November into December, bucks may eat little but use much energy pursuing does. It is not uncommon for prime bucks to deplete their fall accumulation of fat at this time (Sauer 1984, Broadfoot and Lintack 1991).<br>During the winter months, deer in most of Ontario must subsist on a diet of browse. This is a relatively low quality food comprised of the woody twigs of deciduous trees and shrubs, and conifer leaves, such as cedar and hemlock. |

Browse is low in protein and energy and high in fibre (Ullrey et al.1964, 1967; Mautz et al.1976). Even with an unlimited food supply, deer on a winter diet of browse will lose weight because the digestion of high fibre food requires a great deal of energy (Verme and Ullrey 1984, Gray and Servello 1995).

In northwestern Ontario, arboreal lichens (*Usnea* spp.) are an important food supply. Hodgman and Bowyer (1985) believed arboreal lichens, principally *Usnea* spp. and *Evernia* spp., compared favourably with other winter forages with respect to crude protein and available energy, which accounted for their heavy use by wintering deer in Maine. Gray and Servello (1995) believed *Usnea* could be important winter forage for deer owing to its relatively high digestibility when compared to hardwood browse.

During winter, deer reduce their activity and food intake, and are able to lower temperatures in their extremities (Verme and Ullrey 1984). Reduced activity and food intake results in a lowering of metabolism (Silver et al.1969, Mautz et al.1992, Worden and Pekins 1995). On a winter diet of woody browse, fat reserves can be used to balance energy requirements for about 3 months (Worden and Pekins 1995). A winter extended by only a few weeks can significantly reduce the survival of deer (Verme 1968).

In summary, the seasonal biology and habitat needs of deer dictate a diversity of habitat types. Seasonal needs can only be met on a single parcel of land by provision of a variety of habitat types, interspersed with early and late successional stages.

*Seasonal Migration*

A major adaptation of deer to winter conditions in Ontario is seasonal migration. At the onset of winter, deer in most areas of Ontario migrate to winter concentration areas, commonly called yards. These areas are characterized by the presence of conifer forest, which intercepts snowfall (Hanley and Rose 1987), provides shelter from wind, and helps conserve energy loss through radiation.

The presence of conifer is also beneficial to deer because it enhances their ability to access winter food. Irregular terrain and other physiographic features, fallen trees, and dense forest also help deer conserve energy by providing shelter from wind chill. Concentrations of deer result in the establishment of a network of trails and runways that help reduce energy costs and provide escape routes from predators.

Some studies have suggested that deer migration to winter concentration areas has evolved to reduce the chance of predation (Nelson and Mech 1981, Messier and Barrette 1985).

Winter concentrations of deer are established in traditional locations in Ontario. Many areas, particularly in the eastern and central portions of the province, have apparently suitable winter habitat that is not used. Since does return each year to the same winter area accompanied by their fawns, the establishment of new areas is difficult. During mild winters, deer concentrate less and appear reluctant to enter the core areas of yards. Thus, winter concentration areas are used differently each year depending on winter conditions. After a series of mild winters, the establishment of new yarding areas can be expected if food and cover is suitable and predation is not limiting (Broadfoot and Voigt 1996b).

Most deer delay moving into yards until after the snow cover builds to about 20 cm. Thus, in much of Ontario, deer do not enter the yards until about the 3rd or 4th week in December. In early winters, entry to yards may occur before December or in late winters it may not occur until mid-January. The exodus of

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| | deer from yards is delayed until there is only a few centimetres of snow left on the ground. Thus, the dates vary from late March until mid-April (Broadfoot and Voigt 1996b) in central Ontario, to late April in northwestern Ontario.<br><br>Summer dispersion areas can be 7-10 times larger than the winter concentration area, i.e. winter yards comprise only 10-15% of the summer dispersion area (Broadfoot and Voigt 1996b).<br><br>*Carrying capacity, reproduction, and mortality*<br><br>Carrying capacity is a concept basic to wildlife management. Carrying capacity (K) for a population of deer is defined as the maximum number of deer an area can support on a sustained basis, i.e., without detrimental effects on the habitat (Voigt et al.1992). The carrying capacity on any given area is dynamic because it varies as the requirements of deer and resource supplies change (Moen 1973; McCullough 1979, 1984). Deer herds above carrying capacity will consume more food than grows each year which eventually results in a decline in food, carrying capacity, and deer numbers.<br><br>Many factors affect carrying capacity, but the key variable is the amount of food that is available and accessible to deer. Browse that is not accessible to deer does not contribute to carrying capacity. An accurate measure of carrying capacity considers constraints on processing slow-to-digest woody browse, reduced energy requirements of deer, the supply of fat reserves, and the use of thermal cover to conserve energy.<br><br>If the energy needs of deer and the energy supplied by available food can be estimated, carrying capacity can be calculated from the amount of usable forage available divided by individual deer intake (Broadfoot and Voigt 1996a). Since Ontario deer migrate between winter and summer range, they respond to a winter carrying capacity (Kw) and a summer carrying capacity (Ks). Summer and winter carrying capacities are very different because of food quality, quantity, and accessibility, as well as seasonal energetic costs. Because of the high reproductive capability and time-lags in responses of deer and vegetation, it is common for deer numbers to irrupt and overshoot carrying capacity (McCullough 1987). In a stable environment, deer numbers would oscillate around year-round carrying capacity, but, very few environments remain stable for long.<br><br>Habitat has a major influence on deer reproduction. Adult does breed first around mid-November followed by yearling does in late-November and fawn does in early December. At high densities, deer may not be bred until the 2nd or 3rd estrous, resulting in late born fawns with a reduced chance of survival (Ozoga and Verme 1982).<br><br>The percentage of fawn and yearling does that breed depends on their physical development, which is primarily determined by food supply during the growing season, but is also influenced by length of the growing season and conditions during the growing season (Verme 1967). Day length may also have an influence on when, or which, does ovulate (Verme and Ozoga 1987).<br><br>Although some residual effects on doe nutritional status occur after long, severe winters (Mech et al. 1987), the reproductive performance of does is primarily determined by the nutritional value of food obtained on summer range (Verme 1967), as well as the age of the doe.<br><br>The size of the herd in relation to the carrying capacity of the summer range is a major determinant of reproductive rate or gross productivity. The conception rate of does in the fall is a function of their condition or fitness. As density of does increases, the reproductive rate declines, since there is relatively less food available per deer. Theoretically, the reproductive rate would drop to zero if deer |

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| | ever reached 100% of summer carrying capacity.<br><br>Although there is much variation in the quality and quantity of summer range in different areas of Ontario, deer herds are at a relatively low percentage of summer carrying capacity compared to winter carrying capacity. Reproductive rates for Ontario deer suggest that during the summer, densities of deer vary from less than 10 to 50% of summer carrying capacity, since embryos per adult doe vary from about 1.0 to near 2.0. The percentage of fawns that breed varies from 0 to 60%; this is a further measure of summer range and growing conditions. Breeding of fawns often ceases when herds are at 40% of summer carrying capacity (Broadfoot and Voigt 1992).<br><br>Fawn breeding may be related to the weight of fawns during the breeding season. If fawns fail to reach 36 kg, they seldom breed (Moen 1973). Other factors such as day length also affect fawn breeding and may override good summer conditions at northern latitudes (Budde 1983). Doe reproductivity during the mid-1980s for the Algonquin Region suggests that those herds were at about 30% of summer carrying capacity.<br><br>Summer range also has a major effect on antler development in bucks. Since antlers and number of embryos per doe are both affected by summer range, it is not surprising that they are correlated (Severinghaus and Moen 1983). Measurements of the beam diameter of yearling bucks can be used to predict the reproductive rate of does on the same summer range. Yearling antler beam diameters can be used to estimate the percentage of summer carrying capacity that the herd is at (Broadfoot and Voigt 1992).<br><br>Although summer range of deer affects gross reproductive rate, nutritional levels of does (determined by habitat and weather) during the winter can also affect productivity. A long severe winter may have its greatest effect on the survival of newborn fawns. Small, weak, undernourished, and underweight fawns die within a few days or weeks of birth (Verme 1977). Depending on winter severity, the percentage of the fawn crop lost to postnatal mortality may vary from as little as 10% to as much as 70%. This postnatal mortality may be an even greater effect of severe winters than direct mortality due to malnutrition of wintering deer. However, does that lose their fawns at birth may be in much better condition for breeding in the fall of that year (Verme 1967).<br><br>Natural mortality of deer is also affected by deer density in relation to habitat carrying capacity. Since adult deer density during the summer months is low in relation to carrying capacity, adult mortality is also quite low. However, fawn mortality during the summer may be high. It is well documented that predation on fawns by coyotes, wolves, and bears occurs (Mech 1984). Studies indicate that the magnitude of fawn predation is highly variable, ranging between 0% and 80% of total summer fawn mortality. It is quite likely that some of the fawns consumed by wolves and bears are those that died shortly after birth, or fawns that would not have survived. This complicates the assessment of the effects of fawn predation on deer population dynamics. Major causes of summer mortality are road-kills, other accidents, predation, and illegal kills (poaching). These mortality factors usually amount to only 3-7% of the annual mortality of adults (Voigt et al.1992).<br><br>Winter densities are very high since deer concentrate on areas about 10-15% as large as summer dispersion areas (Broadfoot and Voigt 1996b). During winter, the food supply is also much reduced. The consequence of these two factors is that winter carrying capacity is lower and the deer herd is much closer to winter carrying capacity. In many parts of Ontario deer are at 80 to 120% of the carrying capacity of yards during normal winters. Deer populations living at 120% of the winter carrying capacity will incur a winter mortality rate of about 16%. |

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| | Major causes of mortality are starvation and predation (Voigt et al.1992). Fawns from the previous summer are most affected by winter conditions and adult does are least affected.<br><br>Winter food supply has a major effect on winter survival. The amount of available browse (kg/ha) is steadily depleted as winter progresses while body weight declines as fat and muscle tissue are used. Although there is considerable variation between areas and among individual deer, generally there is a rapid increase in mortality rate 10-12 weeks after winter starts in yards with relatively low food supplies (Hobbs 1989). |
| Effects of forest management | Over time, deer habitat, intricately linked to forest succession, is dynamic. In a managed forest, the challenge is to recognize how the form and function of the forest is constantly shifting, and, with respect to deer, ensure their habitat requirements are met. In the absence, or in addition to natural disturbances, forest operations have great potential to influence the amount and quality of deer habitat. For example, forest harvesting can result in an increase in forage, which can benefit deer and result in an increasing population. However, the removal of critical winter conifer cover can reduce winter carrying capacity, and lead to population declines. To ensure forest operations occur in a manner to allow for deer habitat to be managed in a sustainable fashion, a thorough understanding of the effects of forest management on deer habitat is required.<br><br>*General range management*<br><br>During the summer, deer are largely unrestricted in terms of the habitat they occupy. However, deer show preference to early successional forests, or forests with numerous openings. In general, deer will thrive when the summer range has a high proportion of the forest in early successional stages. Conversely, older, relatively undisturbed forests with few openings are generally poor deer habitat, and have a low summer carrying capacity.<br><br>Early successional forest and other forest openings are favoured by deer because they contain a high proportion of herbaceous plants, preferred food during the snow-free months. On summer range, harvest operations are generally beneficial to deer regardless of the silvicultural methods used, and following harvest, there is usually a substantial increase in woody and herbaceous plants.<br><br>However, some types of harvest operations on some deer summer ranges may not provide deer with substantial benefits. For example, selection harvest results in openings in the forest canopy, but unless these openings are of sufficient size, they will not produce a significant increase in the amount of forage. When large tracts of hardwoods are managed under the selection system to maintain a high component of older trees, summer carrying capacity will be relatively low. If the residual basal area is about 12 $m^2$/ha after cutting, good browse conditions will be created, but, if a higher basal area is maintained (i.e., >18 $m^2$/ha), the quantity of browse produced will be much lower.<br><br>Group selection will result in an increase in plant diversity and forage compared to single tree selection. Group selection can also be valuable in managing stands to produce hard mast. When available, hard mast, principally acorns and beechnuts, can dominate a deer's fall and winter diet (Harlow et al. 1975, Johnson et al. 1995). The best mast producers are large, full-crowned, and vigorous trees with a dominant position in the canopy. Often the best producers are only 50-75 year old trees with direct sunlight on the crown.<br><br>Commercial, moderately tolerant species that can be managed using group selection that are also important in the production of mast and/or deer forage, |

include yellow birch, black cherry, white ash, oaks, and red maple. In addition, group selection harvest also allows for the development of numerous non-commercial forage species, including soft mast species such as raspberries.

Unlike group selection, single tree selection limits plant diversity to shade tolerant species. However, it is the preferred system for regenerating American beech, a primary mast producer.

Large clearcuts on a unit of land may produce an abundance of summer forage, but the interior of very large clearcuts (e.g., cover-to-cover distance >400 m) is generally assumed to be used little by deer, despite the abundance of forage (Thomas et al. 1979, Roseberry and Woolf 1998). An abundance of large clearcuts can also create a boom and bust phenomenon in forage supplies and result in large changes in range use occupancy by deer. Smaller clearcuts scattered over the same unit of land will show a similar forage response, with higher use and a less dramatic impact on deer home range.

*Winter concentration areas*

During the winter months, most deer in the forest regions of Ontario are restricted to particular portions of the landscape that provide conditions conducive to their survival. Called winter concentration areas or yards, these tend to be traditional areas where food (browse) and cover (a conifer canopy), and other environmental conditions, are optimal for winter survival, particularly when snow depths exceed a critical depth of about 50 cm. In Ontario, deer winter concentration areas are about 10-15% as large as summer dispersion areas (Broadfoot and Voigt 1996b). Forest operations, particularly if harvest is scheduled during the winter months in deer winter concentration areas, can provide deer with food from the tops of felled hardwood trees or lichens from the upper crowns of conifers. Small harvest operations spread over a number of winters tend to be less disruptive and likely more beneficial than larger operations conducted over a 1 or 2 year period followed by a number of years with no proposed operations.

Forest operations in winter deer yards can also have negative effects. Portions of large clearcuts in or adjacent to winter concentration areas could remove too much conifer cover, and despite an increase in browse in the cutover, it may be inaccessible to deer when snow is deep. Similar situations can occur in areas where selection or shelterwood silviculture is practiced. Regardless of the silvicultural system used, if logging removes too many conifer trees, deer may be unable to move freely among resting and feeding sites.

Renewal and maintenance operations are also of concern to deer habitat management within winter concentration areas. Similar to the impact of a large cutover, if there is too great a shift from conifer to deciduous dominated stands, the lack of conifer canopy may no longer provide for, or allow deer, to access resting and feeding sites when snow is deep.

Renewal of cedar and hemlock can be problematic in deer yards. Although these species provide the best winter cover, they are also favoured as browse. Heavy feeding by deer can result in a complete loss of the target crop species, and a failure to achieve the desired future forest condition. Renewal of cedar and hemlock stands is most difficult in the core of a deer yard (Stratum I), when deer populations are high, or when and where deer can access the regenerating stand.

It may be undesirable to have roads, particularly permanent roads, built through deer wintering areas. Roadkill may be substantial, although unlikely to be a factor at the population level (Forman and Alexander 1998). A permanent road will, however, result in permanent loss of habitat.

*Special concerns*

Some renewal and tending practices, such as chemical release and tending, and prescribed burns, also need to be considered when deer habitat management is an objective. For example, use of some herbicides can result in the lush growth of annuals such as grass and raspberries which can potentially improve summer range condition. However, herbicides can also result in a loss of browse biomass, which might be a concern in winter concentration areas where browse production or improvement is an objective. Although the quantity of forage usually declines with treatment, applications of glyphosate and triclopyr (commonly used herbicides in Ontario) tend to result in improvements to forage quality (Lautenschlager et al. 1999). The greatest effects on deer habitat from herbicide use are during a 4 or 5 year period following application.

The abundance of arboreal lichens may be impacted by forest operations. Harvest operations in rich boreal mixedwood stands, where lichens are often abundant in the crowns of conifers like spruce and balsam fir, can be beneficial to deer when harvest operations are scheduled during the winter (deer feed on the lichens during felling operations). However, forest operations, including tending treatments, can substantially reduce arboreal lichen abundance (Newmaster and Bell 2002). Harvest strategies that retain large conifers in cutovers, and limited use of aerial application of herbicides, can mitigate long-term, negative impacts (Bell[1], pers. comm.2008). In addition, conversion of boreal mixedwood stands to spruce, pine, or hardwood forest units could impact arboreal lichen abundance over the long-term, particularly if balsam fir is eliminated or managed as a very minor component of the stand (*Usnea* spp. thrives on dying and dead balsam fir).

In Ontario, deer abundance and distribution has generally been increasing in recent years. Especially on the northern fringes of their range, these increases are believed to be largely the result of forest management practices and a general trend to milder winter conditions. Increasing deer abundance can have adverse effects on moose, caribou, and elk as a result of disease transmission (e.g., meningeal worm) and by supporting higher predator (e.g., wolf) populations. Increased deer populations even in the core of deer range can be viewed negatively, because of depredation on farm crops, gardens, and increased occurrence of vehicular collisions.

Irrespective of the quality and quantity of deer habitat available, deer populations can be, and often are, affected by a number of other factors. Disease and parasites, predation rates, hunting influences, accidents, and the vagaries of weather (including climate change) can all substantially affect deer populations. Although habitat can exacerbate or mitigate the extent of population change as a result of non-habitat factors, the magnitude of the effect habitat has is variable. For example, deer densities have been found to be greater along wolf pack territorial buffer zones than in wolf pack territory centers, even though there did not appear to be any difference in deer habitat within or outside the buffer zones (Mech et al. 1980). However, in the area where this phenomenon was identified, a deer population decline had begun in the part of the region where deer habitat was poorest (Mech and Karns 1977).

It is possible to enhance summer range by seeding, planting, and fertilizing openings (Voigt et al. 1997). Usually, preferred species for seeding openings include white Dutch and red clovers and birdsfoot trefoil. For a variety of reasons, it may be preferable, when and where available, to use seed mixtures

[1] Wayne Bell, OMNR, Ontario Forest Research Institute, Sault Ste. Marie, ON

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| | of native herbaceous plants. Inoculated seed should be sowed on good sites. Grass-clover mixtures may be required to establish ground cover on poor sites. Grasses and legumes should be seeded at a rate of at least 0.6 kg/ha; rates as high as 2.0 kg/ha will produce a better vegetation cover. Fertilizers may be required to establish cover depending on soil and site conditions. Cool-season forages should be sown in late winter (on snow) or early spring if ground conditions are known. Alternatively, late August to early September seeding should be attempted. Fertilizers can also maintain a desirable forage crop if applied every 3-5 years. Fertilization is not currently approved for use as a forest management tool on crown lands. |

**Rationale for direction**

Deer have long had high social and economic value in Ontario, and the management of deer and deer habitat also has a long history in the province. In Ontario, white-tailed deer are at the northern limit of their distribution and can survive only if rather exacting habitat requirements are met. Management of deer habitat recognizes the social and economic importance of deer and is consistent with objectives to conserve biodiversity.

The management of deer habitat flows from the coarse filter direction provided through application of the *Landscape Guide*. In forest management, the priority areas where specific deer habitat management practices will be followed will be within areas identified by the *Landscape Guide;* generally, LLPs with an objective to manage important winter deer habitat will contain deer winter concentration areas (deer yards). An LLP with an objective to manage deer habitat may contain one or several deer yards.

Within and outside an LLP with an objective to manage deer habitat (and generally where deer habitat management is a consideration on the MU), winter and summer range should be identified and assessed in the context of the wider planning unit of which the MU is part. Planning teams will consult with the local wildlife manager who will determine the need to maintain, enhance, or reduce habitat suitability for deer on the MU. The manager will make that judgment on the basis of an evaluation of the deer population targets for the relevant wildlife management units (WMU's), and translate those habitat requirements into management objectives for the MU. For the most part, in areas outside of LLPs with an objective to manage deer habitat, deer habitat concerns will be accommodated through coarse filter guidance within the *Landscape Guide*.

Deer population targets are established through Ontario's deer management system and are linked to the quantity and quality of suitable habitat available. The wildlife manager responsible for deer management for the WMU and/or the MU will advise the planning team of the need to maintain, improve, or reduce the suitability of winter or summer habitat.

While much of the direction is specific to a particular stratum of deer habitat, deer populations and use patterns change over time. During the 1970s, populations on Ontario's forested deer range were generally low, but by the end of the 20th century, populations were generally high. When deer populations are high and winter conditions mild, habitat may not be limiting, but such a situation can quickly change. After only one or two severe winters, a catastrophic deer decline can occur, which is what happened in central Ontario in the late 1950s and in northwestern Ontario in the mid 1970s. Together, the direction in this section will accommodate changes in deer use of winter habitats due to changes in populations and/or habitat.

In addition, the direction provided here should help provide deer populations with sufficient, suitable habitat to mitigate effects of severe weather, and/or recover after a population decline occurs and more favourable conditions return.

*Guidelines* are provided on the use of silvicultural practices in the GLSL and boreal forest regions to manage the diverse range of conditions which constitute deer habitat in Ontario. Forest operations are encouraged in all areas, including winter concentration areas, with an understanding of the dynamic nature of forest succession, and that forage, thermal cover, and deer use patterns can and will shift over time.

Much of the direction focuses on maintenance of conifer cover in winter concentration areas in recognition of how coniferous trees enhance winter habitat by providing thermal shelter and intercepting snowfall, which allows deer to conserve energy, retain mobility, and access food supplies (Hanley and Rose 1987).

However, each deer winter concentration area is unique, as can be the objectives of the local deer management strategy. As such, a flexible approach to deer habitat management is required. Sometimes, normal operations suffice: for example, if the objective is to increase browse in tolerant hardwoods, standard selection cutting (18-20 m² residual BA/ha) produces as much browse over time as heavier cutting, due to more frequent returns to harvest the same stands (Whitlaw et al. 1993).

Rationale for direction is described below:

| Direction | Rationale |
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| *Standard* - Silvicultural prescriptions will be consistent with deer habitat management objectives. | Silvicultural ground rules must ensure that sufficient habitat is produced to meet population objectives. |
| *Guideline* - For stands within the deer winter LLP, mapped as Stratum I, and managed using the clearcut silvicultural system, harvest in cutblock sizes of 30-60 ha, or in configurations where conifer stand cover-to-cover distances do not exceed 200 m. | In deer winter LLPs where clearcutting is the dominant silvicultural system practiced, the appropriate interspersion of food and cover can be produced by harvesting in relatively small blocks that maximize edge. In parts of deer range where snow depth routinely exceeds 50 cm, such as central Ontario, deer will rarely travel >30 m from winter cover to feed and clearcutting in small patches (<1 ha in size) or narrow strips (<100 m wide) is typically recommended (e.g., Smith and Borczon 1981, Voigt et al. 1997, Naylor 1998b). However, in areas that receive less snow, such as northwestern Ontario, deer may travel up to 100 m from thermal cover to feed and cutblocks 30-60 ha in size or with cover-to-cover distance <200 m have been recommended (Voigt et al. 1997). |
| *Guideline* - If available: i) maintain at least 10-30% of Stratum I area as critical thermal cover (conifer-dominated stands with specific characteristics) dispersed throughout the stratum. The percentage of critical thermal cover within the stratum will be a | In winter, deer seek dense, mature conifer forest that intercepts snow, blocks wind, and retains warm air at night. This 'thermal cover' provides deer with an area that has a lower depth of denser snow, higher mean nighttime air temperatures, and lower daily temperature fluctuations than found in surrounding more open forest stands (Verme 1965, Pruitt and Pruitt 1987). This reduces energy expended by deer to feed and stay warm, thus increasing chances of survival (Voigt et al. 1997).<br><br>Within Stratum I of each deer winter concentration area, stands providing thermal cover will be identified and those required to meet the needs of deer (i.e., critical thermal cover) will be delineated.<br><br>All conifer forest (except that dominated by tamarack) has some value as thermal cover. However, good thermal cover is generally |

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| target associated with the deer habitat management strategies applicable for the management unit; or, ii) where an assessment of critical thermal cover has not been done, maintain a minimum of 30% of Stratum I area as a critical threshold of conifer-dominated stands, with the conifers providing a minimum canopy closure of 60% and a minimum average height of 10 m. | represented by stands in which the conifer component is ≥10 m tall and provides ≥60% canopy closure (Voigt et al. 1997). Conifer species vary in their relative value as thermal cover and tend to rank as follows: hemlock, red spruce, and cedar (high value); white spruce, white pine, and balsam fir (moderate value); and red pine, jack pine, and black spruce (low value) (OMNR 2004).<br><br>There is little research to suggest how large patches of thermal cover must be. Older sources recommended thermal cover be maintained in patches 0.4 to 2.0 ha in size (e.g., Telfer 1978); more recent sources recommend patches at least 10 ha in size (e.g., NBNR 2004).<br><br>There is also little research to suggest how much thermal cover is required in deer yards. Numerous sources recommend 50% of each deer yard be retained as thermal cover (e.g., NSDLF 1989, Reay et al. 1990, Anonymous 1997). It is suggested that at least 10-30% of the forest in deer yards be identified as critical thermal cover based on the recommendation in OMNR (2004). The exact amount of critical thermal cover to maintain will depend on deer yard carrying capacity (K) and associated objectives and targets. For example, a deer yard with a target K of 10 deer/km² may only need 10% critical thermal cover. In contrast, deer yards with a target K of 20 deer/km² will likely require 30% critical thermal cover. |
| *Guideline* - Where practical and feasible, and where it is consistent with the applicable silvicultural ground rules (SGR), schedule harvest operations within Stratum I and II for the winter season. | Harvest operations within Stratum I and II of the winter concentration area should occur mostly during the winter, when practical and feasible and consistent with the applicable silvicultural ground rule. This ensures deer can forage on browse or lichens from felled trees at a critical time of year, which may be particularly important during years of heavy snow loading, a failure of the mast crop, or both. |
| *Guideline* - When harvesting stands within Stratum I identified as critical thermal cover, follow the direction in Appendix 3.3. Where the information required to implement the direction in Appendix 3.3 is lacking; maintain a minimum conifer canopy closure of 60% and a height of the conifer component of at least 10 m, or other prescriptions approved by MNR. | Stands identified as critical thermal cover within Stratum I of deer winter concentration areas may be deferred from harvest. Alternatively, in some situations, partial harvest may be used to increase food supply and thus habitat suitability, as long as the appropriate amount and dispersion of canopy cover is maintained (OMNR 2004).<br><br>Appendix 3.3 outlines the types of silvicultural practices acceptable in stands when the objective is to maintain thermal cover based on forest type. This direction is based largely on Voigt et al. (1997), Naylor (1998a,b), and OMNR (2004).<br><br>The management of conifer cover in Stratum II may also be a consideration, both to provide access to the core of the yard, as well as to be accommodating to changes in deer-use patterns of the yarding area over time. |
| *Guideline* - When | Recently harvested areas may be an important source of browse for |

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| harvesting stands within Stratum I that are not identified as critical thermal cover, but are an important source of browse, follow the direction for maintaining access cover in Appendix 3.3. | deer (see above). However, since deer rarely travel >30 m from cover when snow depth exceeds 50 cm, much of the food in recently harvested areas may be inaccessible.<br>To facilitate foraging within recently harvest areas, retention of *access cover* (i.e., clumps of at least 3-5 conifer trees ≥10 m tall with interlocking crowns spaced no more than 60 m apart) is prescribed in Appendix 3.3. This direction is based largely on Voigt et al. (1997), Naylor (1998a,b), and OMNR (2004). |
| *Guideline* - If the amount of critical thermal cover in Stratum I is less than 10%, the long-term silvicultural objective will include increasing the conifer component to at least the minimal requirement (i.e., 10%), provided the increase in conifer cover is consistent with: i) site conditions, ii) the long-term management direction for the management unit; and iii) the applicable deer management strategy (e.g., associated wildlife management unit targets). | It is assumed that at least 10-30% of the forest in Stratum I should be comprised of thermal cover (see above). Thus, it follows that long-term silvicultural objectives should include an increase in the amount of thermal cover when the current level is <10%. |
| *Guideline* - Where deer over-abundance has been identified as a chronic occurrence, and: i) eco-regional analysis has identified deer winter habitat as abundant (e.g., >15% of the summer range; this analysis is an MNR responsibility); and ii) a reduction in the amount of deer winter cover can be achieved while keeping within the applicable Simulated Ranges of Natural Variation (SRNV) for Landscape Guide indicators; then consider reducing the | In some geographic areas, deer populations have been consistently high for many years. High deer numbers are increasingly being viewed as either undesirable, or as a nuisance. If the WMU and/or the MU has a high population of deer and habitat supply analysis done through Ontario's Landscape Tool provides an assessment suggesting an abundance of suitable winter deer habitat (yards), consideration should be given to at least temporarily reducing the amount of winter deer habitat (e.g., reducing the amount of area with suitable conifer cover in Stratum 1 in a large yard, or eliminating small 'satellite' deer yards). Such consideration should be directed to conifer-dominated winter habitats where the conifer canopy is deteriorating due to the age of the stands and where regeneration of the dominant conifer canopy tree is hindered because of deer foraging behaviour (e.g., cedar-dominated deer yards). Management of some species favoured by deer for cover and forage (e.g., cedar) has been largely ineffective in the presence of high deer densities (Anderson 1992, Miller 1992, Rooney et al. 2002). Reduction of the amount of conifer generally recognized as beneficial to winter deer populations should effectively reduce deer numbers, at least until conifer regeneration has advanced to an age and/or height where deer foraging is not detrimental to continued growth (i.e., 20+ years of age). |

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| amount of suitable winter deer habitat. Where feasible and desirable, this long-term objective can be accomplished by scheduling clearcutting of conifer stands to reduce the conifer component of Strata I and II to below 10%, with mature conifer stands also reduced to <60% canopy closure. | |
| *Guideline* - In northwestern Ontario, if operations are proposed in bur oak stands, or in stands which contain bur oak trees, maintain the bur oak component. These forest stands may also be remnant patches of natural grassland habitat (see Section 4.3.1). | Hard mast (acorns and beech nuts) are recognized as foods deer consume heavily in those years when a seed crop is abundant. Maintenance, development, and enhancement of mast-producing stands within and adjacent to deer winter concentration areas is important, but special direction is not required here (except for bur oak stands in northwestern Ontario), as mast tree management is sufficiently accommodated in Section 3.2.3.1 and in general by selection and shelterwood silvicultural systems.<br><br>In northwestern Ontario, the only relatively common oak is the bur oak, which regionally is characteristically small and scraggly and of no commercial importance. However, this species contributes to biodiversity in the region and is an important mast producer for deer (and other wildlife). Care needs to be taken to ensure any harvesting of bur oaks for fuelwood or other reasons, is consistent with deer habitat objectives and sustainability of related habitats (e.g., natural grassland remnants; see Section 4.3.1). |
| *Guideline* - The development of use management strategies for roads in areas where there is an objective to emphasize deer habitat will: i) consider deer management goals; and ii) avoid building primary (permanent) roads in the core of a deer winter concentration area (i.e., Stratum I). | While harvesting in winter deer concentrations is desirable, and necessitates road construction, primary (permanent) road construction through the core of a deer yard is discouraged. Permanent roads remove suitable forest cover from the area permanently. In addition, roads in areas with high deer densities will likely result in costly deer-vehicle collisions. |
| *Best management practices* | Creation and maintenance of openings is a goal of deer habitat management based on numerous studies of deer in forested habitats. Openings are known to provide deer with preferred summer and cool-season forage; the percentage of 10-15% of openings represents what has been found on many central Ontario forested deer ranges.<br><br>Since creation and maintenance of openings is expensive, |

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| | management for openings should be in areas where natural openings are uncommon, or when combined with other objectives (e.g., beaver pond management). Sites created by other development such as powerline or pipeline rights-of-way, or log landings can also receive priority for treatment. Idle fields with unsuitable forage or shrub invasion should receive priority before creation of new openings expressly for deer. Maintenance and enhancement of openings will normally be accommodated by partnership arrangements with interested parties.<br><br>Long-term maintenance of openings is generally achieved through suppression of woody vegetation and promotion of cool-season deer forage such as grasses and legumes. Seeding (and fertilizing) of roadbeds and log landing with suitable seeds may be required to obtain the desired condition. Although clovers are often the preferred choice of seed, it should be noted most common clovers (e.g., White Dutch, red) are not native species, although they are now considered ubiquitous and naturalized in most of Ontario. Use of native seed mixtures can be used to address biodiversity initiatives or other concerns, but are not always available. |

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### 3.3.4 Moose

#### Background

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| S-rank | S5/G5 |
| Status | Game Mammal (Schedule 2) in the *Fish and Wildlife Conservation Act 1997* |
| Trend – CDN | Stable to increasing (Timmermann 2003) |
| Trend - ON | Stable provincially; locally, may be stable, increasing, or declining. |
| Distribution | In Ontario, moose are found predominantly in the boreal forest region, but they also occur in much of the GLSL forest region (See – Fig. 3.3a). In the boreal forest, moose may occur symaptrically with woodland caribou. In southern portions of the boreal, and most of the GLSL, moose and white-tailed deer often co-exist. Moose also co-exist in parts of Ontario with elk.<br><br>Two sub-species of moose are found in Ontario. The northwestern moose (*Alces alces andersoni*), occurs in the northwestern portion of the province, while the eastern or taiga moose (*Alces alces americana*) occurs in the eastern and central portions. An area of overlap between the two sub-species occurs in the Nipigon/Pukaskwa region (Peterson 1955, Wilson et al. 2003). |
| Habitat and biology | *General*<br><br>Moose use of habitats is highly variable. A large number of factors influence how much area any individual moose or a population of moose, will occupy over time. The age and sex, time of year, habitat quality, quantity and distribution, and ambient weather and climatic conditions are only some of the variables that affect spatial and temporal moose movements (Hundertmark 1998). There is evidence that moose use of some feeding habitats is related to the amount of edge available (e.g., Allen et al. 1987, Mastenbrook and Cumming 1989).<br><br>Moose are termed an ‘early successional species’ and tend to thrive in areas associated with recent disturbances. In Ontario, early successional forests are created by disturbances such as wildfire, blowdown, insect infestation, and forest harvesting. Such forests are usually synonymous with abundant supplies of browse, residual patches of forest, and nearby areas of conifer cover. These forests provide moose with food, suitable microclimates, and shelter from weather and predators, including hunters.<br><br>Relatively high moose populations have been found in forested areas with a mosaic of vegetation types providing a high interspersion of cover and forage (Rempel et al. 1997). When habitat is not homogenous (e.g., the stands providing year-round habitat requirements do not have a relatively uniform distribution across the landscape), moose may be seasonally migratory to meet year-round habitat requirements (Addison et al. 1980).<br><br>Overall, in much of the boreal forest, moose are strongly associated with post-fire habitats. Although each fire event is unique, fire in general results in an abundance of high-quality forage, which in turn leads to increased use by moose. Moose use of burned areas tends to rapidly increase about five years after a fire. Kelsall et al. (1977) concluded that the optimal successional stage for moose in the boreal forest occurred 11 to 30 years after a burn. Once browse production begins to decline in burned areas, use by moose also |

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| | declines.<br><br>The GLSL forest region has a mix of forest communities with a wide range of disturbance regimes. Some forest communities that occur in both the boreal and GLSL have similar, high frequency disturbance regimes (e.g., spruce and balsam fir forests), but other common GLSL communities have disturbance regimes that are much less frequent (e.g., maple and hemlock have been calculated to have a catastrophic event, on average, about once every 1000 years; Canham and Loucks 1984, Whitney 1986, Frelich and Lorimer 1991).<br><br>As a result of the great interspersion of community types with widely varying disturbance regimes, large catastrophic events (e.g., large fires and blowdowns) occur much less frequently in the GLSL forest than in the boreal forest. In general, vegetative communities in the GLSL forest are longer-lived and more stable than those of the boreal forest, and large expanses of early successional forest are relatively rare.<br><br>Owing to their large size and colouration, moose, wherever they occur, have thermoregulatory needs, which reflect upon their behaviour and choice of habitats. Warm temperatures, rather than cold temperatures, are thought to be the most stressful to moose (Schwartz and Renecker 1998). Winter ambient air temperatures greater than -5°C and summer temperatures in excess of 14°C result in moose restricting movements and seeking habitat types where wind and/or water help reduce heat discomfort (Renecker and Schwartz 1998). Murray et al. (2006) speculated that with climate change (warming), moose distribution may become more restricted where climate and habitat conditions are marginal, especially where deer are abundant and act as reservoir hosts for parasites.<br><br>*Spring, summer and autumn*<br><br>In late spring, summer, and early autumn, moose feed extensively on the leaves of a wide variety of deciduous plants. They also use aquatic plants whenever they are available, as these plants may provide nutrients or elements (e.g., sodium) that are uncommon in terrestrial plants (Fraser et al. 1984).<br><br>During summer, when food is most abundant, moose spend little time traveling to find food (Renecker and Schwartz 1998). Many kinds of plants are consumed and moose are relatively non-selective. However, the forest development stage influences moose use of summer habitat. For example, the leaves of plants growing in shade tend to have both a higher protein and water content, and fewer secondary compounds (which can function as an anti-herbivore defense mechanism) than those of plants growing in direct sunlight (Regelin 1971, Hjeljord et al. 1990), and are thought to be more palatable to moose. Conversely, some deciduous plant species that flourish in productive, open habitats (e.g., rich sites that have been recently harvested or burned), can be abundant, grow rapidly, and may also rely little on chemical defense mechanisms (Bryant et al. 1991).<br><br>Favoured moose feeding areas may be somewhat self-perpetuating. Browsing of birch, for example, results in an increase in nitrogen concentration and leaf size, and a decrease in leaf toughness and concentration of carbon-based secondary metabolites (Bryant et al. 1991).<br><br>Riparian habitats, which may or may not be influenced by fire and are often associated with alder and willow communities, can provide moose with both food and cover. Riparian habitats that are periodically flooded (e.g., creek or river floodplains) are often long-lived communities that can provide stable and dependable feeding habitat for moose, and are especially important to moose |

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| | when other terrestrial habitats are sub-optimal. Beaver activity can also create habitat conditions beneficial to moose (Boer 1998).<br><br>Habitat conditions may also be important with respect to calving and nursery habitat. Moose seek secluded areas to give birth to calves, and the selection of habitat characteristics that can reduce the risk of predation may increase calf survival rates (e.g., Addison et al. 1990, Langley and Pletscher 1994). Calving site fidelity by cow moose could be related to past reproductive success (Welch et al. 2000). Cows with calves tend to be found where forage is dense (Thompson and Vukelich 1981), but isolated and secure habitats may be selected at the expense of abundant forage (Peek 1998).<br><br>Moist, cool habitats are needed to provide thermal relief from summer heat. During heat spells, feeding may be restricted to nocturnal hours, when temperatures are coolest. Heat stress in summer is believed to interfere with feeding, and have a greater effect on weight gain, than cold stress does during winter (Schwartz and Renecker 1998).<br><br>*Winter*<br><br>Regardless of their origin or the forest region in which they occur, early winter feeding habitats are usually relatively open areas with abundant and nutritious browse. In unmanaged forests, burns, particularly in the boreal forest, are often the areas which are most attractive to moose. Similar and important moose habitats can also result from blowdown, insect damage (e.g., widespread spruce budworm epidemics) or other factors. Moose can also show preference for very old forests, which are transforming into new, young forests through simple vegetative succession.<br><br>In Ontario, early winter feeding habitats have been described by Jackson et al. (1991) as being characteristically burns, blowdowns, cutovers, insect-damaged forests (typically spruce budworm-ravaged stands with a high balsam fir component) or mature to over-mature, mixedwood stands with relatively low canopy closure (<60%) and a dense understory of shrubs and immature conifers.<br><br>Other habitats (e.g., riparian habitats dominated by willow) can also be good early winter moose feeding habitat.<br><br>As winter progresses, moose become more dependent upon conifer-dominated habitats. Conifer cover ameliorates stress from warm temperatures and reduces snow depth and hardness, resulting in travel that is less energy demanding (Kelsall and Prescott 1971, Peek 1971).<br><br>Winter foods are almost exclusively the current annual growth on the twigs of woody plants. Preferred woody browse in Ontario includes dogwood, willow, aspen, birch, hazel, red maple, mountain ash, and several species of viburnums. In the GLSL forest, sugar maple and hemlock are also preferred. Moose may use but do not feed heavily upon alder, cedar, or pine. Other browse species, such as balsam fir, may be of importance to some local moose populations (Zach et al. 1982).<br><br>Which plant species moose prefer, and why some sites are favoured feeding areas over others, is believed to be at least partially in response to plant defenses against herbivory. Slow growing species, and plants growing on poor soils with low light availability, are more likely to invest in carbon-based defenses (e.g., lignins, tannins, and terpenoids), according to the resource availability hypothesis of Coley et al. (1985).<br><br>Winter is very energy demanding for moose, yet the nutritional value of woody browse is much less than the green forage used during summer. However, |

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| | moose metabolic rates and movement patterns are much reduced during winter, which helps to conserve energy. Stores of body fat also help to meet the energy demands of winter. Moose, with their large body size, good insulation and very long legs, are well adapted to survive conditions of prolonged, extreme cold and deep snow. When snow depth exceeds about 60 cm, moose movements become restricted (Jackson et al. 1991). As snow depths approach 90 cm moose tend to become confined to closed-canopy conifer habitats and reduce daily movements (Coady 1974, Thompson and Vukelich 1981).<br><br>Habitats where moose congregate when winter and snow conditions are adverse in the boreal forest tend to be large stands of mature conifer with high canopy closure. In the GLSL forest, dense pockets of conifer (especially hemlock) used by moose, tend to be much smaller. Presence of food is also a likely consideration, but moose appear to derive more benefit from the structure of winter habitat than any other factor. Dense conifer habitats provide moose with complete overhead protection from snow accumulation and relief from cold winds. However, Cook et al. (1998) reported finding no study that established thermal cover as an enhancement to ungulate survival in winter.<br><br>A dense conifer canopy has been speculated to provide thermal relief on warm, sunny days in late winter and early spring. Renecker and Hudson (1986) determined the upper critical temperature in winter for moose (between -5° and 0°C), was often exceeded in late winter. Ambient daytime temperatures in dense conifer stands are considerably cooler than in open areas on warm, sunny, late winter and early spring days. |
| Effects of forest management | Forest management activities interact with moose populations at two broad scales (Thompson and Stewart 1998). Locally, site specific prescriptions for harvest, renewal, and tending of forest stands and associated access can affect moose populations. At the landscape scale (which can be variable depending on the scope of the analysis), which could be the area encompassed by a forest management plan, a WMU, or a site region, the sum of all management activities can impact moose populations.<br><br>A growing body of evidence suggests moose and the activities associated with forest management can co-exist (Courtois et al. 2002). Thompson and Stewart (1998) believed that the increase in moose in northern Ontario and in British Columbia was related to human disturbances, namely fire and forest operations, which suggested to them that habitat could be managed (through forest operations) to benefit moose.<br><br>In managed forests, clearcutting can result in a substantial increase in forage and subsequent use by moose. However, moose use of clearcuts can be dependent upon the age of the cut – in Quebec, Joyal (1987) reported moose tended to avoid recent clearcuts except in early winter.<br><br>Season can also influence moose use of clearcuts. Thompson and Euler (1987) found that as winter progressed, moose moved to older, regenerated clearcuts, and by late winter had left clearcuts to occupy undisturbed forests.<br><br>Seasonal use of cutovers may reflect site differences as well as the size and pattern of the cut. The sex and age class of moose may also be a factor influencing use of harvested habitats. McNicol and Gilbert (1980) reported on moose use of upland cutovers during late winter north of Lake Superior. Thompson and Vukelich (1981) described the use of logged habitat in winter by cows and calves in northeastern Ontario. Several studies have examined moose use of residual stands of trees following clearcutting, or moose use in areas where modified cutting practices occurred (e.g., Todesco et al. 1985, |

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| | Todesco 1988, Dalton 1989, Mastenbrook and Cumming 1989).<br><br>Forest harvest practices that intersperse suitable conifer cover with harvested areas can increase the availability of browse to moose in winter (Hamilton et al. 1980). In general, moose were found to benefit from forest operations as a result of increased browse availability following harvest. In conifer stands in the GLSL forest, clearcut or shelterwood harvest may increase browse ten-fold over what occurs in dense, mature stands (Allen et al. 1987).<br><br>In summary, moose benefit during the winter from cutovers as a result of increased browse supplies, but are also dependent upon the availability of nearby stands of conifer for cover. Conifer cover shelter in proximity to cutovers appears to be especially crucial for moose as winter progresses.<br><br>The length of time after harvest for which the benefits to moose occurred varied, although a decline in use is usually apparent in cutovers older than 20 years (Timmermann and McNicol 1988).<br><br>While forage increases dramatically following harvest operations, treatments to regenerate the forest and the impacts of these operations have been questioned. Thompson et al. (2003) reported no information on the long-term effects on mammals from use of mechanical site preparation in boreal forests, but did identify two studies from Alberta where browse production was reduced following scarification, resulting in lower use of treated sites than untreated sites by moose, deer, and elk. The practice of tending using herbicides has been shown to result in decreased use of cutovers by moose (e.g., Cumming 1989, Connor and McMillan 1990). Lautenschlager (1993) summarized 13 studies on the use of browse by moose and deer following application of herbicides and concluded that conifer release treatments reduced moose browse production and habitat use for up to 4 growing seasons after treatment. Still, even though areas treated with herbicides are used less by moose as a result of reduced forage biomass, there are often unintentional unsprayed areas due to factors such as uneven application and shielding by taller adjacent vegetation (Lautenschlager 1991).<br><br>Further, Lautenschlager et al. (1999) found forage quality did not decline following applications of herbicide; rather, forage quality for some key moose browse species (i.e., aspen) actually improved. In addition, some studies have found that browse availability, following the initial period of reduction, was actually higher in herbicide-treated cutovers than in non-treated areas (Newton et al. 1989, Raymond et al. 1996), and this effect lasted for 10 to 20 years after cutting.<br><br>While forest harvest operations produce food for moose, they can adversely affect moose by removal of winter or summer cover. During summer, moose bed in cool shady habitats to avoid heat stress (Jackson et al. 1991). Allen et al. (1987) believed lowland conifers (e.g., black spruce, white cedar) provided optimum cover owing to their normally dense canopy and moist substrate. Numerous stands >2 ha scattered through the forest were believed to contribute to and improve habitat quality.<br><br>The effects of forest harvesting on moose calving sites is unclear. Welch et al. (2000) found high variability among collared cow moose in calving site fidelity across two different types of harvested landscapes (patch cuts and progressive clearcuts) in northwestern Ontario. This variability was consistent with studies in Quebec (Chekchak et al. 1998) and Algonquin Park (Addison et al. 1993). Factors other than forest operations, such as predators and climate, were thought to also influence calving site selection.<br><br>Some studies have identified increased hunting pressure and harvest of |

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| | moose in recently logged areas as a result of forest access roads, but these effects were mitigated by use of road closures and controls on hunter access (Eason 1985, 1989; Racey et al. 2000). Rempel et al. (1997) believed moose habitat guidelines, without restrictions on hunter access, were insufficient for increasing moose density.<br><br>Recently, there has been interest in the increased use of intensive forest management (IFM) practices for the purposes of higher fibre yields. Limited long-term information on the effects of IFM on wildlife, and in particular moose, is available; modeling predictions reported by Thompson et al. (2003) suggest the effects on moose would be negative at both stand and landscape scales. However, in Ontario, IFM has not been defined and currently, there are no 'new' forest management practices associated with IFM in the province.<br><br>Forest management activities that improve moose habitat and favour high moose populations may have adverse effects on biodiversity and result in plant-animal interactions that differ in comparison to natural forests (Edenius et al. 2002). Such impacts have been seen in Fennoscandian boreal forests, which are for the most part predator-free and where moose densities tend to be much higher than in Canada. Continued development and testing of habitat suitability models should help managers assess wildlife habitat relationships with other resource management issues (e.g., Schamberger and O'Neil 1986). |

**Rationale for direction**

Previous direction for the integration of moose habitat management within forest management planning was provided by the *Timber management guidelines for the provision of moose habitat* (OMNR 1988). Some direction, particularly with respect to clearcut size, was provided by the *Forest management guide for natural disturbance pattern emulation* (OMNR 2001). OMNR established the Moose Guidelines Evaluation Project (MGEP), at its Centre for Northern Forest Ecosystem Research (CNFER), to examine the effectiveness of the direction in OMNR (1988) and to provide increased understanding of timber management effects on moose populations. Results of this and related studies on moose in Ontario, as well as research on moose carried out in North America and elsewhere, have been considered during preparation of the following direction for moose habitat management.

Areas where moose habitat will be emphasized (*moose emphasis areas*) will normally be LLPs identified through application of the *Landscape Guide*. Based on the literature describing moose habitat, the candidate areas of a MU where an emphasis on managing for moose habitat should receive consideration will be those areas with objectives and targets associated with the achievement of:

- a relatively fine-textured landscape (i.e., young forest interspersed with older forest at the 50-500 ha scale),
- a range of young forest patch sizes (10-500 ha), and
- a relatively high proportion of the area managed as mixedwoods.

These areas have a high potential to be good moose habitat and management of habitat specifically for moose will not compromise the strategic landscape pattern and landscape class composition targets established through application of the *Landscape Guide*. Candidate areas for moose habitat management should also be a component of the long-term management direction of a forest management plan.

Once candidate areas have been identified, further scrutiny, particularly insights from habitat modeling, will finalize the specific areas where the moose direction in this guide will apply.

*Use of models*

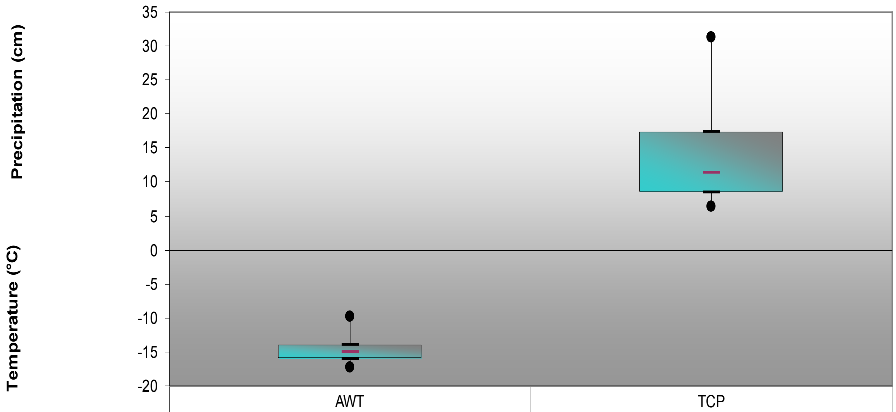
In the GLSL forest, as well as in parts of the boreal forest, moose habitat suitability has in recent years been assessed using the spatial moose model in the Ontario Wildlife Habitat Analysis Models (OWHAM) software package (Naylor et al. 1999). This model is based largely on the Lake Superior Region habitat suitability index model created by Allen et al. (1987). Non-spatial assessments of moose habitat supply over time have been conducted in most MUs using region-specific non-spatial moose habitat suitability models (e.g., Holloway et al. 2004) embedded within the Strategic Forest Management Model (SFMM; Davis 1999). Field assessments of moose habitat suitability in specific areas, using methods in Ranta (1998), have also been done, which identify and rank winter habitat and moose aquatic feeding areas (MAFAs).

The area of wetlands (especially those associated with MAFAs) may influence moose carrying capacity (Allen et al. 1987). The model by Allen et al. (1987) suggests that habitat is most suitable for moose when wetlands comprise 5-10% of an area. This condition should occur in areas where moose habitat management is emphasized and where the direction in this guide is applied. Generally, habitat suitability is also associated with rich, productive forests, which is another consideration when delineating the areas where moose habitat will be emphasized. Normally, candidate areas for moose habitat emphasis will be limited to areas where productive, nutrient rich sites predominate, a suitable mix of wetlands (including MAFAs) occurs, and where modeling suggests there is a high probability of achieving at least moderately high moose densities.

The *Landscape Guide Science and Information Packages* provide estimates of moose carrying capacity across the AOU at the *Landscape Guide* region, ecodistrict, and MU levels. These estimates include simulated ranges of natural variation (SRNV) and estimates at the beginning of the simulation (approx. year 2006). Several models were used depending on the MU. Refer to *Science and Information Package "M"* for a complete description of the models. In general, the SRNV carrying capacity of a MU is an estimate of the potential of the landscape, under a natural disturbance regime, to produce moose habitat, and the accompanying box and whisker plots represent the carrying capacity range. In landscapes where the current carrying capacity is significantly lower than the SRNV, managers should consider moving the landscape closer to the SRNV. This should be done while considering other landscape indicators such as landscape classes, old growth, and young forest consistent with direction provided in the *Landscape Guide*. *Ontario's Landscape Tool* provides the models and framework to do these analyses.

For this guide, a bioclimatic habitat suitability model based on Allen et al. (1987) was developed by CNFER consistent with habitat parameters used in the *Landscape Guide.* The bioclimatic moose model predicts carrying capacity as a function of average conditions of predation, hunting effort, habitat structure, and long-term climatic patterns. The model should not be used to predict the expected density of moose for a particular site because the model does not utilize site and year-specific levels of hunting effort, predation pressure, weather conditions, or other variables such as disease levels. Results of this modeling were used to provide parameters to help planning teams identify where moose habitat management should be emphasized and where the moose habitat direction applies. In addition, the model also provided information used for specific pieces of direction (see bellow).

The bioclimatic model identified that observed moose densities across the province as a whole were determined, at least in part, by average winter temperatures and total cool season precipitation. Highest densities were associated with average winter temperature (the average temperature for the months of Dec. through Feb.) between -16$^0$ C and -14$^0$ C and total cool season precipitation (Oct. through Mar.) between 83.8 mm and 173.2 mm (Fig. 3.3b.




| | AWT | TCP |
|---|---|---|
| Lower Quartile | -16 | 8.3814 |
| Lower Range | -17.3111 | 6.3136 |
| Median | -15.0421 | 11.2975 |
| Upper Range | -9.7291 | 31.2845 |
| Upper Quartile | -14.0807 | 17.32 |

**Fig. 3.3b. Average winter temperature (AWT) and total cool season precipitation (TCP) observed in moose aerial inventory plots from 2000-06 with the highest (top 20%) moose densities (Rempel[1], unpubl. data).**

Fig. 3.3c illustrates predicted moose densities using the CNFER bioclimatic model and observed moose densities based on recent (2001-2006) moose aerial inventory data.

Other sources of information may also be helpful in identifying moose emphasis areas. For example, the Ontario Land Inventory provides a mapped estimate of habitat capability for moose (Thomasson 1972).

The extent of area where the management of moose habitat should be emphasized should consider the outputs of as many of the models the planning team wishes to examine. In addition to models, other factors, such as those related to sustainability (i.e., social and economic issues), can also be considered when determining areas where moose habitat should be emphasized. The relative importance of moose compared to other ungulates in the management unit is another consideration (see OMNR 2009).

[1] Rob Rempel, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

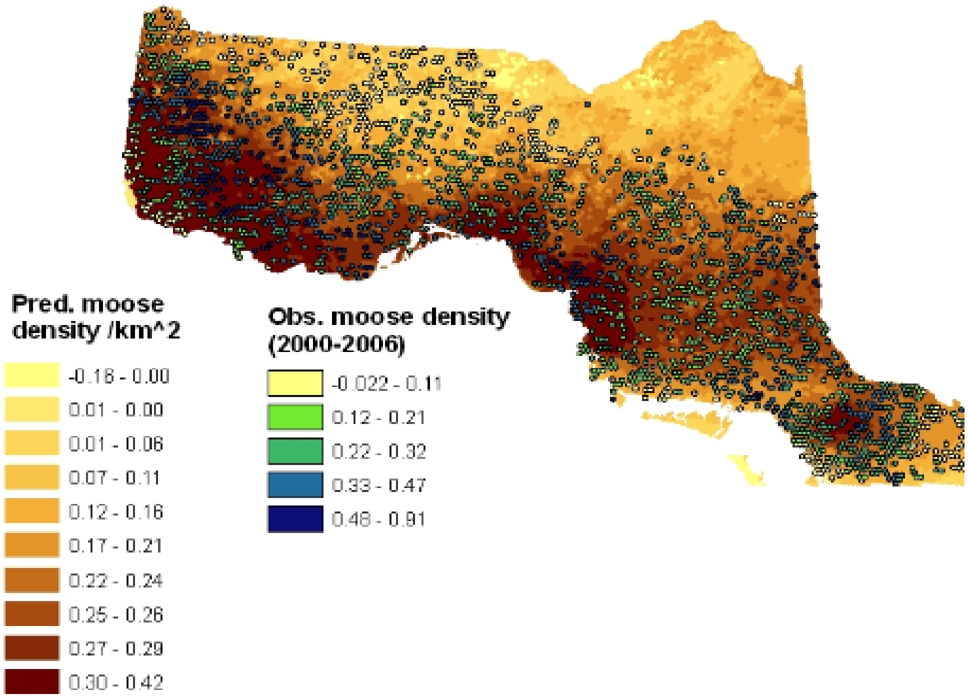



**Fig. 3.3c. Densities of moose observed in aerial inventory plots from 2000-06 and predicted from the bioclimatic model developed by Rempel[1] (unpubl. data).**

Within the area moose habitat is being emphasized, specific types of forest stands will be identified and maintained, or retained to provide moose habitat attributes such as thermal shelter and security cover (see below).

Within their summer home range, cow moose use a wide range of habitat conditions for calving (Addison et al. 1990, Langley and Pletscher 1994, Bowyer et al. 1999). Calving sites are typically occupied for a few days to a week until calves become mobile (Cederlund et al. 1987, Welch 2000). Reuse of specific calving sites appears to be limited and highly variable; mean distance between sites used by individual cows in consecutive years was >3 km in Alaska, Ontario, and Quebec (Chekchak et al. 1998, Testa et al. 2000, Welch 2000). While some fidelity to site location and a broad preference for some site types has been identified, provision of generally suitable habitat for moose over large expanses of forest is believed to provide moose with suitable sites where they can raise young (Welch 2000). Based on present knowledge and the information available, no direction has been provided with respect to management of calving and nursery habitat.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Silvicultural prescriptions will be consistent with moose habitat management objectives. | Forest operations are generally believed to be beneficial for moose and moose habitat. To ensure moose habitat objectives are achieved in areas where moose habitat is emphasized, silvicultural practices are required that will achieve that intent. |

[1] Rob Rempel, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

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*Guideline* - Within each LLP or area, manage the productive forest such that: i) 5-30% of the forest is browse-producing habitat (generally stands < 35 years old and <10 m tall; or stands that have received a selection cut within 10 years or a shelterwood regeneration cut within 20 years); ii) 15-35% of the forest is mature conifer-dominated forest; and iii) 20-55% of the forest is hardwood-dominated or mixedwood forest ≥35 years old or ≥10 m tall, or recent partial harvest areas that meet the definition of residual forest.

A stand will only be attributed to one of the three criteria (e.g. a recent partial harvest in a conifer stand may count towards criteria ii) or criteria iii), but not both).

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Allen et al. (1987) defined the suitability of small landscapes (township-sized areas) for moose based on the percent of the area in shrubby or forested habitat <20 years old, spruce/fir-dominated forest ≥20 years old, hardwood or mixed forest ≥20 years old, and wetlands (Fig. 3.3d).

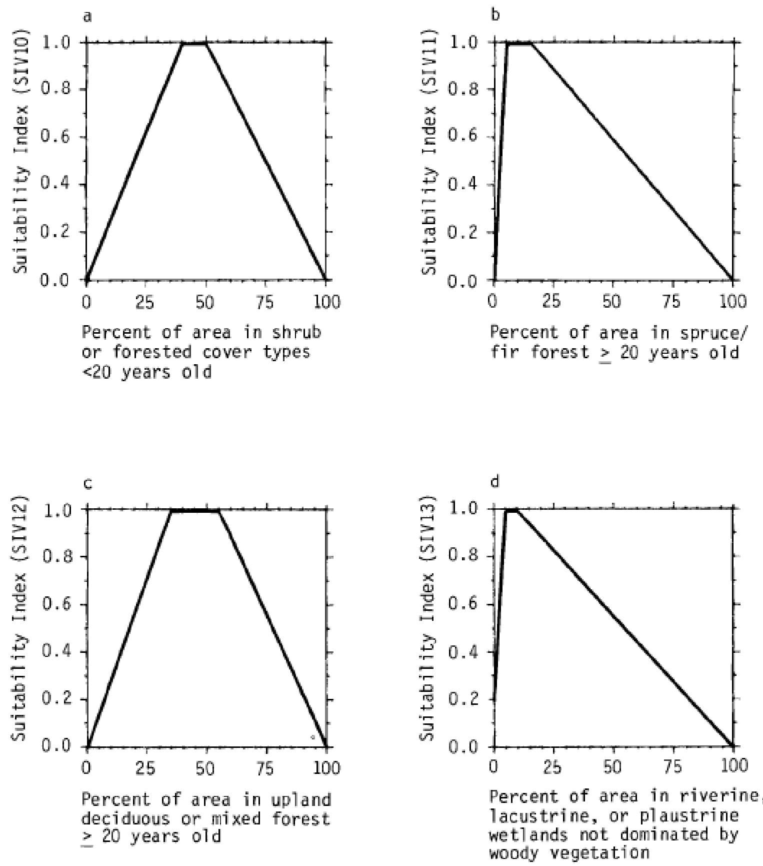


**Fig. 3.3d. Indices used to define habitat suitability for moose within township-sized areas in the model developed by Allen et al. (1987).**

This model was initially calibrated for use in the GLSL forest in the early 1990s (Naylor et al. 1992). More recently, Rempel[1] (unpubl. data) calibrated Allen et al.'s model for use across Ontario using moose aerial inventory (MAI) data from 2000-06. Habitat was described using the provincial forest types and development stages. All 3 forest cover-related parameters were significant predictors of moose density. Observed values are summarized in Fig. 3.3e for the MAI plots with the highest (top 20%) moose densities.

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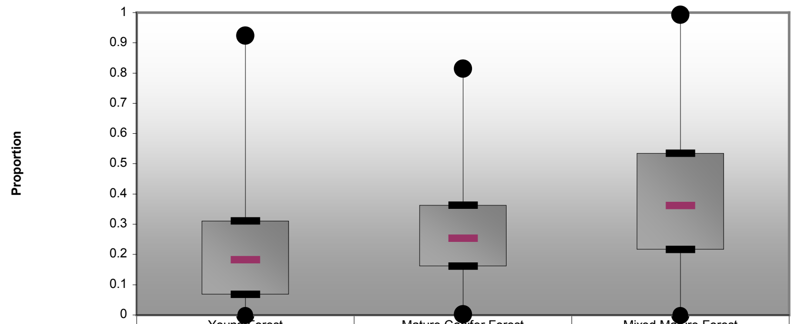
[1] Rob Rempel, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON




| | Young Forest | Mature Conifer Forest | Mixed Mature Forest |
|---|---|---|---|
| Lower Quartile | 0.067885 | 0.16131 | 0.21643 |
| Lower Range | 0 | 0.00165 | 0 |
| Median | 0.1828 | 0.25394 | 0.36134 |
| Upper Range | 0.92342 | 0.81424 | 0.99276 |
| Upper Quartile | 0.310645 | 0.362245 | 0.5342 |

Habitat Type

**Fig. 3.3e. Proportion of productive forest comprised of presapling and sapling forest (Young Forest), mature and old/late conifer-dominated forest (Mature Conifer Forest; PWR, PJK, MCU, & MCL forest types), and immature, mature, and old/late mixed (or hardwood-dominanted) forest (Mixed Mature Forest; MIX, POP, BWT, & TOL forest types) observed in moose aerial inventory plots from 2000-06 with the highest (top 20%) moose densities (Rempel[1], unpubl. data).**

The range of values for each parameter represented by the upper and lower quartiles (Fig. 3.3e) was used to define compositional targets for LLPs or moose emphasis areas as follows:

- 5-30% of the productive forest is maintained as browse-producing habitat (generally stands < 35 years old and <10 m tall[1]; or stands that have received a selection cut within 10 years or a shelterwood regeneration cut within 20 years),
- 15-35% of the productive forest is maintained as conifer-dominated forest in the mature or old/late development stage, and
- 20-55% of the productive forest is maintained as hardwood-dominated or mixedwood forest ≥35 years old or ≥10 m tall[1], or recent partial harvest areas that meet the definition of residual forest.

[1] These criteria are used in place of development stage for reasons discussed in 3.2.2.1 *Defining residual forest*.

*Guideline* - Normally, an area or LLP with an objective to emphasize moose habitat management will be ≥2,000 ha and, preferably, ≥10,000 ha.

Annual home range of moose in eastern North America is typically 20-40 $km^2$ (Crete 1988). Thus, areas where moose habitat is emphasized should be at least 2,000 ha in size.

Ideally, areas where moose habitat is emphasized should be large enough to support a viable local population of moose. Allen et al. (1987) assumed that an area of approximately 10,000 ha could support a viable population if all necessary habitat requirements were present and there was frequent genetic interchange.

*Guideline* - Renewal

Winter carrying capacity is determined by the supply of accessible

[1] Rob Rempel, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

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| and tending practices will have regard for the availability and abundance of moose browse over the short and long-term. | browse (Allen et al. 1987, Crete 1988). Some renewal and tending operations (especially those involving herbicide application) may have, at least temporary, adverse effects on browse supply (see *Effects of forest management*). Potential effects can be at least partially addressed with plans, proposals, or strategies that ensure that forest renewal and tending treatments will have regard for the availability and abundance of browse over time (see *Best management practices*). |
| *Guideline* - Adopt use management strategies for branch and operational roads consistent with moose management objectives. | Without mitigative intervention, forest access roads can lead to an undesirable increase in hunting pressure (see *Effects of forest management*). Thus, when developing road use strategies, as required by the *Forest Management Planning Manual*, strategies will be consistent with moose management objectives. |
| *Guideline* - To manage for summer cover habitat in areas where forest operations are planned, maintain suitable forest stands using the following criteria:<br>**Amount**: ≥3% (15 ha) in any given 500 ha.<br>**Size and Distribution**: minimum 2 ha, 10+ ha preferred, in at least 2 distinct patches within any given 500 ha.<br>**Location**: Summer cover habitat will normally be adjacent to MAFAs moose are most likely to use (i.e., ≤ 200 m, measured from the edge of the MAFA to the nearest edge of the patch of summer cover). Choose MAFAs based on information in Table 1. If such MAFAs are not present, suitable summer cover will be adjacent (≤ 200 m) to other MAFAs, or natural openings (e.g., beaver meadows). Link summer cover to | During summer, moose bed in cool shady habitats (thermal shelter) to avoid heat stress (Jackson et al. 1991, Dussault et al. 2004). The supply of thermal shelter may limit summer carrying capacity (Allen et al. 1987).<br>Forest providing thermal shelter (summer cover) is normally characterized by: trees ≥10 m in height (preferably mature or old development stage); canopy closure ≥70%; an overstory dominated by conifers; an open understory; and a preference for cool lowland sites (Allen et al. 1987; Jackson et al. 1991; Rodgers[1], unpubl. data).<br>To provide an adequate supply of thermal shelter, ≥3% (15 ha) of any 500 ha area will be maintained as suitable summer cover in patches ≥2 ha is size based on assumptions in Allen et al. (1987). Larger stands may provide more suitable micro-climatic conditions than smaller stands – upland and lowland conifer stands managed for summer cover may be of higher value if the stands are at least 10 ha in size (Rodgers[1], unpubl. data). A 500 ha evaluation unit is consistent with the size of evaluation units used in the *Landscape Guide* and is similar to that suggested by Allen et al. (1987). See the *Landscape Guide Science and Information Package* for further information on sampling and evaluation units.<br>Patches of summer cover likely have greatest value to moose when they are adjacent to (i.e., ≤200 m from) preferred feeding habitat, especially aquatic feeding areas (Rodgers[1], unpubl. data). In northwestern Ontario, moose showed a preference for summer cover when adjacent to MAFA's ranked moderate or higher (based on the methodology described by Ranta 1998), that were large in size (>4 ha and preferably >8 ha), and were situated near open, brushy, or treed wetlands (Rodgers[1], unpubl. data; and see Table 3.3a). Summer cover will normally be retained adjacent to the highest quality MAFA's available. |

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immature, mature, old, or residual forests, particularly shoreline forests (See Sections 4.1 and 4.2.4). Linkages are considered adequate when the distance from the edge of a patch of summer cover to immature, mature or residual forests is ≤ 200 m and the terrain is traversable by moose (e.g., the terrain is relatively flat).

**Characteristics**: Maintain or retain the best summer cover habitat available. In general, lowland conifer > upland conifer > lowland or upland hardwood > mixed woods. More specifically, high quality summer cover habitat is comprised of stands that are: i) <u>at least</u> immature in age (i.e., ≥ 35 years; mature stands are preferred) and 10 m in height; ii) have canopy closure ≥ 70%; and iii) have an open understory (i.e., the shrub density is low).

**Table 3.3a. Size of moose aquatic feeding areas (MAFAs) used by moose based on ranking (Rodgers[1], unpubl. data).**

| | Mean Area of Used, Unused, and Available MAFAs by Rank ± 95% CI (ha) | | | |
|---|---|---|---|---|
| MAFA Rank | Very High | High | Moderate | Low |
| Used (*n*=205) | 11.577 ± 4.171 | 8.593 ± 3.793 | 4.229 ± 1.617 | 4.032 ± 1.811 |
| Unused (*n*=3348) | 6.802 ± 2.886 | 4.423 ± 0.729 | 2.125 ± 0.191 | 2.072 ± 0.253 |
| Available (*n*=3553) | 7.807 ± 2.442 | 4.782 ± 0.743 | 2.221 ± 0.198 | 2.146 ± 0.253 |

If high quality MAFAs are unavailable or restricted in distribution, summer cover can be located adjacent to low quality MAFAs or other habitats that receive high use during summer such as natural forest openings (especially beaver meadows) and seasonally flooded habitats. For the benefit of moose and to provide other ecological benefits, linking MAFAs, beaver habitat, forest cover adjacent to these habitats, and shoreline forests, will be a consideration when planning placement of residual forests (see Section 4.1 for further information).

*Guideline* - The portion of the LLP or moose emphasis area where moose concentrate their activity during periods of severe winter conditions will be identified. To manage for winter cover within these *concentration areas*, maintain suitable patches of habitat (stands or parts of stands) using

During periods of deep snow or thermal stress, moose may become restricted to habitats that provide reduced snow depth or ameliorated microclimate (thermal shelter) (Jackson et al. 1991). The supply of thermal shelter may limit winter carrying capacity (Allen et al. 1987).

Forest providing thermal shelter (winter cover) is normally characterized by mature conifer or mixed forest with a conifer canopy component that: is ≥10 m in height; is comprised of tree species capable of intercepting snow; and has ≥60% canopy closure (see Allen et al. 1987, Jackson et al. 1991, OMNR 2004).

Regardless of the silvicultural system used, the conifer component of stands retained to provide winter cover for moose will be dominated by trees with the best snow interception capability available. Species' rankings are based on OMNR (2004) as follows:

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| the following criteria:<br><br>**Characteristics:** Patches of winter cover will normally be mature conifer or mixed forest with a conifer canopy component that: i) is ≥10 m in height, ii) is comprised of tree species that are capable of intercepting snow (subject to availability and the applicable local or regional cervid strategy), and iii) has ≥60% canopy closure (a conifer canopy closure ≥30% may be acceptable if the conifer component has a high snow interception capability and tends to occur in clumps (i.e., ≥3-5 trees with interlocking crowns)). A conifer canopy closure of 60-80% is optimal so some partial harvest may be acceptable where appropriate; if partial harvest is conducted, clumping of residual trees is preferable to uniform spacing of residual trees.<br><br>**Patch size and distribution:** Patches of winter cover will be distributed within concentration areas so that: i) any point within productive forest that does not meet the definition of residual will be <200 m from a patch of winter cover (i.e., 400 m cover-to-cover distance) that is ≥5 ha in size (≥10 ha preferred), and ii) any point within productive | • High – cedar, hemlock, red spruce.<br>• Moderate – balsam fir, black spruce (upland), white pine, white spruce.<br>• Low – black spruce (lowland), jack pine, red pine.<br><br>However, there can be situations where there is a conflict between managing cover for moose and deer. For example, cedar and hemlock trees may be better at snow interception than other conifers, but these species are also preferred by deer as food, and are common cover canopy trees in deer yards. When moose are the species being emphasized, and the strategy is to maintain low deer numbers, or even reduce deer populations, white spruce and upland black spruce would be better choices to use to achieve moose winter cover objectives. Although balsam fir can also provide suitable winter cover (for moose and deer), and is eaten by moose (Zach et al. 1982) and not deer, it is susceptible to spruce budworm outbreaks and may not be desirable from a forest health perspective. In addition, dead and dying stands of balsam fir following a budworm epidemic may be heavily colonized by lichens such as *Usnea* spp., which are attractive winter forage for deer (Hodgman and Bowyer 1985).<br><br>High conifer canopy closure enhances the ability of winter cover to intercept snow and ameliorate microclimate (Jackson et al. 1991). However, dense mature stands may have relatively little available food (e.g., Whitlaw et al. 1993). Thus, conifer canopy closure 60-80% is likely optimal and some partial harvest may be acceptable in patches of winter cover; if partial harvest is conducted, clumping of residual trees is preferable to uniform spacing of residual trees (OMNR 2004).<br><br>Tree species such as cedar, hemlock, and red spruce are especially valuable as winter cover (see above) but may occur in mixedwood stands with <60% conifer canopy closure. Thus, in some situations, retention of patches of winter cover with a conifer canopy closure ≥30% may be acceptable if the conifer component has a high snow interception capability and tends to occur in clumps (i.e., ≥3-5 trees with interlocking crowns).<br><br>To provide an adequate supply of thermal shelter, winter cover will be maintained within those portions of the LLP or moose emphasis area where moose tend to concentrate during periods of deep snow or thermal stress (typically described as *late winter habitat* in past direction; see Ranta 1998 for information on identifying this habitat).<br><br>Within these *concentration areas*, patches of winter cover will be distributed so that moose will be <200 m from a patch of winter cover ≥5 ha in size (≥10 ha preferred) if foraging in forest that does not meet the definition of residual (e.g., a recent conventional clearcut) and <500 m from a patch of winter cover ≥2 ha in size (≥5 ha preferred) if foraging in forest that does meet the definition of residual (e.g., a recent selection cut). The 200 m distance-to-cover threshold is based largely on the distance moose will typically move from cover to forage in clearcuts during winter (Hamilton et al. 1980, Thompson and Vukelich 1981, Allen et al. 1987) and is consistent with OMNR (1988). The 500 m distance-to-cover threshold is based on recent research from Algonquin Park suggesting that moose preferentially forage within about 500 m of winter cover in landscapes dominated by mature and partially harvested forest (Hussey 2009). |

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| forest that does meet the definition of residual will be <500 m from a patch of winter cover (i.e., 1000 m cover-to-cover distance) that is ≥2 ha in size (≥5 ha preferred). | Patch size thresholds are based on consideration of past direction (i.e., 3-5 ha in OMNR 1988), winter habitat preferences shown by moose in northwestern Ontario (i.e., 75% of conifer-dominated stands used in winter were ≥5 ha in size, 50% were ≥11 ha in size; Rodgers[1], unpubl. data), risk of blowdown, and the nature of the forest in which winter cover patches are likely to be embedded (i.e., patch size is smaller when likely to be surrounded by forest that meets the definition of residual). |
| *Best management practices* | *Mitigating effects of chemical tending on browse supply*<br><br>*Best Management Practices* provide suggestions on how to minimize potential negative effects on moose browse, or how to enhance browse quality or quantity. Some of the suggested strategies are specific to the application of herbicides. The impacts of herbicides to moose browse can have a range of effects, both negative and positive.<br><br>Generally, following application of herbicides, the quantity of browse and use by moose in the area where the treatment was applied decline for about 4 years. After that period, the amount of browse increases and quality eventually becomes equal or superior to untreated areas. While herbicide use appears to have relatively minor impacts on moose habitat at a landscape scale, local impacts may be of concern.<br><br>As such, dispersing the use of herbicides to ensure large, contiguous areas of the management unit are not simultaneously impacted will help alleviate short-term drops in forage supplies. Additional *Best Management Practices* suggest other methods to effectively manage and improve forage supplies at a local level. These include 'feathering' (or 'banding'), where the edge of a cutover is managed specifically to encourage browse production; the recognition that nutrient-poor areas can be an important forage area for moose immediately following disturbance (including harvest); and to favour the use of ground tending when using herbicides (to selectively retain preferred browse species not in direct competition with crop trees).<br><br>*Road use strategies*<br><br>Roads and road use by people are an integral part of moose habitat (Rempel et al. 1997).To help achieve consistency with provincial, regional, or local moose management objectives and road use strategies, *Best Management Practices* are provided for access provisions or restrictions as well as for the temporal and spatial aspects of decommissioning.<br><br>Dependent on objectives, use management strategies can range from being very permissive to restrictive. The use of temporal restrictions should consider information which suggests moose hunters prefer cutovers where the typical height of regenerating vegetation is 2 m or less (Bottan et al. 2001), as moose are more easily seen and from greater distances. Once conifer regeneration in cutovers reaches 2 m, it will likely provide moose adequate security cover.<br><br>Conversely, emphasizing moose habitat management in an area or LLP over the long-term may be consistent with open road access. In good habitat, where moose productivity is also good, relatively high moose |

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| | populations and harvests may be simultaneously maintained – road access *per se* might not be problematic, but road *density* might be.<br><br>Patches of summer and winter cover that are retained are intended, at least in part, to function as security cover for moose (isolation and security can be more important than forage supply; Peek 1998). If roads lead directly to such cover, as well as preferred MAFAs, there is a higher likelihood of disturbance from humans as well as increased predation from wolves - roads are believed to increase wolf hunting efficiency (e.g., Bergerud et al*.* 1984). Thus, keeping roads distant from patches of cover in cutovers as well as high quality MAFAs, should improve moose habitat conditions by enhancing security from both wolves and human disturbances. |

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### 3.3.5 Other Species

**Background**

During the implementation of the *Landscape Guide*, a large portion or portions of each MU may be identified where special and specific direction is required to address unique wildlife objectives that cannot be accommodated using area of concern prescriptions. Such areas will be identified and delineated with 1 or more LLPs, and unique objectives will be developed to address the objective(s).

Compelling biological or socioeconomic reasons may be a consideration when such an area is identified and delineated, and the forest cover of the identified LLP may have unique spatial patterns of forest stands (a mosaic) or other quantitative spatial structures which contributed to its identification and delineation.

Normally, wildlife species which lead to the identification and delineation of LLP's with unique objectives for the management of forest cover will be species with scientific (e.g., a species at risk), aesthetic, recreational or commercial value. They may be individual species or combinations of species and can be animals (including insects) or plants. In addition, such species will normally require:

- a large home range, and/or
- habitat attributes best represented by particular forest stands that are uncommon or geographically limited on the MU.

One species that loosely fits most of the above criteria is elk. While elk are generally considered to be habitat generalists, information on local elk restoration areas may be used to provide specific guidance to promote or retain components of local elk habitat where appropriate.
When identifying LLP's with unique objectives for management of forest cover, the planning team will gather relevant information to use when setting the management objectives for the LLP and the associated indicators, desirable levels, and targets. Valuable database information on habitat attributes for species of interest can usually be obtained from MNR's Natural Resource Values and Information System (NRVIS). However, other information sources can also be used and referenced.

**Effects of forest management**

How forest management activities effect the management of an LLP with unique objectives for the forest cover mosaic will depend upon the objectives being proposed. Effects could range from a concern of a particular operational action or the cumulative impacts or forest operations over time.

Generally, LLP's with unique objectives for the forest cover mosaic will be proposed when mitigation through site-specific area of concern prescriptions (Section 4) are acknowledged to be insufficient to manage the identified species, feature, or value.

**Rationale for direction**

Situations may occur at the MU level which require specific management actions to create or maintain a unique landscape mosaic, and where specific guidance or direction is not provided. Proposed management objectives will be consistent with the approved long-term management direction for the MU.

Managing habitat for species or values where direction does not exist may require unique prescriptions, management strategies, objectives, targets, and indicators. Such action and outcomes will be documented in accordance with the requirements of the FMPM.

## 4.0 CONSERVING BIODIVERSITY - Management of Site-specific Habitats

Section 4.0 introduces the content of Sections 4.1 - 4.3 and provides some background and context. No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

### 4.1. Maintaining Ecological Functions of Aquatic and Wetland Ecosystems and Shoreline Forest Including Habitat Suitability and Productive Capacity

Section 4.1 introduces the content of Sections 4.1.1 - 4.1.3 and provides some background and context. No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

#### 4.1.1. Standing waters: lakes and ponds

**Background**

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| Description | Lakes are bodies of moderate to deep standing water characterized by relatively stable shorelines, limited deposition of sediments, low turbidity, stable water levels, and long flushing rates. Primary production is dominated by periphyton and phytoplankton (Wetzel 2001). Lakes are defined by OMNR (2002) as *areas of open water greater than 8 ha and at some location, greater than 2 m in depth from the normal low water mark*. On average, other Canadian jurisdictions define lakes as open bodies of water >2 ha in size; large lakes are defined as >7.5 ha (Lee et al. 2004).<br><br>Most lakes in Ontario are of glacial origin; some developed as the result of the dynamic nature of rivers or the damming of rivers or streams (e.g., reservoirs). Lakes are classified based on degree to which organic matter is supplied by internal (autotrophic) or external (allochthonous) sources (Wetzel 2001). Lakes driven by allochthonous inputs (dystrophic lakes) are typically tea-coloured bog lakes with low productivity. Autotrophic lakes vary in productivity; mesotrophic lakes are generally shallow and productive, oligotrophic lakes are typically deep and with low productivity.<br><br>Ponds are small, shallow bodies of standing water created by glacial or riverine processes or by the damming of streams by beavers. In contrast to lakes, ponds are sufficiently shallow to permit light penetration to the pond bottom over the entire basin. Thus, primary production is dominated by macrophytes, rather than periphyton and phytoplankton (Wetzel 2001). Ponds are classified as *shallow open water wetlands* by the *Canadian Wetland Classification System* (NWWG 1988) but are considered to be *marshes* in the *Ontario Wetland Evaluation System* (OMNR 2002). Ponds are defined here as bodies of shallow open water (generally <2 m in depth) that are ≥0.5 ha (the minimum size of wetland communities considered to be mappable by OMNR 2002) and <8 ha in size (minimum size of lakes; OMNR 2002). |
| Ecological significance | *Lakes and ponds*<br><br>Lakes and ponds provide habitat for a wide diversity of aquatic and semi-aquatic plants and animals. Lakes and ponds represent habitat for about 82 and 12 species of fish, respectively (Scott 1967, Scott and Crossman 1973). Deep oligotrophic lakes are especially important for cold water fish such as lake trout and the *endangered* Aurora trout; shallower, mesotrophic lakes for warm and cool water fish such as walleye, smallmouth bass, and northern pike (Scott and Crossman 1973).<br><br>Lakes and ponds also provide habitat for >80 species of mammals, birds, |

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| | reptiles, and amphibians ranging from numerous species of turtles and waterfowl to aquatic furbearers such as beavers and otters (Bellhouse and Naylor 1997).<br><br>Because of their high primary productivity, ponds (especially those created by beavers) tend to support an extremely diverse array of aquatic and semi-aquatic wildlife (see 4.2.3).<br><br>*Shoreline forest*<br><br>Shade provided by shoreline forest has an important influence on thermal regime in many streams (see 4.1.2). In contrast, shoreline forest provides shade for only a small portion of the surface of all but the smallest lakes and thus appears to have relatively little biologically significant effect on littoral water temperature and the thermal regime of lakes (Steedman et al. 2004).<br><br>Shoreline forest may influence wind velocity, wind-induced water mixing, and depth of the thermocline in some lakes (e.g., France 1997). However, effects are generally assumed to be greatest for small lakes surrounded by relatively flat terrain (Steedman et al. 2004).<br><br>Allochthonous (fine organic) inputs from streamside vegetation are a critical component of foodwebs in stream ecosystems (see 4.1.2). In contrast, allochthonous inputs from shoreline vegetation are generally not as important as autotrophic inputs in most lake ecosystems (Wetzel 2001).<br><br>In contrast to inputs of allochthonous material, inputs of coarse woody material from shoreline forest do provide critical habitat for a diversity of aquatic biota within the littoral zone of lakes and also protect shoreline soil and vegetation from erosion by waves and ice (see *Shoreline trees* below).<br><br>Shoreline forest represents a dynamic link between terrestrial and aquatic ecosystems (Lee and Smyth 2003). Unique edaphic and/or microclimatic factors occurring in this zone may result in development of distinct shoreline forest plant communities (Harper and MacDonald 2001, Pearson and Manuwal 2001, Goebel et al. 2003) that provide habitat for numerous species that either use the distinct shoreline vegetation community or use both aquatic and terrestrial habitats to meet different life requisites (Bub et al. 2004, Macdonald et al. 2006, Mosley et al. 2006). In central Ontario, Bellhouse and Naylor (1997) identified >70 of the native 305 species of mammals, birds, reptiles, and amphibians as users of shoreline forest.<br><br>Shoreline forest is not static. As a consequence of succession and natural disturbance events, such as wildfires, shorelines in natural landscapes are characterized by a shifting mosaic of young and old forest that, at broad scales, typically reflects the age and/or composition of the surrounding landscape (e.g., Andison and McCleary 2002, Macdonald et al. 2004). This diversity is exploited by the shoreline-inhabiting wildlife community. Thirty-five % of the species using shoreline forest listed by Bellhouse and Naylor (1997) preferred young (presapling or sapling stage) forest and 50% preferred mature and older forest (an additional 15% used young and mature and older forest with equal propensity). Species listed as favouring young shoreline forest include common snipe, American woodcock, alder flycatcher, yellow warbler, common yellowthroat, palm warbler, Wilson's warbler, least weasel, long-tailed weasel, meadow jumping mouse, smooth green snake, and midland chorus frog. Species listed as favouring mature and older shoreline forest include eastern screech owl, barred owl, great horned owl, Canada warbler, blue jay, raccoon, American marten, fisher, blue-spotted salamander, and gray tree frog.<br><br>Many species that use shoreline forest are equally abundant in either upland forest (e.g., American marten) or within shrubby wetlands (e.g., common |

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| | yellowthroat). However, for some of the latter species, severe disturbances, such as wildfire, that create early successional shoreline forest, may permit the species to expand the range of habitats occupied from wetlands to adjacent upland forest (e.g., see Kardynal et al. 2009).<br><br>A small set of species appears to be entirely or largely dependent on shoreline forest and includes:<br><br>*American beaver* - This aquatic furbearer typically inhabits ponds it creates by damming streams (but may also use small lakes and rivers) and feeds in shoreline forest (see 4.2.3 for detailed discussion). Younger shoreline forest provides the greatest supply of food since beavers feed preferentially on young trees and shrubs found in early to mid successional plant communities; trembling and large-tooth aspen trees 2.5 to 15 cm dbh are especially preferred. Moreover, tree cutting by beavers and natural succession ultimately deplete food supply in older shoreline forest and ponds become abandoned. Beaver ponds may be reoccupied if shorelines experience a disturbance sufficient to regenerate early and mid successional forest. Shoreline disturbance that affects beavers also indirectly benefits many other species since the beaver is widely considered to be a keystone species (Martell et al. 2006); the mosaic of habitat conditions (newly flooded ponds, stagnant ponds, de-watered ponds, and beaver meadows) this species creates across watersheds leads to increased species richness of both plants and animals (Snodgrass 1997). Beaver ponds are used by a wide range of vertebrates including muskrats, minks, raccoons, deer, moose, woodcocks, wild turkeys, and ruffed grouse (Novak 1987), but are especially important as breeding habitat for boreal anurans (Stevens et al. 2007), nesting habitat for herons (Peck and James 1983), and feeding habitat for dabbling ducks (Rempel et al. 1997, Gabor et al. 2002).<br><br>*Bald eagle* – During the breeding season, eagles rely on large lakes for a supply of fish. Large bulky nests are built in supercanopy trees located in mature or older forest adjacent to lakes and rivers (see 4.2.2.2).<br><br>*Cavity-nesting waterfowl* – The 20 species of waterfowl found in Ontario are primarily associated with aquatic habitats. However, 25% nest in holes in large decadent trees typically associated with mature and older shoreline forest (see 4.2.2.8).<br><br>*Moose* – Moose are habitat generalists that use a wide variety of habitats. However, they spend a large amount of time feeding on aquatic plants during spring and early summer. Older shoreline forest adjacent to aquatic feeding areas may provide visual screening, thermal cover, and a travel corridor (see 4.2.4).<br><br>*Northern waterthrush* – This songbird is widely identified as a shoreline forest specialist, usually associated with forest adjacent to boreal lakes or streams (Whitaker and Montevecchi 1997, Wiebe and Martin 1998, Macdonald et al. 2006, Mosley et al. 2006).<br><br>*Rusty blackbird* – This songbird typically nests in conifer saplings associated with forest openings or young forest created by disturbances such as fire, windthrow, or beaver activity adjacent to lakes, ponds, streams, or wetlands (Peck and James 1987, Avery 1995, COSEWIC 2006).<br><br>*Winter wren* – This songbird, while not considered a shoreline forest specialist, is frequently associated with forest adjacent to lakes, streams, and wetlands (Peck and James 1987, Hejl et al. 2002, Mosley et al. 2006).<br><br>Numerous additional terrestrial species may use shoreline forest as travel corridors. Corridors may facilitate movement of dispersing individuals across |

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| | landscapes to connect local populations and may facilitate movement of individuals within home ranges to access life requisites (Taylor et al. 1993, Rosenberg et al. 1997, Mech and Hallett 2001). Shoreline forest (especially that associated with streams) is viewed as especially important habitat for migrating songbirds (Wiebe and Martin 1998, Mosley et al. 2006).<br>*Shoreline trees*<br>Individual trees retained in shoreline areas provide many of the ecological functions described for wildlife trees in Section 3.2.3. Specifically, residual trees in shoreline areas are especially important components of wildlife habitat when they function as:<br>• supercanopy trees that provide potential nest, perch, and roost sites for large birds such as eagles, ospreys, and herons (see 4.2.2.2),<br>• cavity trees that provide potential nest sites for cavity-using waterfowl such as wood ducks and common goldeneyes (see 4.2.2.8) and roost or den sites for many species of riparian-dwelling bats (see 4.2.6),<br>• scattered coniferous trees (selection FUs) that provide winter shelter for a variety of species (especially ungulates) and nesting and foraging sites for a variety of songbirds, or<br>• veteran trees (clearcut and shelterwood FUs) that will become supercanopy trees and large coarse woody material in the regenerating shoreline forest.<br>Some residual trees retained in shoreline areas will eventually fall into adjacent aquatic habitats, providing coarse wood that is essential to the functioning of these ecosystems. For example, within the littoral zone of lakes, coarse wood may provide both cover from predators and reproductive habitat for fish such as largemouth bass (Hunt and Annett 2002), smallmouth bass (Bozek et al. 2002), and muskellunge (Rust et al. 2002), a substrate for macroinvertebrates and periphyton (Bowen et al. 1998, Vadeboncoeur and Lodge 2000, Smokorowski et al. 2006), and may also protect shoreline soil and vegetation from erosion by waves and ice (Guyette and Cole 1999, Bolgrien and Kratz 2000). Coarse wood in aquatic ecosystems may also represent an important carbon sink because logs in aquatic habitats can persist for an order of magnitude longer than those in terrestrial habitats (Guyette et al. 2002). |
| Effects of forest management | *Lakes and ponds*<br>Extensive forest disturbance (i.e. 25-50% or more of a catchment) by wildfire or harvesting may cause significant but temporary changes in various aspects of the hydrology, water quality, or biota of lakes, including increased concentrations of dissolved material such as organic carbon, cations (particularly potassium), and plant nutrients (nitrogen and phosphorus) (see reviews in Carignan and Steedman 2000, Steedman and Morash 2001, Prepas et al. 2003, Steedman et al. 2004). There is some evidence that effects of harvesting and wildfire may differ (e.g., Carignan et al. 2000, Patoine et al. 2000, Planas et al. 2000, Pinel-Alloul et al. 2002). However, the transitory effects of both fire and harvesting on water quality appear to have limited impact on fish assemblages (St. Onge and Magnan 2000; Steedman 2003; Tonn et al. 2003, 2004).<br>Effects of harvesting and wildlfire on water quality appear to be influenced by the extent of catchment disturbance (Carignan et al. 2000, Prepas et al. 2001a), and do not appear to be prevented by shoreline buffers (Norris 1993, Devito et al. 2000, Carignan et al. 2000, Steedman 2000, Prepas et al. 2001b, Steedman et al. 2004).<br>While shoreline forest may not mitigate catchment-scale effects of harvesting, it |

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| | may influence other functional aspects of lake ecosystems.<br><br>Exposure of mineral soil associated with construction and use of logging roads and skid trails and mechanical site preparation may facilitate transport of sediment in runoff and subsequent deposition in waterbodies (see reviews in Steedman and Morash 2001, Steedman et al. 2004, Croke and Hairsine 2006). Sediment suspended in lake water can reduce sunlight penetration and thus decrease primary productivity of lakes, reduce the abundance of filter-feeding organisms, and affect the feeding efficiency of fish. Sediment may also change the nature of the lake bottom, covering spawning areas and suffocating fish eggs or fry if present (see reviews by Newcombe and McDonald 1991, Ward 1992, Wood and Armitage 1997). Shoreline buffers can provide an effective barrier to movement of sediment into aquatic habitats (see reviews in Castelle et al. 1994, Norman 1996, Lee et al. 2004, Croke and Hairsine 2006). However, shoreline buffers do not need to be comprised of unharvested forest to act as effective filters; characteristics of the forest floor that resist channeling (e.g., intact duff layer and root mat) and trap sediment (e.g., surface obstructions) and the pattern of disturbance of the forest floor (e.g., location and coverage of skid trails) may be the most important factors influencing dispersal of overland runoff and trapping of water-borne sediment (Haupt 1959, Haupt and Kidd 1965, Packer 1967, Martin et al. 2000, Kreutzweiser and Capell 2001, France 2002).<br><br>Removal of shoreline forest influenced diurnal temperature fluctuation but had limited effect on average littoral water temperature or whole-lake thermal regime in experimentally manipulated cold water lakes in northwestern Ontario compared to lakes with undisturbed shorelines (Steedman et al. 1998, 2001; Steedman and Kushneriuk 2000). Unfortunately, there are no comparable data for warm/cool water lakes where littoral waters might be more important fish habitats. However, Steedman (2003) found little impact of shoreline forest removal on the littoral fish community in cold water lakes. Moreover, Steedman et al. (2001) suggested that changes in the littoral water temperature regime they detected were likely not of sufficient magnitude to affect detrital decomposition, primary production, invertebrate growth, or fish behaviour or production (see references cited in Steedman et al. 2001).<br><br>In oligotrophic lakes, allochthonous inputs may represent up to 15% of the total carbon supply (France and Peters 1995) and inputs may be reduced by >90% for several years after harvesting shoreline forest (France 1997), resulting in reduced inputs of dissolved organic carbon (DOC) and total phosphorus (TP) (France et al. 1996). However, these effects are likely swamped by catchment scale inputs of DOC and TP following harvesting; concentrations of DOC and TP typically increase 2-3 times in lakes surrounded by clearcut catchments (see Carignan et al. 2000, Lamontagne et al. 2000). Reduced inputs of allochthonous material may influence litter-colonizing invertebrates. However, because of rapid regrowth of shoreline vegetation after harvest, effects are likely transitory (France 1998).<br><br>Harvesting of shoreline forest may influence future recruitment of coarse woody material into littoral zones (Guyette and Cole 1999, Bolgrien and Kratz 2000).<br><br>Removal of shoreline forest has been associated with increased wind velocity, wind-induced water mixing, and deeper thermoclines in some boreal lakes (France 1997) but not in all (Steedman and Kushneriuk 2000). Effects are generally assumed to be greatest for small lakes surrounded by relatively flat terrain (Steedman et al. 2004). Moreover, removal of shoreline forest by fire or harvesting appears to have similar effects (France 1997). |

*Shoreline forest*

In the absence of wildfire, harvesting is the only predictable tool that can be used to create habitat for species requiring young shoreline forest (see above). Partial harvesting may create sufficiently large canopy gaps to attract some species found in young shoreline forests such as the common yellowthroat and Lincoln's sparrow (Darveau et al. 1995). Moreover, narrow uncut shoreline buffers (which are largely edge habitat) may be used by some species frequently found in young shoreline forest such as the spotted sandpiper, Wilson's warbler, and rusty blackbird (Darveau et al. 1995, Whitaker and Montevecchi 1999). However, narrow unharvested or partially harvested buffers may not support the same community of songbirds as burned shoreline forest (Kardynal et al. 2009).

Moreover, for a species such as the beaver (and all the species dependent on beaver ponds), some clearcutting to the shoreline appears to be required (see 4.2.3). Clearcutting produces > twice as much intolerant hardwood regeneration as partial cutting (Palik et al. 2003). Moreover, early successional shoreline forest created by cutting benefits beavers only if it is accessible (see Potvin et al. 2005); most foraging by beavers occurs within 50 m of the edge of water (Martell et al. 2006).

Retention of narrow strips of shoreline forest is prescribed across North America to protect water quality and to provide habitat for species requiring older forest adjacent to water (see Lee et al. 2004). Can 30-90 m strips of residual shoreline forest (as per direction in Sections 4.1.1 and 4.1.2) provide this latter function?

Numerous studies describe the relationship between the width of strips of shoreline forest and the richness and abundance of breeding birds. In landscapes characterized by an inhospitable matrix (e.g., those dominated by farmland), strips of shoreline forest 100 to 200 m wide may provide habitat for the majority of forest-dependent species (e.g., Stauffer and Best 1980, Keller et al. 1993, Hodges and Krementz 1996, Groom and Grubb 2002).

In predominantly forested landscapes, 30 to 60 m wide strips of shoreline forest have been reported to maintain the preharvest bird community and mitigate edge-related nest predation in some studies (Darveau et al. 1995, 1997; Pearson and Manuwal 2001; Hagvar et al. 2004). However, other studies suggest that narrow strips of shoreline forest may be inadequate to maintain the complete suite of birds found in unharvested shoreline forest (Johnson and Brown 1990, Hagar 1999, Meiklejohn and Hughes 1999, Whitaker and Montevecchi 1999), and that shoreline forest may need to be >150 m wide to maintain all forest-interior species and mitigate edge-related predation (Spackman and Hughes 1995, Vander Haegen and DeGraaf 1996, Hannon et al. 2002).

However, when only terrestrial species that predominantly inhabit older shoreline forest are considered (see *Ecological significance*), narrow strips of shoreline forest appear to be sufficient to meet habitat needs.

For example, the northern waterthrush appears to adapt readily to narrow shoreline buffer strips. In Newfoundland and Quebec, shoreline buffers 20 to 60 m wide were used as frequently as unharvested shoreline forest (Darveau et al. 1995, Whitaker and Montevecchi 1999). Moreover, waterthrushes nesting in narrow buffer strips experienced a lower rate of nest predation than those nesting in unharvested shoreline forest, perhaps as a consequence of development of denser understory vegetation in shoreline buffers (Warkentin et al. 2004). [However, crowding of breeding individuals into narrow strips may reduce foraging efficiency (Warkentin et al. 2003).]

The Louisiana waterthrush is frequently considered to require large patches of

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| | mature forest (Robbins et al. 1989, Prosser and Brooks 1998). However, occupancy of strips of shoreline forest was not related to width in Ohio (Rodewald and Bakermans 2006) and this species has been found in shoreline buffers within clearcuts as narrow as 15 m (Triquet et al. 1990).<br><br>The winter wren will occupy shoreline buffer strips as narrow as 15-30 m (Darveau et al. 1995, Hagar 1999, Haag 2000, Pearson and Manuwal 2001); the influence of width on use is equivocal. In Washington, abundance was not related to buffer width (Pearson and Manuwal 2001) but in Oregon it was (Hagar 1999). In Quebec, shoreline buffers ≥40 m appeared to maintain abundance of winter wrens similar to that in unharvested shoreline forest (Darveau et al. 1995); in Oregon, shoreline buffers ≥80 m appeared to be necessary (Hagar 1999).<br><br>Small and medium mammals (mice to hares) generally appear to use narrow shoreline buffers (20-30 m wide) as frequently as wider ones (or uncut forest) (Cross 1985, Darveau et al. 1998, Hannon et al. 2002, Cockle and Richardson 2003). Moreover, unique small mammal communities associated with shoreline areas tend to occur in the non-forested riparian zone rather than in the shoreline forest (Macdonald et al. 2006).<br><br>Similar to small mammals, narrow shoreline buffers (10 to 35 m wide) appear to provide habitat for a variety of amphibians (especially streamside salamanders) (Hannon et al. 2002, Vesely and McComb 2002, Perkins and Hunter 2006a). This is not surprising since distinct 'riparian' assemblages of amphibians generally occur within a short distance of water (e.g., within 10 m of streams in Maine; Perkins and Hunter 2006b).<br><br>Narrow strips of shoreline forest may also provide habitat for many groups of invertebrates. For example, Monkkonen and Mutanen (2003) reported similar diversity and abundance of moths in 30-70 m wide riparian buffer strips and uncut riparian forest in Finland. Whitaker et al. (2000) found a 120 to 200% increase in the abundance of flying insects (primarily *Diptera* and *Hymenoptera*) in 20 m buffer strips compared to unharvested shorelines in Newfoundland. Hylander et al. (2004) found that 10 m buffer strips maintained the diversity of terrestrial snails in boreal forests in Sweden. However, very narrow buffers (<15 m wide) had a lower diversity of ground-dwelling spiders than did those >50 m wide in Ohio (Buddle et al. 2004).<br><br>Strips of forest 30 m wide generally appear to be adequate to mitigate the effects of harvesting on vascular and non-vascular plants in shoreline forest (Whitman and Hagan 2000, Fenton et al. 2003). This is not surprising since distinct 'riparian' communities of herbaceous plants generally occur within a short distance of water (e.g., within 5 m of streams in Maine; Hagan et al. 2006). Moreover, even clearcutting or burning to the edge of standing timber appears to have little effect on the composition of non-forested riparian vegetation communities (Lamb et al. 2003).<br><br>Retention of linear forested corridors (especially those associated with watercourses) has been a widely recommended strategy to maintain connectivity in landscapes subject to habitat loss or fragmentation (Harris 1984, Hunter 1990, Lindenmayer 1994). However, there remains considerable debate about the true value of corridors (see reviews by Hobbs 1992, Simberloff et al. 1992, Rosenberg et al. 1997, Beier and Noss 1998, MacDonald 2003). Whether residual forest corridors contribute to connectivity appears to be related to landscape structure, characteristics of the corridor itself, the scale at which organisms view their environment, and their relative mobility (Lindenmayer 1994, D'Eon et al. 2002, Taylor et al. 2006).<br><br>In landscapes characterized by an inhospitable matrix, corridors of suitable |

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| | habitat may need to be 100's of meters to 10's of kilometers wide to facilitate regional movement of large mammals such as cougars (Beier 1995) and black bears (Dixon et al. 2006). In contrast, observational and experimental studies suggest narrow corridors (<5 to 30 m wide) may facilitate localized movement of a wide variety of plants, insects, salamanders, and small mammals (La Polla and Barrett 1993, Bennett et al. 1994, Andreassen et al. 1996, Corbit et al. 1999, Haddad 1999, Townsend and Levey 2005, Damschen et al. 2006).<br><br>Even highly mobile animals such as birds may benefit from relatively narrow forested corridors. In the boreal forest, many dispersing songbirds are reluctant to cross wide forest gaps during the post-fledging period (Desrochers and Hannon 1997). Research in boreal Alberta suggests that residual forest corridors (100 m wide) can function as travel routes for dispersing juveniles, at least until adjacent clearcuts begin to regenerate (Machtans et al. 1996, Robichaud et al. 2002), and may have some effect on the composition of the breeding bird community in residual forest patches (Hannon and Schmiegelow 2002). In Chile, forested corridors 10 to 25 m wide facilitated songbird movement in otherwise deforested habitat (Sieving et al. 2000, Castellon and Sieving 2006).<br><br>*Shoreline trees*<br><br>Anthropogenic activities in shoreline areas may influence the dynamics of coarse wood recruitment (Christensen et al. 1996, Jennings et al. 2003, Steedman et al. 2004, Marburg et al. 2006). |
| Past direction | OMNR (1988) specified 30 to 90 m slope-dependent AOCs (measured from the high water mark) for all lakes >10 ha and all headwater lakes. Operations permitted within AOCs based on dominant fish community. |

**Rationale for direction**

Shoreline forest does not appear to have a significant mitigative effect on most watershed-scale impacts of harvest on hydrology or water quality (see above and detailed discussion in 3.2.2.3). However, shoreline forest may act as a barrier to transport of sediment in runoff and subsequent deposition in lakes and ponds (see above). Shoreline forest is also an important source of coarse woody material for the littoral zone of lakes and ponds. Moreover, shoreline vegetation may have some limited influence on water temperature, water circulation, and inputs of allochthonous material in lakes and ponds and may function as important habitat for terrestrial and semi-aquatic wildlife. Section 4.1.1 provides prescriptions for shoreline AOCs or CROs to address the first concern. Retention of residual forest and residual trees within AOCs is also prescribed to address the other concerns.

The federal *Department of Fisheries and Oceans* (DFO) has adopted a risk management approach to guide efforts to mitigate the effects of development on fish and fish habitat (see DFO 2007). Under this approach, appropriate mitigation is a function of risk, where risk is defined by the scale of potential negative effects and the sensitivity of fish and fish habitats. Direction in Section 4.1.1 adopts these guiding principles. Direction is more restrictive when operations have a higher potential for negative effects or when fish or fish habitats are likely to be more sensitive to potential effects. The potential for negative effects is based largely on the amount of site disturbance (e.g., road construction has a greater potential for negative effects than timber harvesting does) and the amount of canopy removal (e.g., clearcutting has a greater potential for negative effects than selection cutting does) associated with operations. When inventory data are available, sensitivity of fish or fish habitat is defined based on resilience of species to perturbation, habitat dependency, species or habitat rarity, and habitat resiliency (see Table 5 in DFO 2007). When inventory data are not available, sensitivity will be based on characteristics of the aquatic feature that are assumed to reflect many of the criteria noted above, such as size or connection to other features known to support, or that potentially support, a fishery. Use of the term sensitivity in this context should not be confused with *sensitive information about values* as defined in the *Forest Information Manual*.

All lakes are considered to have a high potential sensitivity to forest management operations. Ponds range from high to low potential sensitivity based on either assessment of inventory data or, in the absence of inventory data, on the classification of streams to which they are connected.

Lakes and ponds with high (HPS) or moderate (MPS) potential sensitivity to forest management operations are addressed through prescriptions for AOCs that focus on:

- minimizing the risk of sedimentation,
- providing future inputs of coarse woody material,
- mitigating the effects of harvesting on water temperature, water circulation, and inputs of fine organic material,
- mitigating the effects of forest management operations on hydrological linkages between aquatic and terrestrial ecosystems,
- maintaining some shoreline forest as residual habitat and dispersal corridors, and
- managing some shoreline forest to create some early to mid-successional riparian habitat.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* - For *large lakes, medium lakes, small lakes,* and *HPS* ponds, 30 to 90 m AOC based on slope.<br><br>For *MPS ponds,* 30 m AOC. | To minimize risk of sediment entering lakes and HPS or MPS ponds, shoreline AOCs are prescribed.<br><br>Most input of sediment in waterbodies from forestry operations is associated with road construction, landings, and watercrossings (see reviews in Stafford et al. 1996, Steedman and Morash 2001, Steedman et al. 2004). OMNR (1988) based the width of shoreline AOCs on the slope-dependent distance required to attenuate sediment in storm runoff from logging roads in a small study conducted in New Hampshire by Trimble and Sartz (1957). Subsequent research suggests that distance sediment will travel in runoff is strongly influenced by many interacting factors including climate, topography, soil texture, presence of surface obstructions, and numerous road characteristics (Haupt 1959, Packer 1967, Corbett et al. 1978, Swift 1986, Bilby et al. 1989, Elliot and Tysdal 1999, Luce and Black 1999, France 2002). However, slope or road gradient (which may be influenced by slope) is frequently cited as a critical factor influencing either erosion from road surfaces or subsequent sediment transport (Packer 1967, Swift 1986, Bilby et al. 1989, Elliot and Tysdal 1999, Luce and Black 1999, France 2002).<br><br>Buffers ranging from 15 to 60 m wide are generally considered to be adequate to slow surface water flow and trap suspended sediment from major sources of erosion (see reviews in Clinnick 1985, Castelle et al. 1994, Norman 1996, Wenger 1999, Lee and Smyth 2003, Croke and Hairsine 2006). Thus, is the 30-90 m wide AOC prescribed by OMNR (1988) overly conservative?<br><br>To evaluate this direction we modeled the relationship between the length of 174 sediment tracks originating from forest access roads and slope pooling data from studies in North Carolina (Swift 1986) and boreal Ontario (FESC 2004). Slope was a highly significant predictor of the length of sediment tracks ($P$ <0.001, $R^2$ = 0.294). Fig. 4.1a illustrates the functional relationship. The regression line represents the average |

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| | distance sediment traveled downslope from roads based on slope. The upper prediction limit approximates the maximum distance 95% of sediment tracks moved on specific slopes. The vertical lines in Fig. 4.1a partition the x-axis into the 4 slope categories used in OMNR (1988). The y-axis value corresponding to the intersection of the vertical lines with the upper prediction limit provides a conservative estimate of the AOC width needed to trap sediment for the corresponding slope category. Overall, the 30-90 m model proposed by Trimble and Sartz (1957) appears appropriate for slopes 0-15% and is likely conservative for slopes >15%. |

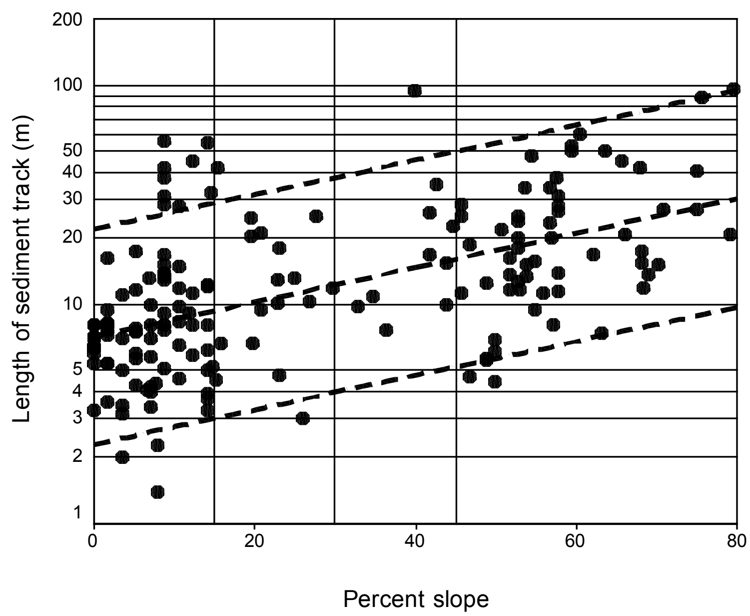


**Fig. 4.1a. Relationship between percent slope and length of sediment tracks based on data from North Carolina and Ontario. The dashed lines represent the regression line (middle) and upper and lower 90% prediction limits.**

Thus, continued use of the AOC width prescribed by OMNR (1988) should provide a conservative buffer between lakes and major potential sources of erosion (roads, landings). A 30-90 m AOC falls within the range prescribed for lakes in various jurisdictions across Canada (see Lee et al. 2004). Moreover, a 30-90 m AOC appears to be wide enough to meet many of the habitat functions of shoreline forest (see below) and at least partially mitigate the visual effects of harvesting in shoreline areas (Hunt and Haider 2004).

Accordingly, a 30-90 m AOC is prescribed for all lakes. However, ponds typically support <20% as many species of fish as lakes (see *Ecological Significance*), disturbance around ponds benefits keystone species like beavers (see 4.2.3), ponds within fire events would typically have higher levels of shoreline disturbance than would lakes (see Appendix 2), and visual effects of shoreline harvesting are generally less around ponds than lakes. Thus, the prescription for ponds varies based on the potential sensitivity to forest management operations. Ponds with a high potential sensitivity receive a 30-90 m AOC. Those with a moderate potential

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| | sensitivity receive a 30 m AOC. |
| *Standard* -The AOC is measured in the field from the edge of vegetation communities capable of providing an effective barrier to the movement of sediment. This will normally be those communities with ≥25% canopy cover of trees, tall (≥1 m high) woody shrubs such as alder or willow, or low (<1 m high) woody evergreen shrubs such as Labrador tea or leatherleaf. For mapping purposes, the AOC may be measured from the edge of polygons identified as FOR, TMS, or BSH. If the inner edge of the AOC will be ≥300 m from the shoreline of a lake or pond when these criteria are used, an AOC is not required adjacent to those sections of shoreline, unless the intervening wetland is known to provide components of fish habitat for which there is a high species' dependence (e.g., spawning habitat). | Shoreline AOCs should be comprised of vegetation communities capable of serving as a barrier to transport of sediment. All upland vegetation communities are considered to be potentially effective barriers. Moreover, wetlands that are not permanently or seasonally flooded (tall shrub fens, moderately rich to poor fens, all types of bogs, all types of swamps) may also be effective barriers to sediment transport (Racey 1997). Wetlands can be classified using the keys in OMNR (1993) or Harris et al. (1996). However, for ease of consistent identification (especially during winter operations), the AOC can be measured from the edge of wetland vegetation with ≥25% cover of trees, tall woody shrubs (e.g., alder), or low woody evergreen shrubs (e.g., Labrador tea) (see OMNR 1993:32); wetland communities with low woody deciduous shrubs (e.g., sweet gale) are typically poor barriers to sediment movement. For depiction on operations maps, the AOC can be modeled from the edge of polygons that are forest (code FOR), treed wetland (code TMS), or brush and alder (code BSH).<br><br>This approach is likely conservative and will exclude some acceptable fens and bogs that are dominated by sedges and grasses (see Harris et al. 1996 for information on the composition of wetland vegetation communities). Moreover, wide zones of marsh or fen vegetation presumably provide some filter functions (see Johnston et al. 1984, Whigham et al. 1988, Wardrop and Brooks 1998). Unfortunately, there is little published information to define an appropriate width threshold. The 30 m threshold defined for vegetation communities that are effective filters (as described above) is likely too narrow. A threshold 2 orders of magnitude greater (3000 m) is likely too conservative. As a precautionary approach, the direction prescribes an arbitrary threshold between these extremes (300 m). Consequently, if the inner edge of the AOC will be ≥300 m from the shoreline of a lake or pond when the above criteria are used, an AOC is not required adjacent to those sections of shoreline, unless the intervening wetland is known to provide components of fish habitat for which there is a high species' dependence (e.g., spawning habitat). |
| *Standard* - No harvest, renewal, or tending operations are permitted within the AOC that will result in damage to littoral zones or shorelines and associated stabilizing vegetation, or deposition of sediment within lakes or ponds. Operations specifically prohibited | Harvest, renewal, and tending operations could potentially damage littoral zones or shorelines and associated stabilizing vegetation, or result in the deposition of sediment within lakes or ponds. A number of restrictions are prescribed to mitigate potential effects and minimize the risk of creating a harmful alteration, disruption, or destruction of fish habitat. |

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| within the AOC include: | |
| … Machine travel within the inner 3 m of the AOC. | Creation of ruts or exposure of mineral soil directly adjacent to lakes or ponds is likely to result in deposition of sediment in the water feature. Compaction could also potentially reduce filtering capacity of the forest floor. The 3 m 'buffer' is based on OMNR (1998). |
| … Felling of trees into lakes or ponds or the inner 3 m of the AOC. Trees accidentally felled into lakes or ponds will be left where they fall. | Trees that fall into the littoral zone of lakes and ponds provide habitat for a wide range of aquatic species (see above). However, trees that are felled into water may potentially damage the littoral zone or shorelines and associated stabilizing vegetation when they are extracted. Direction is based largely on OMNR (1998). |
| … Excessive removal or damage of sapling-sized trees (<10 cm dbh) and shrubs within the inner 3 m of the AOC. | Removal or damage of sapling-sized trees (<10 cm dbh) and shrubs within the inner 3 m of the AOC may potentially reduce the stability and filtering capacity of the shoreline forest floor (see OMNR 1998). Ideally, no removal or damage of sapling-sized trees and shrubs should occur within this zone. However, zero removal or damage is likely not practical or feasible. How much removal or damage can occur before there is an effect on water quality is unknown. Operators must strive to limit removal or damage of sapling-sized trees and shrubs to that absolutely necessary for safe operations within shoreline areas. |
| … Disturbance of the forest floor that leaves ruts or a significant area of exposed mineral soil within the inner 15 m of the AOC (see Section 5.2). Ruts and significant patches of exposed mineral soil will be promptly rehabilitated to prevent sediment from entering a water feature. Patches of mineral soil exposed by natural events are excluded. | Mineral soil exposed by mechanical site preparation (Steedman and Morash 2001) or skidding (Stafford et al. 1996) is a potential (minor) source of sediment.<br><br>Skid trails may be problematic when they create channels for water flow that are perpendicular to shorelines (Kreutzweiser and Capell 2001; Kreutzweiser[1], pers. comm. 2006). Numerous studies suggest that effects of skid trails can be mitigated by applying careful operating practices (e.g., Martin and Hornbeck 1994, Martin et al. 2000, Kreutzweiser and Capell 2001, Macdonald et al. 2003). Plamondon (1982) suggested that effects of skidding can be mitigated by retaining a buffer of undisturbed forest floor 10-15 m wide. In low slope conditions (<15%), buffers of undisturbed herbaceous vegetation 10-20 m wide trap >80% of suspended sediment in water runoff from agricultural fields (see review in Wenger 1999).<br><br>Thus restrictions are placed on ruts and mineral soil exposure within the inner 15 m of the AOC. |
| … Disturbance of the forest floor that disrupts hydrological function (i.e., impedes, accelerates, or diverts water movement; see Section 5.2) within | Ephemeral streams that channel runoff from snow melt or rainfall events directly into water features can be significant conduits for the movement of sediment (Haupt and Kidd 1965, Kreutzweiser and Capell 2001, Maine Forest Service 2004). When springs, seeps, and other areas of shallow groundwater discharge enter lakes they can create important summer habitat for cold water fish such as brook trout (see 4.2.1). Thus, direction prohibits disruption of hydrological function within these features when associated with AOCs surrounding lakes or ponds. |

[1] Dave Kreutzweiser, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON

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| recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge connected to lakes or ponds. | |
| *Standard* - Harvest is permitted within the AOC subject to the following conditions: | Within AOCs, retention of some shoreline forest is prescribed because of its potential influence on water temperature, water circulation, and inputs of fine and coarse organic material (see above), as well as its role as habitat and dispersal corridors for terrestrial and semi-aquatic wildlife (see above). However, some management of shoreline forest is also encouraged to create young shoreline forest that is beneficial to a range of wildlife species (see above). Shoreline management is especially important around ponds to promote persistence of beavers and associated wildlife (see 4.2.3).<br><br>Macdonald et al. (2004) argued that narrow shoreline buffers have no natural analogue and thus do not emulate natural patterns. However, within disturbance events, small residual patches of unburned or lightly burned forest are often associated with shoreline areas (e.g., Heinselman 1973, Rowe and Scotter 1973, Eberhart and Woodard 1987). Studies from across the Canadian boreal forest suggest that shoreline forest tends to burn less frequently than surrounding upland forest (Larsen 1997, Andison and McCleary 2002, Landstrom 2003, Lee and Smyth 2003), possibly because shoreline areas differ in topography, soil moisture, and/or fuel availability, or act as effective fire breaks (Andison and McCleary 2002, Landstrom 2003, Lee and Smyth 2003). These results lend support for the retention of some residual forest strips adjacent to aquatic areas within the paradigm of emulating natural patterns (Lee and Smyth 2003). Moreover, they can fulfill a number of important ecological functions noted above. |
| … ≥50% of the area of the AOC (based on delineation of the AOC around the entire water feature, both inside and outside the harvest area) associated with *small lakes, HPS ponds,* and *MPS ponds,* ≥75% of the area of the AOC associated with *medium lakes,* and ≥90% of the area of the AOC associated with *large lakes* will be retained as forest that meets the definition of residual (see Section 3.2.2). | What mix of young and older shoreline forest is needed to meet the various ecological functions noted above? Unfortunately, there is no definitive answer to this question in the ecological literature. As a surrogate, we assume that ecological functions will be maintained when natural patterns are emulated (see Thompson et al. 2009).<br><br>What proportion of shoreline forest burns in natural disturbance events? Across North America, there is considerable empirical evidence that fire can play an important role in the dynamics of shoreline forest (Heinselman 1973, Eberhart and Woodward 1987, Denneler et al. 1999, Russell and McBride 2001, Dwire and Kauffman 2003, Pettit and Naiman 2007). However, only a small number of studies provide detailed quantitative information on the amount of shoreline burned within disturbance events. For example, Landstrom (2003) studied 23 large fires in northwestern Ontario and found that fire burned about 60% of the shoreline area within 50 to 100 m of lakes and streams.<br><br>Analysis of the pattern of shoreline disturbance around >1800 lakes within 42 fire events in the boreal and transition forests of Ontario suggests that an average of about 40 to 60% of shorelines associated with lakes and streams burn (see Appendix 2).<br><br>Overall, the median percent of shoreline area burned around lakes tended to be inversely related to the size of lakes (see Appendix 2). A median of 35-65% of the shoreline of lakes <100 ha burned while a median of 10- |

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| | 35% of the shoreline of lakes ≥100 ha burned. However, there was tremendous variation with values for individual lakes ranging from 0 to 100% for all sizes of lakes. Moreover, data were not normally distributed. For small lakes especially, fires typically burned <20 or >80% of the shoreline.<br><br>Based on these analyses, strict adherence to a natural disturbance paradigm might suggest that harvesting of entire shorelines of lakes could be permitted, as long as the average within events approached the average observed in natural disturbances. However, this approach would be relatively complicated to implement and monitor. Moreover, given the ecological importance of residual shoreline forest (see *Ecological significance*), the uncertainty about how much residual forest is required to meet all ecological functions, the inherent differences between burned and harvested forest, and the social resistance to shoreline harvesting, a more conservative approach based on the median estimates from the analysis in Appendix 2 that will maintain at least some residual forest around every lake and HPS or MPS pond is prescribed as follows:<br><br>• at least 50% of the shoreline of HPS or MPS ponds and lakes <100 ha in size will be maintained as residual forest,<br>• at least 75% of the shoreline of lakes ≥100 ha in size will be maintained as residual forest,and<br>• at least 90% of the shoreline of lakes ≥1000 ha in size will be maintained as residual forest.<br><br>This gradation in disturbance is intended to capture some of the variability typical of naturally disturbed landscapes and reflects the following factors:<br><br>• the median % of shoreline burned is inversely related to the size of lakes/ponds,<br>• wildlife using young shoreline forest is more typically associated with smaller lakes/ponds,and<br>• there are typically more potential aesthetic, recreational, and tourism concerns associated with larger lakes.<br><br>The residual forest target for lakes ≥1000 ha in size reflects the low end of the range noted for lakes ≥100 ha in size in Appendix 2 (there were few lakes in the dataset ≥1000 ha in size) and considers the potential aesthetic, recreational, and tourism concerns associated with very large lakes. |
| … When retaining residual shoreline forest, the inner 15 m will be mature forest with a relatively uniform canopy closure ≥60% (canopy openings not to exceed individual tree crowns) unless the adjacent harvest area outside the AOC meets the definition of residual forest. | Retaining mature forest within the inner 15 m increases the potential for the strip of shoreline forest to function as a travel corridor, provides more visual screening of the adjacent harvest area, and creates a pattern that is potentially more natural and aesthetically pleasing. |
| … Harvest that retains | Harvest that does not retain residual forest (e.g., conventional clearcutting) |

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| forest that does not meet the definition of residual (e.g., conventional clearcutting) is permitted within the AOC only where slope is ≤30%. | is not permitted on step slopes (i.e., >30%) because of the increased risk of erosion (see Archibald et al. 1997). |
| … For each ha of shoreline forest harvested that does not meet the definition of residual (e.g., conventionally clearcut) 1 ha of residual shoreline forest will be retained that has not been harvested within 20 years. | This *Standard* encourages retention of some shoreline forest that will develop old growth characteristics. |
| … Within the AOC, direction for the retention of downed woody material (see Section 3.2.3) will be followed. | Downed woody material is an important component of habitat for a wide variety of wildlife species, including those found in shoreline forest (see 3.2.3.2). Downed woody material may also impede downslope movement of soil, litter, and particulate matter, thus reducing risk of deposition of sediment in water features (Harmon et al. 1986, Maser et al. 1988). |
| *Standard* - No contamination of lakes or ponds by foreign materials is permitted. Specifically, | The *Fisheries Act 1985* prohibits the deposition of a deleterious substance of any type within water frequented by fish. Thus, restrictions are prescribed on the use and storage of fuels, equipment maintenance, and application of pesticides in shoreline areas. |
| … The use and storage of fuels will be carried out in accordance with the *Liquid Fuels Handling Code.* | Fuels and other oils that enter water may have a range of both acute and chronic effects on a wide array of aquatic organisms (Bhattacharyya et al. 2003) with the level of impact dependent on the type and amount of petrochemical involved, and the characteristics of the receiving water and its biota (Lytle and Peckarsky 2001). The use and storage of fuels will be carried out in accordance with the *Liquid Fuels Handling Code 2007.* |
| … No equipment maintenance (e.g., washing or changing oil) is permitted within 30 m of lakes or ponds. | See rationale for fuels and other oils above. |
| … Aerial application of pesticides for renewal, tending, or protection is permitted within the AOC but will follow spray buffer | Spray buffers for aerial application of pesticides for renewal, tending, and protection are outlined in the *Ontario Ministry of Environment/Ontario Ministry of Natural Resources Buffer Zone Guidelines for Aerial Application of Pesticides in Crown Forests of Ontario (1992)*.<br>The only insecticide routinely used for forestry applications in Ontario, *Bacillus thuringiensis* subsp. *kurstaki* (*Btk*), is considered to have very low |

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| zones for *significant areas* or *sensitive areas* (as appropriate) as prescribed in the *Ontario Ministry of Environment/Ontario Ministry of Natural Resources Buffer Zone Guidelines for Aerial Application of Pesticides in Crown Forests of Ontario* (1992). Machine-based ground application of herbicides (e.g., air-blast sprayers mounted on skidders) is permitted within the AOC; spray buffer zones will be 30 m for *significant areas* and 60 m for *sensitive areas*. Hand-based ground application of herbicides (e.g., back-pack sprayers) is permitted within the AOC; spray buffer zones will be 3 m. All spray buffer zones will be measured from the inner boundary of the AOC. | toxicity to non-target organisms (Gebhard et al. 1997, WHO 1999, Glare and O'Callaghan 2000). Consequently, no spray buffer zones are prescribed.<br><br>The most commonly used herbicides in Ontario (e.g., glyphosate) are also generally considered to have low toxicity to non-target organisms when applied at recommended doses; the potential for toxic effects is generally considered to be greatest in aquatic ecosystems (see reviews in Giesy et al. 2000, Lautenschlager and Sullivan 2002, Solomon and Thompson 2003, Tatum 2004). Thus, precautionary spray buffers of 60 and 120 m are prescribed adjacent to *significant* and *sensitive* aquatic areas, respectively.<br><br>Machine-based ground application of herbicides (e.g., air-blast sprayers mounted on skidders) is not addressed in the *Ontario Ministry of Environment/Ontario Ministry of Natural Resources Buffer Zone Guidelines for Aerial Application of Pesticides in Crown Forests of Ontario*. Spray buffer zones are prescribed based on the following information. The effective swath width of the air-blast sprayer typically used in Ontario (the Algonquin ABS) is normally considered to be about 25 m (i.e., about 12-13 m on either side of the prime mover), but may range from 20 to 34 m depending on the density and height of residual vegetation (Desrochers and Dunnigan 1991, Sidahmed and Brown 1994). Two studies conducted in central Ontario suggest that herbicide deposition was negligible >15 m and >20 m from the sprayer in shelterwood cuts and clearcuts, respectively (OMNR 1991, Brown and Sidahmed 1994). Thus, minimal herbicide deposition is likely to occur outside the targeted spray area and a spray buffer zone of 30 m between the targeted spray area and a water feature should be very conservative for most applications adjacent to *significant areas* (a 60 m buffer is prescribed for *sensitive areas*). The *Ontario Pesticides Act 1990* does not require a spray buffer during hand-based ground application of herbicides (backpack sprayers, basal bark applicators, injection equipment) adjacent to water features. However, to be precautionary, a 3 m buffer is prescribed. |
| *Guideline* - Harvest, renewal, and tending operations will follow appropriate operating practices to minimize rutting, compaction, and mineral soil exposure that could lead to erosion and subsequent transport and deposition of sediment in lakes or ponds (see Section 5.2). Particularly, … | Rutting and exposure of mineral soil is restricted within the inner 15 m of the AOC (see above). Following practices that minimize rutting and mineral soil exposure within the remainder of the AOC is also likely prudent to minimize the risk of sediment deposition in water.<br><br>The example addressing extraction trails simply expands on the direction (above) that restricts disruption of hydrological function in ephemeral streams, springs, seeps, and other areas of groundwater discharge. |
| *Guideline* - Harvest, renewal, and tending operations will, to the extent practical and feasible, encourage perpetuation of the | The composition and/or structure of shoreline forest may differ from that of adjacent upland forest. For example, in the GLSL forest, a narrow band of hemlock-dominated forest is frequently found bordering lakes within an otherwise, tolerant hardwood-dominated landscape (Guyette and Cole 1999). This distinctive shoreline forest condition may be a relatively rare component of the landscape and may influence the diversity of both |

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| distinctive character of the shoreline forest while emulating natural disturbances and/or succession (unless conversion is required to meet other ecological objectives). | terrestrial and aquatic organisms found in the riparian ecotone (e.g., Snyder et al. 2002, Bub et al. 2004). Silvicultural systems/harvest methods used within the shoreline AOC must be appropriate for the management of these distinct forest conditions and should, to the extent possible, emulate natural disturbances and/or succession typical of shoreline areas. |
| *Guideline* - Some or all of the requirements for the retention of residual forest within the AOC may be met by residual shoreline forest outside the harvest area, residual shoreline forest retained in overlapping AOCs, or residual shoreline forest retained in areas with steep slopes (>30%). Additional requirements for residual shoreline forest may be met by: | For efficiency, some or all of the requirements for the retention of residual forest within the AOC may be met by residual shoreline forest outside the harvest area, residual shoreline forest retained in overlapping AOCs, or residual shoreline forest retained in areas with steep slopes. |
| … Retaining residual shoreline forest to maintain the suitability of special habitats associated with lakes and ponds. | Retaining residual shoreline forest adjacent to special habitats (that are not otherwise identified as AOCs) may increase their suitability. For example, residual forest adjacent to MAFAs may provide access routes and visual screening (see 4.2.4). |
| … Retaining residual shoreline forest to maintain internal and external connectivity. To the extent practical and feasible within the AOC, a relatively continuous corridor (average width of gaps <50 m; maximum width of gaps <200 m) of residual forest at least 30 m wide will be retained along at least 1 side of each lake or pond to connect special habitat features (e.g., osprey nests, MAFAs) | The potential function of residual shoreline forest as a travel corridor is discussed above.<br>To the extent practical and feasible, residual forest should be retained to connect other shoreline forest retained for specific reasons (e.g., osprey nests, MAFAs) (internal connectivity) and link with residual forest associated with other water features (external connectivity).<br>Does riparian forest need to be in a continuous band to function as a corridor? Small songbirds are usually reluctant to cross gaps >50 m wide but will occasionally cross gaps up to 200 m wide depending on the length of alternate routes (Desrochers and Hannon 1997, St. Clair et al. 1998, Belisle and Desrochers 2002). Larger birds such as hairy woodpeckers and blue jays frequently cross gaps >200 m wide (Grubb and Doherty 1999). Small mammals such as red squirrels and eastern chipmunks will readily cross gaps >200 m wide (Bowman and Fahrig 2002, Bakker and Van Vuren 2004). Medium-sized mammals such as the American marten typically do not venture >50 m into forest <5 years old and >100 m into forest <20 years old (Thompson[1], pers. comm.  2007). Large mammals such as moose are generally reluctant to go >100 m into young forest |

[1] Ian Thompson, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, ON

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| associated with the lake or pond and link with residual forest on connected lakes, ponds, rivers, and streams. | during winter (Hamilton et al. 1980, Thompson and Vukelich 1981). Thus, riparian forest retained as corridors should be as continuous as possible; most gaps should likely be <50 m and none should exceed 200 m. |
| … Retaining residual shoreline forest to emulate natural patterns. | Retaining residual shoreline forest to emulate natural patterns is consistent with OMNR's overall philosophy of emulating natural disturbances. A number of factors appear to influence the likelihood that patches of forest will remain unburned within a wildfire:<br>• forest on the leeward shore of lakes appears to have a lower likelihood of burning (Thomas 1998),<br>• some forest types (e.g., hardwood) may be less flammable and thus appear to have a lower likelihood of burning (Smyth 1999, Kafka et al. 2001, Epting and Verbyla 2005), and<br>• forest on wet sites (e.g., lowland conifer) appears to have a lower likelihood of burning (Arsenault 2001, Nowak et al. 2002, Rees and Juday 2002).<br>However, there is high variability in the type, amount, and distribution of residual forest within wildlfires (e.g., Perera et al. 2009). Thus, retention of residual shoreline forest to emulate natural patterns should normally not over-ride other ecological considerations noted above. |
| … Retaining residual shoreline forest that has the highest likelihood of being windfirm. | To the extent practical and feasible, retention of shoreline forest that is windfirm is preferable since forest that blows down will not function as residual habitat or a travel corridor. However, identification of windfirm forest can be problematic since many factors including local climate, topography, soil characteristics, tree species, and stand height, age, and density interact to determine risk of windthrow (Ruel 1995). Some windthrow hazard rating systems are available (e.g., Ruel et al. 2002). |
| *Guideline* - Within the inner 15 m of the AOC, at least 10 trees/100 m of shoreline spaced about 10 m apart will be retained as a potential source of future aquatic coarse woody material. Living trees with the following characteristics will be preferentially retained:<br>• At least 15 m tall (or the tallest of those available).<br>• Close to the shoreline (ideally within ½ the height of the tree).<br>• Leaning toward the | Coarse wood provides many essential ecological functions in lake habitats (see above). Thus, direction requires retention of some residual trees along shorelines that will eventually fall into aquatic habitats to replace decay of existing supplies.<br>Estimates of the supply of coarse wood in the littoral zone of individual lightly developed lakes within the GLSL/transition forests of Ontario, Michigan, and Wisconsin are highly variable, ranging from <100 to >1000 logs/km of shoreline (Christensen et al. 1996; Jennings et al. 1999; Mallory et al. 2000; Marburg et al. 2006; Sass et al. 2006; Cole[1], unpubl. data), with a mean from about 50 lakes of 300 to 400 logs/km. Only one study documents littoral zone coarse wood in boreal lakes; Steedman et al. (2004) reported 100 to 200 logs/km in 3 boreal lakes from northwestern Ontario. While Steedman et al.'s estimate is lower than the mean for GLSL lakes, it is well within this range. Thus, 300 to 400 logs/km may be an acceptable approximation for the entire AOU.<br>There is little published information on the rate of decay of coarse wood in lake ecosystems. Mean residence time of conifer logs was estimated at about 260 years (decay rate of 0.3%/yr) in one study in central Ontario (Guyette et al. 2002). However, this estimate is based on large diameter |

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| shoreline.<br>• Coniferous supercanopy trees, scattered conifers, and veterans, especially large cedars, white pines, red pines, hemlocks, white spruces, red spruces, and jack pines. | white pine logs and may underestimate decay rate of smaller logs of other tree species (Cole[1], pers. comm. 2007). Annual rate of decay in terrestrial situations for tree species typical of the boreal and GLSL forests in Ontario generally ranges from 2 to 10% (see summary in Tyrell and Crow 1994). Since, coarse wood can reside for an order of magnitude longer in lakes than in terrestrial ecosystems (Guyette et al. 2002); comparable annual rates of decay in lakes are assumed to range from 0.2 to 1.0%. Assuming 350 logs/km of shoreline and an annual decay rate of 0.6%, an annual input of about 2.1 logs/km of shoreline would be required to balance losses to decay.<br><br>Does this mean that 2.1 trees must fall into the water along each km of shoreline each year to maintain the supply of coarse wood? Trees typically break into smaller pieces following death and thus may contribute >1 log to aquatic systems (Lienkaemper and Swanson 1987, Bragg et al. 2000). In central Ontario, 780 pieces of aquatic coarse wood averaged 2.9 m in length (Cole[1], unpubl. data). Thus, desired input can be expressed as a total of about 6.1 linear m of coarse wood/km/yr.<br><br>How many shoreline trees are needed to provide this rate of recruitment? Based on taper equations developed for 10 common tree species found in Ontario (Zakrzewski 1999, Zakrzewski and MacFarlane 2006), a 15 m tall shoreline tree potentially contains about 9.0 linear m of bole that is at least 10 cm in diameter (range 6.4 to 11.2 m). However, since individual logs averaged 2.9 m in length in central Ontario (see above) and logs in this study only needed to be 10 cm at the large end to be classed as coarse wood, the total amount of coarse wood that a 15 m tall tree could contribute is likely closer to 12.0 linear m. This is a conservative estimate because it does not consider the potential contribution of large limbs.<br><br>The probability of a 15 m tall tree falling into water is inversely related to distance from the shoreline and ranges from about 75% right at the water's edge to 28% when 10 m from the water's edge (see Appendix 3). When a 15 m tall tree falls into the water, the amount of the bole that enters the water as coarse wood is also inversely related to the distance from the shoreline and ranges from 12.0 m right at the water's edge to 2.0 m when 10 m from the water's edge. Combining these 2 factors and assuming a uniform distribution of trees between 0 and 10 m from shore suggests that individual shoreline trees likely contribute an average of about 4.2 linear m of coarse woody material or 1.4 logs (see Appendix 3).<br><br>Thus, to provide an annual input of 6.1 linear m/ or 2.1 pieces of coarse wood/km to balance losses to decay requires the death/falling of about 1.5 trees/km/yr. Assuming a rotation age of 50 to 100 years for even-aged silviculture, the retention of 75 to 150 trees/km within about 10 m of water features at the time of harvest should maintain a relatively stable supply of coarse wood in the littoral zones of lakes. Since estimates of input rate are likely conservative (contribution of large limbs not included, contribution from segments of the shoreline that are retained as residual forest underestimated), the lower end of this range is used (10 trees/100 m of shoreline, spaced approximately 10 m apart).<br><br>Any residual tree may potentially contribute to the pool of coarse wood in lakes and ponds if within ½ to 1 tree height (Christensen et al. 1996, Steedman et al. 2004, Reeves et al. 2006) of the shoreline. However, |

[1] Bill Cole, OMNR, Ontario Forest Research Institute, Sault Ste. Marie, ON

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| | scattered coniferous trees and coniferous supercanopy trees and veterans may be especially valuable. Coniferous logs have a longer residence time than hardwood logs (Cole et al. 2003). Coniferous trees also typically have a more complex branching structure and more complex bark than hardwoods, and thus provide better cover for schooling fish such as minnows, bluegills, and walleye (Newbrey 2002) and may support a higher diversity of invertebrates (Bowen et al. 1998).<br><br>Thus, the majority of trees retained to produce coarse wood should be living coniferous supercanopy trees (all FUs), scattered conifers (selection FUs), or veterans (shelterwood and clearcut FUs) because of their value to terrestrial wildlife, their longevity as logs, and their increased value to fish and other aquatic organisms (see above). Trees should be at least 15 m tall (or the tallest of those available). Trees closer to shorelines and leaning toward water should be retained preferentially because they have a higher likelihood of falling into the water feature. This direction applies to all FUs. However, tree retention practices in uneven-aged silvicultural systems will likely usually exceed this standard and thus may require relatively minor modification (e.g., more focus on retention of conifers). |
| *Guideline* - Within the remainder of the AOC, the general direction for retention of wildlife trees in harvest areas (see Section 3.2.3) will be followed. However, the focus will be on living trees with preferential retention of windfirm trees that provide the following special habitat features for wildlife:<br><br>• Supercanopy trees (all forest units) of value to eagles and ospreys such as white and red pines (and poplars in the boreal forest).<br>• Large living hardwood trees with existing cavities or the potential to develop cavities (all forest units).<br>• Scattered coniferous trees (selection forest units) or veteran trees (clearcut and shelterwood forest units). | Within the remainder of the shoreline AOC, retention of residual trees should follow the general direction for retention of wildlife trees in areas of operations (Section 3.2.3) with the following modifications.<br><br>In wildfires, a higher proportion of residual trees in moist sites, such as riparian habitats, tend to be living compared to those in drier, upland sites (Andison and McCleary 2002, Keeton and Franklin 2004). Moreover, trees with special ecological significance in shoreline areas tend to be living (see above).<br><br>Thus, retention of wildlife trees in the remainder of the shoreline AOC should focus on 25 living trees/ha (approximate spacing of 20 by 20 m) with preferential retention of windfirm trees that provide special habitat features for wildlife that inhabit shoreline forest including supercanopy trees (for eagles and ospreys), large living hardwood trees with existing cavities or the potential to develop cavities (for cavity-nesting waterfowl), and scattered coniferous trees or veterans (especially large cedars, white pines, red pines, hemlocks, white spruces, red spruces, or jack pines) (future supercanopy trees). |

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| *Best management practices* | To the extent practical and feasible, minimizing machine travel and avoiding piling of felled trees within the inner 15 m of the AOC will reduce disturbance of the forest floor and further reduce the risk of deposition of sediment within water features.<br><br>When normal harvest, renewal, and tending operations may not perpetuate the distinctive character of the shoreline forest while emulating natural disturbances and/or succession, prescribed burning should be considered a renewal option. |
| *Standard* - No landings or aggregate pits are permitted within the AOC. | Since roads, landings, and aggregate pits are the primary source of exposed mineral soil that can lead to sediment deposition in water (see above), landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - New roads that are not associated with an approved crossing are not permitted within the AOC unless no practical or feasible alternative exists, appropriate mitigative measures are taken to minimize the risk of sediment entering lakes or ponds (see Section 5.1), and the road, including specific location, is identified and justified through the FMP AOC planning process. | Since roads, landings, and aggregate pits are the primary source of exposed mineral soil that can lead to sediment deposition in water (see above), new roads are not permitted within the AOC unless no practical or feasible alternative exists, appropriate mitigative measures are taken to minimize the risk of sediment entering lakes or ponds (see Section 5.1), and the road, including specific location, is identified and justified through the FMP AOC planning process. |
| *Guideline* - New roads that traverse the AOC will be planned to avoid areas with a high potential to contain ephemeral streams, springs, seeps, and other areas of groundwater discharge. Crossings of recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge will consider the design principles in Section 5.1 to minimize the risk of sediment delivery and | The importance of ephemeral streams, springs, seeps, and areas of groundwater discharge is discussed above.<br><br>New roads within the AOC will be planned to avoid areas with a high potential to contain these features to minimize potential for impacts. These areas may be identified by hydrological modeling (e.g., see 5.2.5), examination of air photos, or field surveys.<br><br>Crossings of recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge will consider the design principles in Section 5.1 to minimize the risk of sediment delivery and disruption of hydrological function. |

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| disruption of hydrological function. | |
| *Guideline* - When new roads traverse residual forest within the AOC, the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | Width of the cleared road corridor should be as narrow as practical and feasible to facilitate the travel corridor function of residual shoreline forest. A maximum width of 20 m was considered an achievable target. |

Ponds with low potential sensitivity to forest management operations are addressed through CROs. These consist of a subset of restrictions prescribed for HPS or MPS ponds and focus on minimizing site disturbance within 15 m of LPS ponds. There is no requirement to retain residual shoreline forest adjacent to LPS ponds. This provides an opportunity for disturbance of entire shorelines on some (the least sensitive) water features to emulate patterns created by natural disturbances such as wildfire (see Appendix 2).

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### 4.1.2. Flowing waters: rivers and streams

**Background**

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| Description | Rivers and streams are relatively shallow linear bodies of unidirectional flowing water characterized by constantly changing shorelines, highly variable deposition of sediments, high and variable turbidity, large fluctuations in water level, and rapid flushing rates (Wetzel 2001).<br><br>Characteristics and dynamics of flowing watercourses vary predictably from their headwaters to their mouths (Wetzel 2001). Headwater streams (stream orders 1 to 3) are typically <10 m wide. Surrounding forest canopy limits light availability and thus headwater streams have low primary productivity and depend on inputs of allochthonous organic material to support food webs. Invertebrate communities tend to be dominated by large particulate shredders and fine particulate collectors. Rivers (midreaches) (stream orders 4 to 6) are wider (10 to 50 m) and thus less influenced by the adjacent forest canopy. Increased light availability results in greater primary productivity attributable to benthic periphyton. Inputs of allochthonous materials are less significant to food webs. Consequently, invertebrate communities are dominated by fine particulate collectors, periphyton grazers, and benthic filter feeders. Large rivers (stream orders 7 to 12) are wide (>50 m); the shoreline forest has little influence on light availability. Consequently, primary production is high and associated with benthic periphyton, macrophytes, phytoplankton, inputs of fine particulate matter from flood plains, and upstream accrual. Invertebrate communities tend to be dominated by benthic filter feeders, sediment burrowers, and water column filter feeders.<br><br>Two types of streams are often defined (Hewlett 1982, NC Div. Wat. Qual. 2005). Permanent streams have a well-defined channel and flow throughout the majority (≥90%) of the year. The streambed is generally located below the water table and groundwater (or a permanent water feature) is the primary source of flow. Intermittent streams also have a well-defined channel but flow only during wet seasons (30-90% of the year). During the driest part of the summer flow may be reduced to a trickle or may only occur within the streambed. |
| Ecological significance | *Rivers and streams*<br><br>Rivers and streams provide habitat for a wide diversity of aquatic and semi-aquatic plants and animals. This includes >60 species of mammals, birds, reptiles, and amphibians ranging from turtles to waterfowl to aquatic furbearers such as beavers, muskrats, and otters (Bellhouse and Naylor 1997).<br><br>Rivers and streams support about 40 and 50 species of fish, respectively (Scott 1967, Scott and Crossman 1973). This list includes game fish, such as the brook trout, northern pike, and smallmouth bass, as well as 4 species at risk, including the northern brook lamprey (see 4.3).<br><br>Very small streams (especially those that flow intermittently) may support few species of fish but may provide nursery habitat for some species such as brook trout (Curry et al. 1997, Borwick et al. 2006), may support a diverse invertebrate community (Huryn 2000), may represent unique habitats for other organisms (Moore and Richardson 2003), and contribute to the quality of water in higher order streams (Naiman and Latterell 2005).<br><br>*Shoreline forest*<br><br>Temperature of streams influences many ecological processes and biotic interactions from rates of primary production to solubility of oxygen (Johnson |

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| | and Jones 2000). Because fish have specific temperature tolerances (Richards and Hollingsworth 2000), the assemblage of species found in streams is strongly influenced by thermal regime (e.g., Barton et al. 1985). Stream temperature represents a complex interaction between shade produced by shoreline vegetation along a specific reach, the amount of shoreline vegetation upstream, the stream's width, gradient, and total discharge, and proximity to groundwater discharge (Barton et al. 1985, Story et al. 2003, Sridhar et al. 2004, Wilzbach et al. 2005).<br><br>Inputs of fine organic matter (leaves, twigs) from shoreline vegetation are a critical component of food webs of headwater stream ecosystems (Wetzel 2001).<br><br>Shoreline forest also provides inputs of coarse woody material that are generally considered to be functionally important, especially in stream ecosystems (see *Shoreline trees*).<br><br>See 4.1.1 for a general discussion of the significance of shoreline forest as habitat for a variety of terrestrial and semi-aquatic species.<br><br>A number of species appears to be entirely or largely dependent on shoreline forest. Many of these species are found in shoreline forest adjacent to both standing or flowing water (see 4.1.1), but the following species appear to be restricted to shoreline forest associated with rivers and streams:<br><br>*Louisiana waterthrush* –This species at risk is usually considered to be a shoreline forest specialist. It typically nests in mature hardwood or mixedwood forest, within 5 m of permanent headwater streams (see 4.3.6).<br><br>*Wood turtle* – This *endangered* turtle is typically associated with large streams and rivers and associated shoreline habitats; alder thickets and young open mixed forest appear to be especially favoured habitats (see 4.3.5). While female turtles may wander >250 m from water during summer, the majority of sightings of both sexes are within 30 m of water (e.g., Wesley 2006).<br><br>*Shoreline trees*<br><br>See 4.1.1 for a general discussion of the significance of shoreline trees as habitat for a variety of terrestrial, semi-aquatic, and aquatic species.<br><br>Further to the general discussion in 4.1.1, in streams, coarse wood may trap particulate organic matter, influence stream velocity, channel morphology, and the formation of pools, thus creating a diversity of habitat conditions for aquatic organisms (Harmon et al. 1986, Dolloff and Webster 2000, Johnson et al. 2003, Naiman and Latterell 2005; but see Kreutzweiser et al. 2005b). |
| Effects of forest management | *Rivers and streams*<br><br>Disturbance of small headwater catchments by harvesting and wildfire typically results in changes in water yield, peak flows, water chemistry, and water temperature (see reviews in Steedman and Morash 2001, Steedman et al. 2004, Nitschke 2005); some effects may last 10 to 30 years following harvesting (Swank et al. 2001, Brown et al. 2005, McLaughlin and Phillips 2006). Hydrologic response to disturbance on larger catchments appears to be more limited (Buttle and Metcalfe 2000). There is some evidence that effects of harvesting and wildfire on water yield and chemistry may differ (Nitschke 2005). Moreover, effects of severe fires may result in at least temporary loss of certain fish species from burned reaches (see review in Dunham et al. 2003).<br><br>While shoreline forest may not mitigate catchment-scale effects of harvesting in lakes (see 4.1.1), it may have a more significant role in stream ecosystems |

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| | because shoreline forest adjacent to streams is more likely to be associated with major watershed flow paths (Trettin et al. 1997, Hornbeck and Kochenderfer 2000, Verry and Dolloff 2000).<br><br>Moreover, shoreline forest may also help maintain other ecological functions of river and stream ecosystems. For example, shoreline vegetation (especially the expansive root systems of trees) buffers stream banks from the erosive force of flowing water (see summary in Palik et al. 2000).<br><br>Exposure of mineral soil associated with construction and use of logging roads and skid trails and mechanical site preparation may facilitate transport of sediment in runoff and subsequent deposition in watercourses (see review in Steedman and Morash 2001, Steedman et al. 2004). Sediment suspended in water can reduce sunlight penetration and thus decrease primary productivity, reduce the abundance of filter-feeding organisms, and affect the feeding efficiency of fish. Sediment may also change the nature of the river or stream bottom, covering spawning areas and suffocating fish eggs or fry if present (see reviews in Newcombe and MacDonald 1991, Ward 1992, Wood and Armitage 1997). Shoreline buffers can provide an effective barrier to movement of sediment into aquatic habitats (see reviews in Castelle et al. 1994, Norman 1996, Lee et al. 2004, Croke and Hairsine 2006). However, shoreline buffers do not need to be comprised of unharvested forest to act as effective filters; characteristics of the forest floor that resist channeling (e.g., intact duff layer and root mat) and trap sediment (e.g., surface obstructions) and the pattern of disturbance of the forest floor (e.g., location and coverage of skid trails) may be the most important factors influencing dispersal of overland runoff and trapping of water-borne sediment (Haupt 1959, Haupt and Kidd 1965, Packer 1967, Plamandon 1982, Martin et al. 2000, Kreutzweiser and Capell 2001, France 2002).<br><br>Removal of shoreline forest influences thermal regime in headwater streams (see reviews in Steedman and Morash 2001, Steedman et al. 2004). Effects of clearcutting and wildfire on maximum daily temperature and diurnal flux are generally of similar magnitude (see review in Nitschke 2005). However, thermal regime of streams adjacent to clearcuts appears to be more variable, perhaps because fire-killed trees provide some functional shade (Nitschke 2005). Effects can be mitigated by partial harvest (Macdonald et al. 2003; Kreutzweiser et al. 2004, 2009; Nitschke 2005) or retention of forested streamside buffers (Steedman et al. 2004).<br><br>Clearcutting streamside forest can reduce fine organic matter inputs (Webster and Waide 1982, Webster et al. 1990, Hartman et al. 1996). However, partial harvest (up to 40% BA removal) did not affect inputs of fine organic matter or associated macroinvertebrates in headwater streams in the Algoma area (Kreutzweiser et al. 2004, 2005a). Moreover, consumers may be able to adjust to relatively low levels of shoreline forest removal (England and Rosemond 2004).<br><br>Clearcutting shoreline forest may result in a reduction in recruitment of coarse woody material until the regenerating forest matures, with the potential for long-term effects on stream geomorphology and function (Dolloff and Webster 2000, Meleason et al. 2003, Jones and Daniels 2008). However, partial harvest may have minimal effect on recruitment in streams (Kreutzweiser et al. 2004). Moreover, the influence of coarse woody material on stream morphology and pool formation appears to be less significant in the boreal forest than in other forest regions because of the relatively small size and instability of coarse woody inputs (Kreutzweiser et al. 2005b). |

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| | *Shoreline forest*<br>See 4.1.1 for a discussion of the general effects of harvest on use of shoreline forest by terrestrial and semi-terrestrial wildlife. |
| Past direction | OMNR (1988) specified 30 to 90 m slope-dependent AOCs (measured from the high water mark) for all permanent streams and intermittent streams providing spawning habitat. Operations permitted within AOCs based on dominant fish community. |

**Rationale for direction**

Shoreline forest does not mitigate all catchment-scale impacts of harvest on hydrology or water quality. However, shoreline forest associated with streams may have a greater mitigating influence on some effects than does shoreline forest associated with lakes (see above). Moreover, shoreline forest may stabilize banks, act as a barrier to transport of sediment in runoff and subsequent deposition in rivers and streams, and may be an important determinant of water temperature, inputs of fine and coarse organic material (see above) and may function as important habitat for terrestrial and semi-aquatic wildlife. Section 4.1.2 provides prescriptions for shoreline AOCs or CROs to address the first two concerns and retention of residual forest and residual trees within AOCs to address the latter 4 concerns.

The federal *Department of Fisheries and Oceans* (DFO) has adopted a risk management approach to guide efforts to mitigate the effects of development on fish and fish habitat (see DFO 2007). Under this approach, appropriate mitigation is a function of risk, where risk is defined by the scale of potential negative effects and the sensitivity of fish and fish habitats. Direction in Section 4.1.2 adopts these guiding principles. Direction is more restrictive when operations have a higher potential for negative effects or when fish or fish habitats are likely to be more sensitive to potential effects. The potential for negative effects is based largely on the amount of site disturbance (e.g., road construction has a greater potential for negative effects than timber harvesting does) and the amount of canopy removal (e.g., clearcutting has a greater potential for negative effects than selection cutting does) associated with operations. When inventory data are available, sensitivity of fish or fish habitat is defined based on resilience of species to perturbation, habitat dependency, species or habitat rarity, and habitat resiliency (see Table 5 in DFO 2007). When inventory data are not available, sensitivity will be based on characteristics of the aquatic feature that are assumed to reflect many of the criteria noted above, such as size, upstream catchment area, flow regime, and/or connection to other features known to support, or that potentially support, a fishery. Use of the term sensitivity in this context should not be confused with *sensitive information about values* as defined in the *Forest Information Manual*.

All rivers are assumed to have a high potential sensitivity to forest management operations. Streams range from high to low potential sensitivity.

Numerous regional, watershed, and reach-scale factors influence fish assemblages in streams (e.g., Wang et al. 2003, Brazner et al. 2005, Frimpong et al. 2005). For permanent mapped streams, catchment area and distance to a source of fish (i.e., lake, river, or large stream) are used to estimate potential sensitivity in the absence of inventory data. Catchment area is used because it is easily modeled and tends to be correlated with stream size and thermal regime and has a strong influence on fish assemblages (Zorn et al. 2002, Wang et al. 2003). For example, brook trout generally have a low likelihood of occupying streams (and associated beaver ponds) if upstream catchment area is <3 $km^2$ (Parker 2006; Mackereth[1], unpubl. data). However, brook trout may occupy streams with catchment area <3 $km^2$ if streams are connected to a fish source; brook trout have been found to travel from <100 to >500 m up small streams that are connected to lakes or larger streams (Curry et al. 1997; Borwick et al. 2006; Mackereth[1], unpubl. data).

[1] Rob Mackereth, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

For permanent unmapped streams encountered during operations, catchment area will be unknown. Instead, potential sensitivity (in the absence of inventory data) is based on distance to a source of fish. Permanent unmapped streams are assumed to have a moderate potential sensitivity if they are within 500 m of a fish source (see above).

In the absence of inventory data, intermittent streams are assumed to have a low potential sensitivity unless they are connected to lakes or streams known to support brook trout (see Curry et al. 1997, Borwick et al. 2006).

Rivers and streams with high or moderate potential sensitivity to forest management operations are addressed through prescriptions for AOCs that focus on:

- protecting beds, banks, and shorelines,
- minimizing the risk of sedimentation,
- mitigating the effects of harvesting on water temperature and inputs of fine organic material,
- mitigating the effects of forest management operations on hydrological linkages between aquatic and terrestrial ecosystems,
- providing future inputs of coarse woody material,
- maintaining some shoreline forest as residual habitat and dispersal corridors, and
- managing some shoreline forest to create some early to mid-successional riparian habitat.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* – For *rivers* and *HPS* streams, 30 to 90 m AOC based on slope.<br>For *MPS streams,* 30 m AOC. | To minimize risk of sediment entering rivers and HPS or MPS streams, shoreline AOCs are prescribed.<br>See discussion of factors affecting sediment inputs from forestry operations in 4.1.1.<br>Continued use of the AOC width prescribed by OMNR (1988) should provide a conservative buffer between rivers and streams and major potential sources of erosion (roads, landings). Accordingly, 30-90 m AOCs are prescribed for rivers and streams that have a high potential sensitivity to forest management operations. However, since these AOC widths are conservative and since streams would frequently burn to the shore (see Appendix 2), a 30 m AOC is prescribed for streams with moderate potential sensitivity. These specifications generally fall within the range prescribed for rivers and streams in various jurisdictions across Canada (see Lee et al. 2004). |
| *Standard* – The AOC is measured in the field from the edge of vegetation communities capable of providing an effective barrier to the movement of sediment … | See 4.1.1 for rationale. |
| *Standard* – No harvest, renewal, or | Harvest, renewal, and tending operations could potentially damage stream beds or banks and associated stabilizing vegetation, or result in the |

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| tending operations are permitted within the AOC that will result in damage to river or stream beds or banks and associated stabilizing vegetation, or deposition of sediment within rivers or streams. Operations specifically prohibited within the AOC include: … | deposition of sediment within rivers or streams. A number of restrictions are prescribed to mitigate potential effects and minimize the risk of creating a harmful alteration, disruption, or destruction of fish habitat.<br><br>See 4.1.1 for rationale. |
| *Standard* – Harvest is permitted within the AOC subject to the following conditions: | In contrast to lakes, shoreline forest adjacent to streams has some mitigative influence on catchment-scale effects of harvest and a significant influence on water temperature and inputs of allochthonous materials (see above). Similar to lakes, it provides habitat and dispersal corridors for terrestrial and semi-aquatic wildlife (see above). Minimum levels of forest retention are required within AOCs. However, some management of shoreline forest is also encouraged to create young shoreline forest that is beneficial to a range of wildlife species (see above). |
| … Forest that meets the definition of residual (see Section 3.2.2) must be retained within the AOC (based on delineation of the AOC along the entire water feature, both within and outside the harvest area) on at least 1 side of *rivers, HPS streams*, and *MPS streams* to provide a travel corridor. | What mix of young and older shoreline forest is needed to meet the various ecological functions noted above? Unfortunately, there is no definitive answer to this question in the ecological literature. As a surrogate, we assume that ecological functions will be maintained when natural patterns are emulated (see Thompson et al. 2009).<br><br>What proportion of shoreline forest burns in natural disturbance events? Across North America, there is considerable empirical evidence that fire can play an important role in the dynamics of shoreline forest (see references in 4.1.1). However, only a small number of studies provide detailed quantitative information on the amount of shoreline burned within disturbance events. For example, Landstrom (2003) studied 23 large fires in northwestern Ontario and found that fire burned about 60% of the shoreline area within 50 to 100 m of lakes and streams. Lee and Smyth (2003) studied one large fire in Alberta's Foothills area and noted 30 and 16% unburned forest within 20 m of large and small streams, respectively.<br><br>Analysis of the pattern of shoreline disturbance around >1000 stream segments within 42 fire events in the boreal and transition forests of Ontario suggests that an average of about 45-50% of shorelines associated with streams burn (see Appendix 2). However, there was tremendous variation with values for individual stream segments ranging from 0 to 100%. Data were not normally distributed, with typically <20 or >80% of shoreline area burned, especially for short stream segments.<br><br>Based on these analyses, strict adherence to a natural disturbance paradigm might suggest that harvesting of entire shorelines of rivers and streams could be permitted, as long as the average within events approached the average observed in natural disturbances. However, this approach would be relatively complicated to implement and monitor. Moreover, given the ecological importance of residual shoreline forest (see *Ecological significance*), the uncertainty about how much residual forest is required to meet all ecological functions, the inherent differences between burned and harvested forest, and the social resistance to shoreline |

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| | harvesting, a more conservative approach that maintains residual forest on at least 1 side of all rivers and HPS or MPS streams is prescribed. |
| … Mature forest with relatively uniform canopy closure ≥60% (canopy openings not to exceed individual tree crowns) must be retained within the inner 15 m of the AOC on both sides of *HPS* and *MPS streams* to provide shade, unless the inner boundary of the AOC is >15 m from the active channel. If forest is not mature or does not have an initial canopy closure ≥60%, no harvest is permitted. | Stream temperature is influenced by forest within 10 to 30 m of shorelines (Barton et al. 1985, Castelle et al. 1994, Sridhar et al. 2004. Wilkerson et al. 2006); it is generally assumed that the majority of allochthonous inputs come from vegetation within about ½ tree height of shorelines, but forest within 30 m of shorelines can make a significant contribution (Palik et al. 2000, Reeves et al. 2006). Shading is also directly related to tree height and canopy density (Barton et al. 1985, Sridhar et al. 2004). For streams with a high or moderate potential sensitivity, retention of forest that has a high likelihood of influencing water temperature and providing allochthonous inputs (i.e., mature forest with relatively uniform canopy closure ≥60% within 15 m of the stream) is prescribed. Some harvest within shoreline forest within 15 m of streams is permitted because moderate levels of canopy removal can increase light availability with minimal effects on water temperature (Zwieniecki and Newton 1999, Mellina et al. 2002, Wilkerson et al. 2006, Kreutzweiser et al. 2009) but with resultant increases in productivity of aquatic systems (Newton and Cole 2005, Wilzbach et al. 2005, Nislow and Lowe 2006); however, partial harvests that retain <40% canopy closure may provide insufficient shade to mitigate effects on water temperature (e.g., Macdonald et al. 2003).<br><br>Shade cast by shoreline forest has the greatest potential to influence water temperature for streams <6-12 m wide (see Whitledge et al. 2006). Thus, retention of forest cover for shading is not required adjacent to rivers. |
| … Harvest that retains forest that does not meet the definition of residual (e.g., conventional clearcutting) is permitted within the AOC only where slope is ≤30%. | See 4.1.1 for rationale. |
| … Within the AOC, direction for the retention of downed woody material (see Section 3.2.3) will be followed. | See 4.1.1 for rationale. |
| *Standard* – No contamination of rivers or streams by foreign materials is permitted. Specifically, … | See 4.1.1 for rationale. |
| *Guideline* – Harvest, renewal, and tending operations will follow appropriate operating | See 4.1.1 for rationale. |

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| practices to minimize rutting, compaction, and mineral soil exposure that could lead to erosion and subsequent transport and deposition of sediment in rivers and streams (see Section 5.2). Particularly, … | |
| *Guideline* – Harvest, renewal, and tending operations will, to the extent practical and feasible, encourage perpetuation of the distinctive character of the shoreline forest while emulating natural disturbances and/or succession (unless conversion is required to meet other ecological objectives – see below). | See 4.1.1 for rationale. |
| *Guideline* – Some or all of the requirements for retention of residual forest within the AOC may be met by residual shoreline forest outside the harvest area, residual shoreline forest retained in overlapping AOCs, or residual shoreline forest retained in areas with steep slopes (>30%). Additional requirements for residual shoreline forest may be met by: … | See 4.1.1 for rationale. |
| *Guideline* – Within the inner 15 m of the AOC, at least 10 trees/100 m of shoreline spaced about 10 m apart will be retained as a potential source of | Coarse wood provides many essential ecological functions in stream habitats (see above). Estimates of the supply of coarse wood within streams from western North America typically average >300 logs/km of stream (20 studies cited in Kreutzweiser et al. 2005). There is relatively little data for the boreal or GLSL forests; individual estimates for about 30 Canadian boreal streams range from 49 to 780 logs/km, with a mean of about 200 logs/km (Mossop and Bradford 2004, Kreutzweiser et al. 2005). Decay rate of coniferous logs in streams typically ranges from 1 to 3%/yr |

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| future aquatic coarse woody material. Living trees with the following characteristics will be preferentially retained: … | (see review in Scherer 2004). This translates to a loss of about 2 to 6 logs/km/yr. Following the assumptions in Box 4.1, an annual input of 4 logs/km of stream is needed to balance losses to decay and this requires the annual death/falling of about 2.9 trees/km of stream. Coarse wood can be provided by forest on either side of a stream. Thus, the target for each side of the stream is about 1.5 trees/km. Since this number is the same as that derived for lakes, the same direction is specified (10 trees/100 m of shoreline, spaced approximately 10 m apart).<br><br>Since retention of mature shade-producing forest within 15 m of HPS and MPS streams (see above) ensures retention of >10 trees/100 m of shoreline, this direction is most relevant for harvested shorelines adjacent to rivers. However, while partial harvest permitted within shade-producing forest will normally leave >10 trees/100 m of shoreline, operations must ensure that the preferred types of trees are retained (i.e., leaning coniferous trees at least 15 m tall growing close to the active channel). |
| *Guideline* – Within the remainder of the AOC, the general direction for retention of wildlife trees in harvest areas (see Section 3.2.3) will be followed. However, the focus will be on living trees with preferential retention of windfirm trees that provide the following special habitat features for wildlife: … | See 4.1.1 for rationale. |
| *Standard* – No landings or aggregate pits are permitted within the AOC. | See 4.1.1 for rationale. |
| *Guideline* – New roads that are not associated with an approved crossing are not permitted within the AOC unless no practical or feasible alternative exists, appropriate mitigative measures are taken to minimize the risk of sediment entering rivers or streams (see Section 5.1), and the road, including specific location, is identified and justified through the FMP AOC | See 4.1.1 for rationale. |

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| planning process. | |
| *Guideline* – New roads that traverse the AOC will be planned to avoid areas with a high potential to contain ephemeral streams, springs, seeps, and other areas of groundwater discharge. Crossings of recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge will consider the design principles in Section 5.1 to minimize the risk of sediment delivery and disruption of hydrological function. | See 4.1.1 for rationale. |
| *Guideline* – When new roads traverse residual forest within the AOC, the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | See 4.1.1 for rationale. |

Streams with low potential sensitivity to forest management operations are addressed through CROs. These consist of a subset of restrictions prescribed for HPS or MPS streams and focus on minimizing site disturbance within 15 m of LPS streams. LPS streams are typically very narrow. Thus, short vegetation (e.g., saplings and shrubs) can likely provide adequate shade (see Blann et al. 2002) so there is no requirement for retention of residual forest for shade. This provides an opportunity for disturbance to the edge of some (the least sensitive) streams to emulate patterns created by natural disturbances such as wildfire (see Appendix 2).

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#### 4.1.3. Wetlands

**Background**

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| Description | Wetlands are lands that are seasonally or permanently flooded by shallow water as well as lands where the water table is close to the surface; in both cases the presence of abundant water results in the formation of hydric soils and favours the dominance of either hydrophytic or water tolerant plants (OMNR 2002). Four types of permanent wetlands are generally identified (OMNR 2002):<br>*Bogs* - Peatlands (>40 cm of organic matter over mineral soil) dependent on nutrients from precipitation and air. Dominated by *Sphagnum* mosses and ericaceous shrubs that are adapted to acidic, nutrient-poor conditions. May be treed or treeless – stunted black spruce may be common in bogs.<br>*Fens* – Nutrient-rich peatlands which receive groundwater discharge from adjacent uplands. Dominated by sedges and mosses, fens may also contain grasses, reeds, orchids, and ericaceous shrubs. May be treed or treeless – trees typical of fens are white cedar and tamarack.<br>*Marshes* – Wet areas periodically inundated with standing or slowly moving water, and/or permanently inundated areas characterized by robust emergents, and to a lesser extent, anchored floating plants and submergents. Marshes characteristically show zones or mosaics of vegetation (e.g., rushes, reeds, sedges, low shrubs), frequently interspersed with channels or pools of deep or shallow open water (where submerged or floating plants flourish). Marshes also include small bodies of open water such as beaver ponds that are <8 ha in surface area (note: these are referred to as shallow water wetlands in the national wetland classification (NWWG 1988)).<br>*Swamps* – Wetlands with over 25% cover of trees or tall shrubs. Standing water may persist for long periods on the surface and there is often an abundance of pools and channels indicating subsurface water flow. Vegetative cover may consist of coniferous or deciduous trees, tall shrubs, herbs, and mosses.<br>OMNR (2002), Harris et al. (1996), and Lee et al. (1998) provide aids to classify wetlands in northern and southern Ontario.<br>Permanent wetlands may be identified as *Provincially Significant Wetlands* (PSWs) based on the presence of outstanding biological, social, or hydrologic values as outlined in the *Ontario Wetland Evaluation System* (OMNR 2002).<br>Woodland pools are special classes of small seasonal wetlands and include ephemeral pools, vernal pools, and autumnal pools. Woodland pools are small isolated open water wetlands that have hydrologic regimes characterized by alternating periods of flooding and drying (Colburn 2004). Because they are isolated from perennial sources of water, they typically rely on inputs from snow-melt and rainwater. Woodland pools may contain water for only a few weeks to months during spring each year; some may be continuously flooded through most years but then dry completely once every 5 to 10 years. Woodland pools are generally classified as (adapted from Colburn 2004):<br>*Ephemeral pools* - Pools that fill with melt-water or rain-water but typically remain flooded for only a few weeks to months.<br>*Short-cycle spring-filling (vernal) pools* – Pools that fill with melt-water in spring and typically remain flooded for 3-4 months.<br>*Long-cycle spring-filling (vernal) pools* – Pools that fill with melt-water in spring and typically remain flooded for 5-8 months. |

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| | *Short-cycle fall-filling (autumnal) pools* – Pools that fill with water in late fall-early winter and typically remain flooded for 7-9 months.<br><br>*Long-cycle fall-filling (autumnal) pools* – Pools that fill with water in late fall-early winter and typically remain flooded for 9-11months.<br><br>*Semi-permanent pools* – Pools that are continuously flooded through most years (with maximum water level in spring) but then dry completely in some years.<br><br>Woodland pools typically occur in or next to forests or other treed areas (Colburn 2004). Those described in the literature range from 16 to 7,500 $m^2$ in surface area and from 16 to 300 cm in depth but are typically <0.1 ha in size and <1 m deep. Woodland pools occur throughout the glaciated parts of northeastern North America, but have been most intensively studied within temperate forests from Maine across to Minnesota (Colburn 2004). There is relatively little known about woodland pools in Ontario, especially in the boreal forest. |
| Ecological significance | Permanent wetlands provide many ecological services depending on their characteristics and context (see reviews in NWWG 1988, Sheehy 1993, Carter 1997, Bullock and Acreman 2003, Price et al. 2005), including:<br>• water storage and flood control,<br>• ground water recharge and discharge,<br>• water quality improvement by trapping, transforming, recycling, and exporting sediments, nutrients, contaminants, and organic matter,<br>• protecting shorelines of lakes and rivers from erosion by wind and wave action, and<br>• sequestering carbon.<br><br>Within a forest management context, permanent wetlands may represent hydrological linkages between aquatic and terrestrial habitats (Rummer 2004), ‘hotspots’ for methylation of mercury (Mitchell et al. 2008) or other biogeochemical processes (McClain et al. 2003), and may play a significant role in mitigating catchment-scale effects of harvesting on water quality (Prepas et al. 2003).<br><br>Permanent non-forested wetlands are important habitats for a wide range of plants and animals. Wetlands, especially marshes, may be used as spawning, nursery, or feeding habitat by at least 40 species of fish found in Ontario (see review in Hall-Armstrong et al. 1996). Non-forested wetlands are used as nest sites, breeding sites, or feeding habitat for >30 species of reptiles and amphibians, >100 species of birds (including ospreys and herons), and >40 species of mammals (Bellhouse and Naylor 1997). They are especially important as breeding and staging habitat for waterfowl, aquatic feeding habitat for moose, and breeding season habitat for reptiles and amphibians, including numerous species at risk (e.g., Blanding’s turtle, spotted turtle). Wetlands are also home to a tremendous diversity of plants, including numerous species at risk (e.g., small white lady’s-slipper, branched bartonia). In addition, wetlands provide essential habitat for many invertebrates, including provincially rare dragonflies and damselflies.<br><br>Permanent forested wetlands are also used by a wide variety of birds and mammals (see Holloway et al. 2004). Rich hardwood-dominated swamps are especially important because they support a diverse array of herbaceous plants, sedges, and bryophytes including some species at risk such as the flooded jellyskin, a *threatened* lichen (see 4.3.1). Moreover, rich hardwood-dominated swamps may represent important summer thermal cover for moose (Allen et al. |

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| | 1987) and spring forage sites for black bears (Rogers et al. 1988).<br><br>Because woodland pools are isolated from perennial water sources and exhibit annual or semi-annual drying, they generally do not support fish. Because fish are absent, woodland pools may support unique communities of vertebrates and invertebrates (see reviews in Colburn 2004, Patton 2005, Williams 2005). Ephemeral pools may support distinct communities of protists, rotifers, crustaceans, diatoms, algae, and insects (Colburn 2004). Woodland pools with longer hydroperiods are important breeding sites for many amphibians such as wood frogs, and spotted, blue-spotted, and four-toed salamanders (Colburn 2004, Calhoun and deMaynadier 2004, Brooks 2005, Calhoun et al. 2005). Diversity and/or abundance of pool-breeding amphibians are positively related to hydroperiod (Kolozsvary and Swihart 1999, Babbitt 2005, Burne and Griffin 2005). Short-cycle pools typically support breeding by spring peepers and wood frogs; long-cycle pools support breeding by these species as well as by spotted and blue-spotted salamanders (Colburn 2004). |
| Effects of forest management | *Permanent wetlands*<br><br>Similar to upland forest, timber harvest of forested wetlands may alter the composition and/or structure of habitat and thus the suitability for a variety of species (e.g., Verme 1965, Dawson 1979, Twedt et al. 1999). In contrast to upland forest, significant canopy removal (e.g., clearcutting) in forested wetlands may result in an elevated water table (“watering-up”), with potential short or long term effects on vegetation development and wildlife habitat (Sheehy 1993, Sun et al. 2001, Hutchens et al. 2004, Nicoll and Zimmerling 2006).<br><br>Soils associated with wetlands are generally more susceptible to rutting and compaction than those associated with upland forest (Archibald et al. 1997). Rutting and compaction, especially that associated with extraction trails, may affect hydrologic function by altering infiltration rates, hydraulic conductivity, and surface flows (Sheehy 1993, Grigal and Brooks 1997, Rummer 2004). In extreme cases, site disturbance may exacerbate the effects of an elevated water table, shifting tree species composition to more water-tolerant species or even converting forested sites to non-forest vegetation (e.g., Sheehy 1993, Gale et al. 1998, Aust et al. 2006).<br><br>Harvesting within or adjacent to wetlands may also alter biogeochemical processes and the chemical properties of sheetflow or surface waters (e.g., Sheppard 1994, Lockaby et al. 1997b, Whitfield and Hall 1997).<br><br>Many potential effects of silvicultural operations can be avoided by following appropriate mitigative practices (Lockaby et al. 1997a, Sun et al. 2001, Rummer 2004).<br><br>Roads in upland areas may affect water quality in wetlands if their design and proximity leads to sediment input (Sheehy 1993).<br><br>Roads through wetlands may also be a potential source of sediment or may impede or divert water flow, resulting in ponding on the upslope side of the road (Sheehy 1993, Lockaby et al. 1997a, Miller et al. 1997). However, in contrast to roads in uplands, roads in wetlands are less prone to erosion and sediment transport since slopes are insignificant and overland and ditch flow has less erosive energy (Rummer 2004).<br><br>Many inhabitants of permanent wetlands, especially reptiles and amphibians, also use the surrounding upland forest for feeding, nesting, or overwintering. The diversity of various taxa (especially herpetofauna) is typically correlated with the amount of forest cover adjacent to wetlands (Findlay et al. 2001, |

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| | Houlahan and Findlay 2003, Herrman et al. 2005).<br>Harvest, renewal, or tending operations in adjacent forest may disturb wetland-nesting birds such as ospreys and herons (see 4.2.2) or remove important structural components such as cavity trees, stick nests, and perch or roost trees.<br>*Woodland pools*<br>Removal of forest cover may alter input of organic matter, nutrient content, and pH of inflowing surface or groundwater, and/or permit penetration of sunlight, influencing algal production, water temperature, and hydroperiod. Moreover, activity of heavy equipment in or around woodland pools can disrupt breeding activity of amphibians and can result in sedimentation of pools or may channel runoff into or away from woodland pools (deMaynadier and Hunter 1995, Batzer et al. 2000, Calhoun and deMaynadier 2004, Colburn 2004, Hutchens et al. 2004, Williams 2005).<br>Clearcutting may increase the abundance of woodland pools because tree removal may elevate the water table and heavy equipment may create new depressions (e.g., ruts, aggregate pits) that accumulate water (deMaynadier and Hunter 1995, Waldick 1997, Russell et al. 2004). However, woodland pools in clearcuts and young regenerating forest are more exposed to evaporative water loss, often resulting in reduced hydroperiod. As a consequence, amphibian larvae may be subject to high mortality in all but very wet years (Waldick 1997, Waldick et al. 1999, DiMauro and Hunter 2002). Higher temperatures in exposed pools may also result in accelerated amphibian larval development, reduced size at metamorphosis, and increased risk of desiccation and mortality (Waldick 1997, DiMauro and Hunter 2002). However, effects of clearcutting may last <20 years (Batzer et al. 2000, Palik et al. 2001) and effects may be mitigated by buffers as narrow as 15 m (Palik[1], pers. comm. 2006).<br>In contrast, selection cutting appears to have relatively limited effects on the abundance or diversity of breeding amphibians in woodland pools in hardwood forest (Enright 1998, Cromer et al. 2002). |
| Past direction | No comprehensive guide for permanent wetlands. Numerous guides provided general direction for wetlands or species-specific direction with implications for wetlands (e.g., Hickie 1985, James 1985, OMNR 1988). The silviculture guides and tree marking guide provide direction for forested wetlands (OMNR 1997a, b; 1998a, b; 2000; 2003; 2004).<br>OMNR (2004) provided tree marking direction for woodland pools in the GLSL forest. |

**Rationale for direction**

*Provincially significant wetlands*

Provincially Significant Wetlands (PSWs) represent ecosystems with outstanding biological, social, or hydrologic value. PSWs are wetlands identified by the MNR using evaluation procedures established by the Province. At present, criteria outlined in the *Ontario Wetland Evaluation System* (OMNR 2002) are used to identify wetland significance – these criteria may be amended from time to time to reflect new science, technology, or information. PSWs are considered valuable natural areas by the Province. This is reflected in the *Provincial Policy Statement* (2005) (PPS) which contains policies (s. 2.1.3 and 2.1.4) intended to protect PSWs

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from development and site alteration as defined by the PPS. Decisions that must be consistent with the PPS are those under the *Planning Act 1990* and other decisions closely related to municipal planning. On crown land, MNR may consider the policies or otherwise meet the intent of the PPS. Thus, PSWs are identified as AOCs. Direction focuses on maintaining the natural features and ecological functions that make a wetland provincially significant.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* - 120 m AOC surrounding the delineated PSW. | Landuse patterns surrounding wetlands influence water quality and the diversity of the wetland community (Crosbie and Chow-Fraser 1999, Houlahan and Findlay 2003, Herrmann et al. 2005). Size of buffers required to mitigate effects depends on the features and functions to be conserved, characteristics of the buffer, and the nature of the activity occurring adjacent to the wetland (Castelle et al. 1994, Norman 1996). If the wetland provides habitat for a rare plant community, protecting the wetland itself from disturbance may be sufficient. If water quality is an issue, buffers of between 30 to 90 m may be adequate to moderate water temperature, trap sediments, and filter nutrients (Castelle et al. 1994). If the wetland contains a rare wildlife community that relies on both the wetland and adjacent forest to meet its requirements, the AOC may need to extend ≥150 m into the adjacent forest (e.g., Semlitsch and Bodie 2003). Considering this range of factors, an AOC of 120 m is prescribed. |
| *Standard* - No contamination of PSWs by foreign materials is permitted. Specifically, … | See 4.1.1 for rationale. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the PSW unless an Environmental Impact Study (EIS), and subsequent review and approval by MNR, demonstrates that the proposed operations will either: … | To be consistent with the PPS*,* no harvest, renewal, or tending operations are permitted within the PSW unless an EIS, and subsequent review and approval by MNR, demonstrates that the proposed operations will either:<br>• not result in the loss of natural features or ecological functions that make the wetland provincially significant or<br>• may result in some loss of natural features or ecological functions that make the wetland provincially significant but the loss is deemed by MNR to be minimal and necessary to sustain the natural features or ecological functions that make the wetland provincially significant. |
| *Guideline* - Harvest, renewal, and tending operations are permitted within the AOC (outside the PSW) without an EIS if they retain residual forest (see Section 3.2.2) and will not result in direct damage to vegetation within the | It is assumed that harvest, renewal, and tending operations that retain residual forest (e.g., selection or shelterwood harvest) will not adversely affect the natural features or ecological functions that make the wetland provincially significant as long as the careful operating practices as defined in Section 4.1.1 (e.g., no machine travel within the inner 3 m of the AOC) are followed to ensure that there will be no direct damage to vegetation within the PSW, deposition of sediment within the PSW, or disruption of hydrological connections. |

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| PSW or deposition of sediment within the PSW. Planning teams may elect to further restrict harvest, renewal, or tending operations within a portion of the AOC based on characteristics of the PSW. Operations specifically prohibited within the AOC include: … | |
| *Guideline* - Harvest, renewal, and tending operations that do not retain residual forest, will result in direct damage to vegetation within the PSW, or will deposit sediment within the PSW are only permitted within the AOC (outside the PSW) if an EIS, and subsequent review and approval by MNR, demonstrates that the proposed operations will either: … | It is assumed that harvest, renewal, and tending operations that do not retain residual forest (e.g., clearcut harvest) may adversely affect the natural features or ecological functions that make the wetland provincially significant. Thus, to be consistent with the PPS*,* these operations are not permitted within the AOC unless an EIS, and subsequent review and approval by MNR, demonstrates that the proposed operations will either:<br>• not result in the loss of natural features or ecological functions that make the wetland provincially significant or<br>• may result in some loss of natural features or ecological functions that make the wetland provincially significant but the loss is deemed by MNR to be minimal and necessary to sustain the natural features or ecological functions that make the wetland provincially significant. |
| *Guideline* - Harvest, renewal, and tending operations within the PSW and AOC will follow the appropriate operating practices described in Section 5.2 to minimize rutting, compaction, and mineral soil exposure that could lead to erosion and subsequent transport and deposition of sediment within the PSW or the disruption of hydrological function. | Harvest, renewal, and tending operations have the potential to influence water quality or hydrological function within wetlands (see above). Thus, operations permitted within the PSW or AOC must follow practices described in Section 5.2 to minimize rutting, compaction, and mineral soil exposure that could lead to erosion and subsequent transport and deposition of sediment within the PSW or disruption of hydrological function. |
| *Guideline* - New roads, landings, and aggregate pits are not permitted within the | It is assumed that roads, landings, and aggregate pits may adversely affect the natural features or ecological functions that make the wetland provincially significant. Thus, to be consistent with the PPS*,* these operations are not permitted within the AOC unless an EIS, and |

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| PSW or AOC unless an EIS, and subsequent review and approval by MNR, demonstrates that the proposed operations will either: … | subsequent review and approval by MNR, demonstrates that the proposed operations will either:<br>• not result in the loss of the natural features or ecological functions that make the wetland provincially significant or<br>• may result in some loss of the natural features or ecological functions that make the wetland provincially significant but the loss is deemed by MNR to be minimal and necessary to avoid undesirable ecological or socio-economic impacts of other feasible alternatives. |

*Rich lowland hardwood-dominated forest*

Operations within forested wetlands are subject to direction within MNR's silviculture guides (see OMNR 1997a, b; 1998a, b; 2000; 2003). These guides must be considered when developing silvicultural ground rules (SGRs) for forest units. However, rich hardwood swamps typically occur as small inclusions within larger stands of a different forest unit and thus are not usually covered by SGRs for the associated allocated stand. Thus, CROs that apply to pockets of rich lowland hardwood-dominated forest ≥0.5 ha in size encountered during operations are prescribed that focus on minimizing activity that would disturb the forest floor or alter hydrological function (with potential effects on the plant community) and retention of residual forest to regulate light levels for the plant community, provide cover for moose and black bears, and retain sufficient trees to encourage perpetuation of the cover type.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - No harvest, renewal, or tending operations are permitted that exceed the rutting and compaction standards for *selection, shelterwood, and commercial thinning* operations (see Section 5.2) or disrupt hydrological function (see Section 5.2). | Wet mineral soils associated with rich lowland hardwood-dominated forest are very sensitive to rutting and compaction which may disrupt hydrological function (see above). Operations should ideally be conducted during winter when soil is frozen (see OMNR 2000 and Section 5.2). When this is not practical or feasible, site disturbance must be minimized; the most conservative site disturbance standards from Section 5.2 (i.e., those associated with selection, shelterwood, and commercial thinning operations) will apply. |
| *Standard* - Harvest will follow direction for rich lowland hardwood-dominated forest found in MNR's silviculture guides. | Silvicultural practices prescribed in OMNR (1998a, 2000) will ensure perpetuation of this forest type while maintaining residual cover for species such as moose and black bears. |
| *Standard* - Landings and aggregate pits are not permitted within rich lowland hardwood-dominated | Landings and aggregate pits are significant potential sources of sediment and may disrupt hydrological function, and are thus not permitted within rich lowland hardwood-dominated forest. |

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| forest. | |
| *Guideline* - Reasonable efforts will be made to avoid crossing rich lowland hardwood-dominated forest with extraction trails during the frost-free period. During all seasons, crossings will be minimized and will follow the appropriate operating practices described in Section 5.2 to minimize potential site damage and effects on hydrological function. | Extraction trails within lowland forest may create site damage and disrupt hydrological function, especially if created during the frost-free period (see above). Extraction trails are permitted but crossings must be minimized (e.g., minimize number of crossings, cross at narrowest points) and use appropriate mitigative techniques (e.g., brush mats) when there is risk of site damage (see Section 5.2). |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads within rich lowland hardwood-dominated forest. When necessary, road construction will follow the design principles in Section 5.1 to minimize disruption of hydrological function. | Within lowland forest, roads may disrupt hydrological function (causing flooding on the upslope side and drying on the downslope side) and represent a potential source of sediment (see above). Thus, construction of roads within rich lowland hardwood-dominated forest should be avoided unless there are no feasible alternatives. When constructed within wetlands, roads must be designed to permit adequate water movement (see Section 5.1). |

*Mapped permanent non-forested wetlands*

Wetlands providing critical (spawning or nursery) habitat for fish will generally be identified as ponds or will be associated with lakes, rivers, or streams. Thus, they will by default be addressed by direction for standing or flowing waters (see Sections 4.1.1 and 4.1.2).

Direction for non-forested wetlands that are not critical fish habitat is contained in Section 4.1.3. The FRI identifies 3 types of non-forested wetlands: open wetlands (code OMS), treed wetlands (code TMS), and brush and alder wetlands (code BSH). Open wetlands are generally marshes, open fens, or open bogs. Treed wetlands are typically treed bogs or treed fens. Brush and alder wetlands are usually thicket swamps (Jeglum and Boissonneau 1977).

Operations in and within the immediate vicinity of mapped wetlands are addressed by CROs that focus on:

- minimizing the risk of sedimentation,
- minimizing the risk of disrupting hydrological function, and
- minimizing changes to the composition and structure of wetland communities.

The boundary between non-forested wetland and forest is defined where tree canopy cover is ≥25% (see OMNR 2002).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - No harvest, renewal, or tending operations are permitted that will result in significant damage to wetland vegetation or disruption of hydrological function. Operations specifically prohibited include: … | Activity of heavy equipment within and adjacent to wetlands may damage wetland vegetation or disrupt hydrological function (see above). Wetlands (or portions of wetlands) dominated by open water or non-woody vegetation (e.g., marshes, fens) are assumed to be most sensitive to deposition of sediment or physical disturbance.<br>Direction focuses on restricting operations in and around wetlands (or portions of wetlands) dominated by open water or non-woody vegetation and follows that prescribed for LPS ponds (see 4.1.1). |
| *Standard* - Aggregate pits are not permitted within 15 m of non-forested wetlands. | Direction follows that prescribed for LPS ponds (see 4.1.1). |
| *Standard* - No contamination of wetlands by foreign materials is permitted. Specifically, … | Direction follows that prescribed for LPS ponds (see 4.1.1). |
| *Guideline* - Landings are not permitted within the wetland itself or within adjacent forest that is <15 m from those portions of the wetland dominated by open water or non-woody vegetation. | Direction follows that prescribed for LPS ponds (see 4.1.1). |
| *Guideline* - Reasonable efforts will be made to avoid crossing wetlands with extraction trails during the frost-free period. During all seasons, crossings will be minimized and will follow the appropriate operating practices described in Section 5.2 to minimize potential site damage and effects on hydrological function. | Extraction trails within wetlands may create site damage and disrupt hydrological function, especially if created during the frost-free period (see above). Extraction trails are permitted within wetlands but crossings must be minimized (e.g., minimize number of crossings, cross at narrowest points) and use appropriate mitigative techniques (e.g., brush mats) when there is risk of site damage (see Section 5.2). |
| *Guideline* - | Within wetlands, roads may disrupt hydrological function (causing flooding |

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| Reasonable efforts will be made to avoid construction of new all-weather roads within wetlands or portions of wetlands characterized by open water or non-woody vegetation. When construction of all-weather roads in wetlands is necessary, it will follow appropriate design principles in Section 5.1 to minimize risk of sediment entering the wetland and disruption of hydrological function. | on the upslope side and drying on the downslope side) and represent a potential source of sediment (see above). Thus, construction of all-weather roads within mapped wetlands will be avoided unless there are no feasible alternatives. When constructed within wetlands, roads must be designed to permit adequate water movement (see Section 5.1). |

*Woodland pools*

Woodland pools supporting a diversity of pool-breeding amphibians are significant habitats. Woodland pools and their inhabitants can be negatively affected by forest management practices (see above); effects may not be explicitly mitigated by other direction.

Identification of significant woodland pools should ideally be based on presence of a diversity of pool-dependent inhabitants (e.g., Calhoun et al. 2005) but pool sampling is not practical at the scale of forest management operations. However, the surface area of woodland pools tends to be correlated with hydroperiod (DiMauro and Hunter 2002, Brooks and Hayashi 2002) and thus with the diversity of inhabitants (Babbitt 2005, Burne and Griffin 2005). Thus, pool size can likely be used as a rough indicator of the potential significance of pools. In Rhode Island, woodland pools <500 $m^2$ in surface area generally had hydroperiods <24 weeks; the approximate time required for about 50% of spotted salamanders to emigrate from ponds (Skidds and Golet 2005, Skidds[1] pers. comm. 2006). In Massachusetts, woodland pools <500 $m^2$ rarely supported viable populations of spotted salamanders; pools ≥500 $m^2$ in size accounted for about 80% of the regional breeding population (Windmiller 1996). Thus, direction (CROs) is provided for woodland pools with surface area ≥500 $m^2$ (approximately, 25 m diameter pool if circular) and focuses on:

- minimizing the risk of sedimentation,
- minimizing the risk of disrupting hydrological function,
- minimizing disturbance of amphibian breeding activity, and
- minimizing changes to canopy cover and light penetration.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - No harvest, renewal, or tending operations are permitted that will | Activity of heavy equipment in and around woodland pools can disrupt amphibian breeding activity and can result in sedimentation of pools, may reduce the water holding capacity of pools, or may channel runoff into or away from pools (Calhoun and deMaynadier 2004, Colburn 2004). |

[1] Dennis Skidds, Univ. Rhode Island, Environmental Data Center, Kingston, RI

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| result in deposition of sediment within, or reduction of the water-holding capacity of, woodland pools. Operations specifically prohibited include: … | Direction to minimize disturbance of woodland pools follows that prescribed for LPS ponds (see 4.1.1). |
| *Standard* - No contamination of pools by foreign materials is permitted. Specifically, … | Direction follows that prescribed for LPS ponds (see 4.1.1). |
| *Standard* - Landings and aggregate pits are not permitted within 15 m of the high-water mark of pools. | Direction follows that prescribed for LPS ponds (see 4.1.1). |
| *Guideline* - Retention of residual forest within and adjacent to pools will be based on forest unit as follows*:* | Removal of all forest cover surrounding woodland pools may result in altered hydroperiod and/or changes in water chemistry (Waldick 1997, Batzer et al. 2000, DiMauro and Hunter 2002). Surrounding forest also provides allochthonous inputs that may form the basis of some detritivore-based foodwebs (Palik et al. 2006). Moreover, shade provided by surrounding forest may moderate conditions in 'dry' pools, influencing survival of some inhabitants (Batzer and Sion 1999). |
| *… Selection and shelterwood forest units* – Trees will be retained in, and within, 3 m of the high-water mark of pools to provide ≥70% canopy cover; residual forest will be retained within 15 m of the high-water mark of pools to provide amphibian cover. | Information on the amount of tree cover required to maintain ecological function is equivocal. Skidds and Golet (2005) found little relationship between the BA of trees adjacent to woodland pools and hydroperiod in Rhode Island. Moreover, a number of studies suggest that some species of amphibians may actually have lower growth or survival rates in heavily shaded pools (Werner and Glennemeier 1999; Skelly et al. 2002, 2005).<br>However, climate change is predicted to have a negative effect on the hydroperiod of woodland pools (Brooks 2004). Thus, retention of forest to provide dense overhead shade (*sensu* OMNR 2004) is prescribed for all woodland pools in selection and shelterwood cuts.<br>The amount of forest vegetation surrounding woodland pools may also influence their use (DiMauro and Hunter 2002, Homan et al. 2004). Linkages with mature forest may be important for dispersal of newly metamorphosed juveniles (Waldick 1997, deMaynadier and Hunter 1999). Various jurisdictions recommend from 15 to 30 m buffers around important woodland pools (e.g., Kittredge and Parker 1996, Calhoun and deMaynadier 2004). Thus, retention of residual forest is also required within 15 m of pools in selection and shelterwood cuts. |
| *… Clearcut forest units* – Unmapped residual patches required to meet the direction in Section 3.2.2 will preferentially be connected to pools. | High intensity natural disturbances such as wildfires would likely remove most living tree cover from around many woodland pools in boreal-like forest types. Thus, retention of cover is not required for all woodland pools in clearcuts. However, unmapped residual patches are required in clearcuts (see Section 3.2) and these should be attached to woodland pools whenever practical and feasible. When creating residual patches around pools, the direction for selection and shelterwood cuts applies. |

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| When connecting residual patches to pools, trees will be retained in and within 3 m of the high-water mark to provide overhead shade and residual forest will be retained within at least 15 m of the high-water mark to provide amphibian cover. | |
| *Guideline* - New roads are not permitted within 15 m of the high-water mark of pools unless there is no practical or feasible alternative and appropriate mitigative measures are taken to minimize the risk of sediment entering pools and disruption of hydrological function (see Section 5.1). | Direction follows that prescribed for LPS ponds (see 4.1.1). |

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### 4.2 Special Habitat Features

Section 4.2 introduces the content of Sections 4.2.1-4.2.6. No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

#### 4.2.1 Groundwater recharge areas associated with brook trout spawning sites

**Background**

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| Description | Groundwater is an important component of the hydrologic cycle in forest ecosystems and has a significant effect on aquatic habitats and their biota (Verry 2000, Steedman et al. 2004). Precipitation is the ultimate source of all groundwater. Precipitation may be intercepted by vegetation, form surface run-off, or infiltrate the soil column. Water that enters the soil column may be returned to the atmosphere by evaporation or transpiration or may percolate through the column to enter shallow or deep groundwater tables. Those parts of the landscape that are sources of groundwater are referred to as *recharge areas* (Alley et al. 2002). Groundwater flows vertically and horizontally across the landscape. It may emerge in relatively focused *discharge areas* such as springs or seepages. In areas dominated by bedrock (such as occurs across much of the Canadian Shield), recharge areas and discharge areas may be connected by relatively isolated lenses of permeable surficial material such as sand, gravel, or till deposits that direct and accelerate groundwater flow (Curry and Devito 1996). |
| Ecological significance | Groundwater plays an important role in the life history of a number of fish species, especially the brook trout (Power et al. 1999). Within lakes and streams on the Canadian Shield, female brook trout typically lay eggs in nests (redds) that are constructed in cobble-gravel-sand substrates associated with areas of groundwater discharge (Curry and Nokes 1995). Groundwater flow through nests provides a stable temperature and oxygen regime and removes metabolites during incubation (Curry et al. 1995). Flow rate appears to influence egg survival and thus reproductive success (Blanchfield and Ridgway 2005). Sites suitable for nesting may be limiting since females complete for nesting sites (Blanchfield and Ridgway 2005) and nesting sites receive extensive reuse (Blanchfield and Ridgway 1997). Both selection of sites and extent of reuse appear to be related to the rate of groundwater flow (Blanchfield and Ridgway 1997, Ridgway and Blanchfield 1998).<br><br>Young-of-the-year brook trout also use areas of groundwater discharge as thermal refugia (nursery sites) during the warmest parts of the summer (Biro 1998, Borwick et al. 2006).<br><br>Suitable areas of groundwater discharge are frequently associated with lenses of coarse till that direct and accelerate groundwater flow (Curry and Devito 1996). In bedrock-controlled landscapes, these lenses may be associated with unchannelized surface flow (e.g., seeps) or shallow groundwater flows; areas of groundwater discharge are typically close to shore in shallow water (Curry and Devito 1996, Borwick et al. 2006). However, in some lakes, spawning areas may occur in deeper water beyond the littoral zone (Quinn 1995) and may be fed by discharge associated with deeper groundwater flow (Ridgway and Blanchfield 1998).<br><br>Curry and Devito (1996) estimated the size of sub-catchments necessary to supply groundwater to maintain flow rates observed in brook trout nests. These *recharge areas* may be up to 10 ha in size. |

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| Effects of forest management | Numerous authors suggest that forest management practices have the potential to influence groundwater discharge associated with spawning or nursery sites (Curry and Devito 1996, Biro 1998, Ridgway and Blanchfield 1998, Borwick et al. 2006). Specific concerns include:<br>• tree harvest may result in a shallower water table and subsequently higher groundwater temperature,<br>• tree harvest may result in fluctuating rates of groundwater discharge that might influence the stability of water temperature or oxygen content in redds, and<br>• road construction and aggregate extraction may disrupt groundwater recharge or flow.<br>Clearcutting has been shown to influence thermal regime in brook trout redds in Newfoundland, where temperature is influenced primarily by downwelling surface water, not by upwelling groundwater (Curry et al. 2002). However, effects are largely speculative for groundwater-based systems (Curry and Noakes 1995) and it is even possible that harvesting may enhance groundwater discharge and increase the quality of spawning sites (Curry and Devito 1996). |
| Past direction | OMNR (1997) provided best management practices to minimize disruption of subsurface water flow; springs were specifically highlighted. OMNR (1998a, b; 2004) prescribed high canopy closure around seeps and avoidance by skid trails and landings in the GLSL forest. |

**Rationale for direction**

Brook trout is a species of high socio-economic concern. On the Canadian Shield, spawning sites appear to be closely linked to areas of groundwater discharge (see above). These sites appear to be rare; supply of suitable sites may be limiting (see above). Strong perception that forest management operations conducted in recharge areas, especially road construction and aggregate extraction, might adversely affect the quantity, quality, or stability of groundwater flow and thus the suitability of spawning sites (see above). Thus, direction specifies an AOC for recharge areas associated with known brook trout spawning sites that have been identified by field surveys or hydrological modeling and focuses on:

- minimizing risk of interrupting and redirecting groundwater flow and
- minimizing risk of altering infiltration capacity.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC. | Effects of tree harvest are equivocal, and may even enhance groundwater discharge (see above). Moreover, harvest is not likely to produce effects dramatically different from natural disturbances. Thus, no restrictions are placed on regular harvest, renewal, or tending operations. |
| *Guideline* - Extraction trail location and design will follow the operating practices described in Section 5.2 to minimize rutting | Rutting and compaction associated with extraction trails may potentially disrupt shallow groundwater flow, especially on organic soils (Sheehy 1993, Grigal and Brooks 1997, Rummer 2004). Thus, extraction trail location and design must follow the operating practices described in Section 5.2 to minimize rutting that could disrupt shallow groundwater |

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| that could disrupt shallow groundwater flow. | flow. |
| *Standard* - Landings and aggregate pits are not permitted within the AOC. | Aggregate extraction can potentially affect the characteristics and/or flow of groundwater (Johnson 1987, Hatva 1994). Landings can potentially affect water infiltration capacity (e.g., Johnson and Beschta 1980). Thus, landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - New all-weather roads are not permitted within the AOC unless no practical or feasible alternative exists, appropriate mitigative measures are taken to minimize the risk of interrupting or redirecting shallow groundwater flow (e.g., no ditching or grubbing, appropriate cross drainage is provided; see Section 5.1), and the road, including specific location, is identified and justified through the FMP AOC planning process. | Construction of all-weather roads (and associated ditching) could potentially interfere with infiltration or disrupt shallow groundwater flow (Megahan 1972, Wemple et al. 1996, Rummer 2004). Thus, new all-weather roads are not permitted within the AOC unless no practical or feasible alternative exists and appropriate mitigative measures are taken to minimize the risk of interrupting or redirecting shallow groundwater flow. |

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### 4.2.2 Bird nest sites

Section 4.2.2 introduces the content of Sections 4.2.2.1-4.2.2.8. No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

#### 4.2.2.1 Peregrine falcons

No *Standards*, *Guidelines*, or *Best Management Practices* are presented. Habitat protection addressed by ONTARIO REGULATION 436/09.

#### 4.2.2.2 Bald eagles and ospreys

**Background**

| **Species** | **Bald eagle** |
|---|---|
| S-rank | S4B/G4 |
| Designation | *Special concern*. |
| Trend – CDN | Increasing or stable (Kirk and Hyslop 1998). |
| Trend - ON | Increasing. About 1,400 pairs nesting in Ontario in 1998 (Grier et al., in prep.). The number of known nests in 1998 was almost double that reported by Jones (1995) based on a survey in 1990. Moreover, counts of migrating eagles at Grimsby (Ontario) and Duluth (Minnesota) during the 1970s and 1980s suggest an annual increase in the provincial population of 14 to 19 percent (Hussell and Brown 1992). Probability of observation during BBAs about 4 times greater in the 2000s relative to the 1980s; similar change in GLSL and boreal regions (Armstrong 2007). |
| Distribution | Breeds from Alaska across to Newfoundland and along the eastern seaboard to Florida (Buehler 2000). Widely distributed across Ontario (Armstrong 2007); the greatest concentration of nests is in the northwest. In 1998, there were 15 occupied nests in Southern Region, 185 occupied nests in Northeast Region, and 1193 occupied nests in Northwest Region (Grier et al., in prep.). |
| Nesting | Builds large bulky nests of sticks in stout-limbed, open-crowned trees. In Ontario, nests are generally (75%) in living trees; white pines (74%) and trembling aspens (19%) are used predominantly (Jones 1995). Supercanopy trees are typically used because they are easily accessed. A home range typically contains a primary nest that is currently or has been recently occupied. May also contain alternate nests that may have been used at some past date; number of nests per home range averages about 1.5 across the species range (Buehler 2000). Eagles exhibit strong nest site fidelity (Gerrard et al. 1983, Kennedy and McTaggart-Cowan 1998); individual nests have a life expectancy of about 4 to 6 years (Grier 1974, Gerrard et al. 1983, Curnutt and Robertson 1994) but may last as long as 20 to 25 years (Todd and Owen 1986). Nesting season March through August. |
| Habitat | Characteristics of stands used for nesting suggest a preference for mature, open forest with a discontinuous canopy (Snow 1973, Gerrard et al. 1975, |

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| | Hodges et al. 1984, Peterson 1986), likely because eagles are unable to maneuver through closed canopies (Andrew and Mosher 1982). Canopy cover at nest sites averaged about 60% in Ontario (Jones 1995) and Maryland (Andrew and Mosher 1982). Canopy cover as low as 20-30% is considered to be acceptable in California (Lehman 1980) and Oregon (Anthony and Isaacs 1989).<br><br>The supply of potential nest, perch, and roost trees appears to be an important attribute of nesting habitat. Livingston et al. (1990) found that density of supercanopy trees was a significant predictor of the location of nests in Maine. Jones (1995) found that density of potential perch trees was the primary difference between sites used and not used in northwestern Ontario. Chandler et al. (1995) noted that use of shorelines was influenced by density of suitable perch trees in Maryland.<br><br>Size of forest patch used for nesting may be unimportant if isolated from human disturbance (Buehler 2000).<br><br>Nests are generally close to water, ideally adjacent to lakes >10 km$^2$ in surface area (Peterson 1986). Whitfield et al. (1974) noted that 90% of nests in Manitoba and Saskatchewan were within 200 m of a lake or river. Large, productive waterbodies are important because eagles are primarily fish eaters during the breeding season (Snow 1973, Peterson 1986). Productivity of the water feature adjacent to eagle nests may determine territory size (Gerrard et al. 1983), density of nesting eagles (Dzus and Gerrard 1993), growth rate of young (Bortolotti 1989), and number of young fledged (Gende et al. 1997). |
| Effects of forest management | Numerous descriptive and experimental studies have examined the influence of various human activities (e.g., pedestrians, boating, all terrain vehicles, camping, aircraft, and military activities) on nesting, roosting, and hunting eagles (Stalmaster and Newman 1978; Knight and Knight 1984; Fraser et al. 1985; Wood et al. 1989; Buehler et al. 1991; Grubb and King 1991; McGarigal et al. 1991; Grubb et al. 1992; Bowerman et al. 1993; Watson 1993; Steidl and Anthony 1996, 2000; Stalmaster and Kaiser 1997, 1998; Fletcher et al. 1999; Watson et al. 1999; Wood 1999; Grubb et al. 2002). These studies suggest that response to disturbance is highly variable and depends on numerous factors including timing of disturbance, type of disturbance, distance to disturbance, duration of disturbance, and degree of habituation.<br><br>There is little information on the effects of forestry operations during the breeding season. In one study, Therres et al. (1993) described 3 case studies where clearcutting during the breeding season appeared to cause eagles to abandon nest sites along Chesapeake Bay. Cutting occurred from 91 to 366 m from nests; the authors concluded that no clearcutting should be permitted within 400 m of nests during the breeding season.<br><br>The documented effects of roads on nesting eagles are equivocal. Most studies fail to reveal any clear impact of the density, proximity, or level of use of roads on productivity (Mathisen 1968, McEwan and Hirth 1979, Andrew and Mosher 1982, Wood et al. 1989, Parson 1994, Anthony 2001), with the notable exception of Anthony and Isaacs (1989). They found that productivity of eagle nests in Oregon was negatively correlated with proximity of main logging roads. However, their study is far from clear as productivity was positively associated with the proximity of paved roads.<br><br>In contrast, there is considerable evidence that the location of eagle nests may be influenced by roads. For example, Andrew and Mosher (1982) found that eagle nests were significantly further from paved roads (but not unpaved roads) than expected by chance in Maryland. Anthony and Isaacs (1989) observed that |

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| | new nests were built significantly further from logging roads, paved roads, and unpaved roads than were old unused nests in Oregon. Livingston et al. (1990) noted that density of roads had a negative effect on the location of eagle nests in coastal (but not inland) habitats in Maine. Parson (1994) found that density of both paved and unpaved roads tended to be lower within than beyond 140 m of eagle nests in Washington. Jones (1995) noted that lakes with eagle nests in northwestern Ontario were significantly further from roads than were lakes without nests.<br><br>Numerous studies document the effects of habitat alteration associated with forest management operations on nesting eagles in various jurisdictions. Studies that did not quantify the type, proximity, or amount of timber harvest, or simply pooled timber harvest and other land clearing activities generally failed to detect an effect of harvesting on occupancy or productivity (e.g., Mathisen 1968, McEwan and Hirth 1979, Anderson 1985, Parson 1994, Anthony 2001).<br><br>In contrast, studies that quantified the amount or proximity of clearcut harvesting have generally revealed significant effects. For example, Corr (1974) suggested that clearcuts within 200 m of nests had a negative effect on breeding eagles in southeast Alaska. Anthony and Isaacs (1989) found that nest site occupancy and productivity were negatively related to proximity to clearcuts (age not described) in Oregon; they recommended no clearcuts within 400 m. Livingston et al. (1990) compared characteristics of habitat within 500 m of nest sites and randomly chosen potential sites in Maine. On inland lakes, sites with nests had a significantly lower area of clearcuts (<20 years old) than sites without nests. Gende et al. (1998) found that the proximity of clearcuts (<20 years old) affected the location of occupied nests, but did not appear to affect productivity in Alaska. Clearcuts within 100 m had the greatest impact, but effects were detectable up to 300 m away from nests.<br><br>Few studies have evaluated the effects of partial cutting. Anderson (1985) reported on the use of 31 nesting areas in Oregon and Washington. He found no significant difference in the percent of nests that were occupied for sites that had (47% occupied) or had not (54% occupied) experienced some form of 'selective' timber harvest within 1 km of nests. However, in 2 of 4 case studies presented, selective timber harvest close to nests appeared to have caused eagles to abandon nesting areas or relocate nests to adjacent uncut habitat. In Oregon, Anthony and Isaacs (1989) found that the occupancy and productivity of eagle nests were unrelated to the proximity of 'partial' cuts. A number of authors suggest that some partial harvesting may actually improve habitat suitability (Burke 1983, Anderson 1985, Cline 1990). |
| Past direction | First direction provided by James (1984). This direction was revised, expanded and described in OMNR (1987). OMNR (1987) identified a number of components required for the conservation of bald eagle habitat in Ontario including protecting individual nest sites and managing for habitat supply at a regional scale.<br><br>One study in Ontario attempted to evaluate the effectiveness of the site-specific direction in OMNR (1987). Jones (1995) compared productivity at occupied nests in northwestern Ontario that were surrounded by either uncut forest, forest cut following the direction in OMNR (1997), or forest cut without application of this direction. Sites cut following this direction were slightly more productive (1.8 young/nest) than sites cut that did not follow this direction (1.3 young/nest), but undisturbed sites had the lowest productivity of all the treatments (0.9 young/nest). Overall, none of the treatments differed significantly, likely because of the small sample size (total of 29 nests, only 4 |

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| | nests in areas cut following OMNR (1997)). |

**Rationale for direction**

Species of *special concern* throughout the AOU. Strong nest site fidelity and sensitivity to forest harvesting (see above). Thus, direction identifies nests as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Nesting areas contain up to 5 nests (average about 1.5; Buehler 2000), typically within a circle with a radius of about 400 m (Whitfield et al. 1974, Palmer 1988).

In the boreal forest of Saskatchewan, individual eagle nests have a typical life span of about 5 years (Gerrard et al. 1983). Thus, any nests known or suspected to have been occupied within 5 years are considered active (and thus either a primary or alternate nest).

Despite strong nest site fidelity, it is not unusual for 10-20% of nesting areas to be unoccupied each year; even in occupied areas, 5 to 15% of pairs may attend nests but not lay eggs (Gerrard et al. 1983, Grubb et al. 1983). For example, two of 20 areas studied in Arizona for 5 years were reoccupied following 2 consecutive years of no nesting activity (Grubb et al. 1983); one of 3 areas in Saskatchewan monitored for 14 years was reoccupied following 3 years of no nesting activity (Gerrard et al. 1983). Thus, nesting areas that become unoccupied for a few years should not be considered abandoned. However, if all nests within a nesting area can be documented as unoccupied for ≥3 consecutive years, all nests within the nesting area can be considered inactive.

If a nest blows out of a tree, the nest was the only active one within the nesting area, and the tree and habitat remain suitable for nesting, the nest should be considered a value for 3 breeding seasons to provide the eagles an opportunity to rebuild their nest (OMNR 1987, US Fish & Wildlife Service 2007).

Rationale for direction for primary nests is described below:

| **Direction** | **Rationale** |
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| *Standard* - 400 m radius AOC centred on primary nests. | A 400 m radius AOC is prescribed for primary nests based on the distance required to mitigate potential effects of disturbance during the *critical breeding period* (see below). |
| *Standard* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions: … | OMNR's original direction (1987) was based largely on that proposed by the US Fish & Wildlife Service (Grier et al. 1983) and prohibited conventional clearcutting within at least 400 m of eagle nests (although Grier et al. only explicitly prohibited clearcutting within 200 m of nests).<br><br>The recently revised US Fish & Wildlife Service direction for bald eagles only prohibits clearcutting within 100 m of nests (US Fish & Wildlife Service 2007). This change is based on the perception that eagles are more tolerant of human modifications to the landscape than previously suspected (Grier[1], pers. comm. 2007) and is supported by a study of 120 nests in Minnesota suggesting that habitat used by nesting eagles is highly variable (habitat requirements not as restrictive as previously perceived) and that productivity at nests shows little relationship to nest site characteristics (Guinn 2004).<br><br>However, Guinn (2004) did not specifically study the effect of forest management operations on nesting eagles. Moreover, previous research suggests that clearcutting within 100 to 500 m may affect the distribution, |

[1] James Grier, North Dakota State Univ., Department of Biological Sciences, Fargo, ND

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| | occupancy, and/or productivity of nests (Corr 1974, Anthony and Isaacs 1989, Livingston et al. 1990, Gende et al. 1998).<br><br>Some dense mature forest is likely important immediately around nests to protect nests and nest trees from damage during operations, provide visual screening, and protect nests from wind (*sensu* Saurola 1997). Moreover, Wood et al. (1998) recommended retention of mature forest within 200 m of nests to provide post-fledging habitat. Thus, prescribed direction prohibits clearcuts within 200 m of primary nests.<br><br>Ideal nesting habitat typically has canopy cover around 60% (see above). Thus, some harvest that maintains canopy closure ≥60% is permitted within 200 m of primary nests. However, to protect primary nests during harvest and maintain habitat conditions immediately around nests, no harvest is permitted within 100 m.<br><br>Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <60% within 200 m of primary nests.<br><br>In the event that a nest is located or established after harvesting has occurred, but prior to renewal and tending, these treatments can occur within that portion of the AOC where harvesting would normally not be permitted, but only outside the *critical breeding period* (see below). |
| *Guideline* - If harvest that retains <60% relatively uniform canopy closure occurs within 200 m of a primary nest prior to its discovery, an additional patch of unharvested forest equivalent to the area harvested will be retained, preferably attached to the remaining unharvested forest surrounding the nest (to provide a supply of potential nest and roost trees). | This direction ensures at least 12 ha of dense mature forest is associated with primary nests. |
| *Guideline* - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. Wildlife trees that may function as potential nest, perch, and roost sites will be preferentially | The supply of potential nest, perch, and roost trees appears to strongly influence habitat suitability; ideal density appears to be between 20 and 40 of these trees/ha (Lehman 1980, Chandler et al. 1995, Jones 1995). Trees used for nesting, perching, and roosting are generally living trees with diameters and heights greater than the surrounding stand; supercanopy white and red pines are especially favoured (Mathisen 1983, Chester et al. 1990, Bowerman et al. 1993, Chandler et al. 1995, Jones 1995, DellaSala et al. 1998, Thompson and McGarigal 2002). Thus, when retaining 25 wildlife trees/ha (as per Section 3.2.3), preference should be given to well-spaced supercanopy trees, veteran trees, cavity trees, and other live dominant or codominant trees that are windfirm, especially white pines, |

<table>
<tr><td>retained, based on the following order of priority: 1) supercanopy trees, 2) veteran trees, 3) cavity trees, and 4) other live dominant or codominant trees that are windfirm. White pines, red pines, and poplars will be favored when available.</td><td>red pines, and poplars.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 100-400 m of occupied primary nests during the critical breeding period based on potential impact of the operation (see below), except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Forest management operations in the vicinity of occupied nests during the critical breeding period may result in nest abandonment or lost productivity (see above).<br><br>The model in Appendix 4 suggests a timing restriction of about 550 m for High Impact Operations. However, detailed research on the response of eagles to human activities suggests that only about 25% of nesting birds flush when disturbances are further than 200 (Grubb et al. 1992) to 300 m (Grubb and King 1991) from nests. Thus, the following temporal buffers should likely be adequate to protect 95% of nests (sensu direction in Appendix 4):<br><br>
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>400 m</td></tr>
<tr><td>Moderate</td><td>200 m</td></tr>
<tr><td>Low</td><td>100 m</td></tr>
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<br>These are likely conservative buffers; the revised US Fish & Wildlife Service direction for eagles (US Fish & Wildlife Service 2007) only prohibits high impact activities such as timber harvesting and road construction during the nesting season if within 200 m of nests.</td></tr>
<tr><td>Guideline - The critical breeding period is defined as March 1 to August 31 for Northwest and Northeast Regions, and February 15 to August 15 for that portion of Southern Region within the AOU. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to breeding territories in Ontario by early March; median egg dates are April 10 – May 7 (Peck and James 1983, James 1991). Based on an incubation period of 35 days and a nestling period of about 11 weeks (Buehler 2000), most fledging likely occurs by mid-August. Thus, the critical breeding period is likely about March 1 to August 31 for Northwest and Northeast Regions and February 15 to August 15 for Southern Region.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits are not</td><td>Most eagles appear to avoid nesting near roads (see above) and roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and aggregate pits are not</td></tr>
</table>

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| permitted within 200 m of primary nests. | permitted within 200 m of primary nests. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 201-400 m of primary nests. | Roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009). Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within 201-400 m of primary nests. |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 100-400 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations (see Guinn (2004) for a discussion of habituation in bald eagles). |

Loss of the only nest in a nesting area can cause eagles to defer breeding for a year (Kennedy and McTaggart-Cowan 1998). Alternate nests are also important; eagles may switch nests among years as nests are lost to tree senescence and blowdown (Gerrard et al. 1983), or as a result of reproductive failure (Gende et al. 1997, Steidl et al. 1997). Trees that contain dilapidated nests are also valuable as eagles may rebuild and use a nest that has been unoccupied for several decades (Todd and Owen 1986). Thus, some protection is prescribed for all nest trees, even those that no longer contain a nest, if the tree is still suitable for nesting.

Direction for primary and alternate nests is similar (with the exception of restrictions on the timing of operations) since alternate nests are considered to have a high likelihood of reuse. Direction for inactive nests is less restrictive since these nests are considered to have a low likelihood of reuse.

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**4.2.2.2 Continued**

**Background**

| **Species** | **Osprey** |
|---|---|
| S-rank | S4B/G5 |
| Designation | None |
| Trend – CDN | Increasing or stable (Kirk and Hyslop 1998). |
| Trend - ON | Increasing or stable? Counts of migrating ospreys at Grimsby (Ontario) and Duluth (Minnesota) during the 1970s and 1980s suggest an annual increase in the provincial population of 5 to 7 percent (Hussell and Brown 1992). Ontario BBS data from 1981-2005 suggest a significant increasing trend (12%/yr). However, similar probability of observation during BBAs in the 1980s and 2000s; same trend for GLSL and boreal forests (Naylor 2007). |
| Distribution | Breeds from Alaska across to Newfoundland and along the eastern seaboard to Florida (Poole et al. 2002).Widely distributed across Ontario (Naylor 2007). Abundance appears to be highest in Northeast Region (634 nests in NRVIS); Northwest (446 nests) and Southern (433 nests) Regions have similar numbers of known nests. |
| Nesting | Builds a large bulky nest of sticks in dead trees, living trees with dead tops, utility poles or towers, or on man-made structures (Peck and James 1983). Nest sites appear to have two important characteristics; they represent a stable platform and they must provide an unobstructed view (Vana-Miller 1987). Strong nest site fidelity (Poole 1981, Postupalsky 1989); individual nest sites may be used 6 to 10 years (Todd and Owen 1986). Nesting typically occurs from April through August. |
| Habitat | Nests are generally found in marshes, swamps, flooded areas, bogs, along the shores of lakes and rivers, and on islands (Peck and James 1983). Although they will nest in very open habitats and may not require forest cover (Schroeder 1972), they appear to need suitable perches in the vicinity of nests (Vana-Miller 1987). Moreover, overly exposed nests may be more susceptible to both blowdown and predation (Saurola 1997).<br><br>Ospreys usually nest close to or over water (Peck and James 1983), but nests may be >3 km from water (D'Eon and Watt 1994). Ospreys are strongly associated with water because they feed almost exclusively on fish (Zarn 1974, Vana-Miller 1987). Food availability does not apparently influence clutch size (Poole 1983, Eriksson 1986) but may affect chick survival and thus productivity (Poole 1982, Lohmus 2001). Ospreys are extremely adaptable, hunting along large rivers, lakes, reservoirs, estuaries, and ocean coastlines. Suitability of waterbodies used for feeding may be influenced by proximity to nests, fish productivity, and factors affecting hunting success such as transparency and the presence of structures that obscure the surface of the littoral zone (Vana-Miller 1987, Usgaard and Higgins 1995, Lohmus 2001). |
| Effects of forest management | Numerous studies have shown that human disturbance can cause nest site abandonment or reproductive failure (Lind 1976, Swenson 1979, Poole 1981, Levenson and Koplin 1984, Vana-Miller 1987, Ewins 1997, Saurola 1997, |

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| | Thomas and Bird 1998).<br><br>Timber harvest is widely regarded as an important disturbance factor (Ewins 1997, Saurola 1997). Two anecdotal studies (each involving only one nest) suggest that timber harvest within 100 m of nests during the breeding season did not affect reproductive output (Melo 1975, Adams and Scott 1979). In contrast, Saurola (1997) suggests that road construction, timber harvest, and planting near nests during the nesting season has caused lost productivity in Finland. Moreover, in California, 15 nests subject to intense human activity (described as "generally logging") during the breeding season produced about one-third as many chicks as 33 nests with minimal human disturbance (Levenson and Koplin 1984). Unfortunately, Saurola (1997) presents no data and Levenson and Koplin (1984) did not quantify the type, proximity, or amount of harvesting conducted around nests. Regardless, these sources do suggest that forest management operations conducted during the breeding season may have immediate effects on productivity.<br><br>Even so, short term effects of disturbance during the breeding season may be transitory; Naylor (2009) found no relationship between the proximity or amount of timber harvest (or other silvicultural operations) conducted during the breeding season and long term occupancy or productivity of 150 nests in Ontario.<br><br>Effects of roads and traffic are equivocal. Melo (1975) and Adams and Scott (1979) reported successful fledging at individual nests that were approximately 30 m from active logging roads. In contrast, Lanier and Foss (1989) described a nest that was 250 m from a moderately used unpaved road that produced young only once in 8 years.<br><br>In highly developed landscapes, proximity of roads and associated human disturbance may affect productivity. For example, Levenson and Koplin (1984) noted lower (but not statistically significant) productivity at 34 nests in California that were subject to disturbance associated with county and state highway traffic (and related human activities) compared to 33 remote nests. In a study of 110 nests in Idaho, Van Daele and Van Daele (1982) found that nests >1.5 km from well-traveled roads had higher productivity than those within 1.5 km of roads. In contrast, Naylor (2009) found no relationship between proximity of logging roads and occupancy or productivity of nests. The latter study was conducted in continuously forested landscapes where roads were associated with forestry operations but with relatively few other human development pressures.<br><br>Reaction of ospreys to human disturbance is clearly related to degree of habituation (D'Eon and Watt 1994). In many areas, ospreys successfully nest in close proximity to houses, cottages, marinas, roads, railways and areas of high recreational activity (Poole 1981, Van Daele and Van Daele 1982, Ewins 1997). In contrast, lower amounts of disturbance can disrupt breeding activity at remote nests (Van Daele and Van Daele 1982, Poole 1989a, Ewins 1997). It appears that ospreys that initiate nesting activities near sources of human disturbance will tolerate more disturbance during the nesting season (Swenson 1979, Poole 1981, Vana-Miller 1987, Ewins 1997).<br><br>Significant habitat modification associated with major land use changes can alter the abundance or distribution of nesting ospreys. However, as long as nest structures are available (natural or man-made), ospreys appear to be able to adapt to a high degree of habitat modification, frequently nesting in or near houses, cottages, marinas, highway medians, runways, and even parking lots (Zarn 1974, Poole 1981, Vana-Miller 1987, Ewins 1997). |

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| | Timber harvest is often considered to have a negative effect on ospreys because it may remove existing or potential nest sites (Saurola 1997). However, few studies have quantified the effects of habitat modification caused by timber harvest. One nest observed by Melo (1975) was reused 2 seasons after partial cutting occurred 30 m from the nest (cited in Adams and Scott 1979). Adams and Scott (1979) reported that one nest was occupied for 7 consecutive years after partial timber harvest (30% of BA removed) was conducted to within 60 m.<br><br>Levenson and Koplin (1984) described the effects of timber harvest during the nesting season on productivity in the year of disturbance (see above). Unfortunately, they did not quantify the effect of habitat modification on nest site occupancy or productivity in subsequent years.<br><br>In the only comprehensive study to date, Naylor (2009) studied the effects of forest management operations on 150 osprey nests in central and northeastern Ontario. No significant difference in occupancy or productivity was found among nest sites that had experienced cutting that followed Ontario's guidelines (Szuba and Naylor 1998), had been cut in a way that was not consistent with the guidelines, or had not experienced any cutting. Moreover, no relationship was found between occupancy or productivity and the proximity or amount of timber harvest or other silvicultural operations (site preparation, planting, tending) that had occurred within 10 years.<br><br>Minimal impact of forest management operations that alter habitat surrounding nests is not surprising given the nature of habitat typically selected by nesting ospreys (D'Eon and Watt 1994). Ospreys routinely nest in exposed situations with little surrounding forest cover such as beaver-controlled wetlands and recent burns (Swenson 1981, Peck and James 1983). |
| Past direction | Direction provided by Penak (1983) prescribed a 800 m AOC. This direction was modified (300 m AOC) for use in GLSL forest (Szuba and Naylor 1998) based largely on recommendations by Naylor (1994).<br><br>Naylor (2009) studied the effects of forest management operations on 150 osprey nests in central and northeastern Ontario. He concluded that even the direction used in the GLSL was effective in maintaining the long term occupancy and productivity of nests, but were likely conservative. However, this study was unable to identify whether forest management operations during the nesting season influenced occupancy or productivity during the year of disturbance.<br><br>Based largely on the study by Naylor (2009), the AOC for nests across the province was standardized (300 m) in 2006 (OMNR 2006). |

**Rationale for direction**

Uncommon species; historic population declines related to DDT and its perceived sensitivity to disturbance have resulted in it traditionally being classified as a regionally featured species within the context of forest management operations. Thus, direction identifies nests as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Protection of individual nests important since ospreys show strong nest site fidelity (Poole 1981, Postupalsky 1989). Moreover, the availability of suitable nest sites may limit population density (Poole 1989a, Witt 1990, Ewins 1997).

Annual rate of reoccupancy of nesting areas typically >80% (Poole et al. 2002) suggesting an average nesting area is used for >4 years. Thus, nests known to have been occupied within 5 years are considered either primary or alternate nests.

Not all nesting areas are occupied each year and even within occupied nesting areas, some pairs may not lay eggs in a specific year (e.g., Swenson 1979). Thus, a nesting area apparently unoccupied in a single year should not be considered abandoned (inactive). Unfortunately, long term data on the pattern of nest occupancy is lacking. Nesting areas are considered inactive if unoccupied for ≥3 consecutive years following direction for bald eagles.

Rationale for direction for primary nests is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standards* - 300 m radius AOC centred on primary nests. | A 300 m radius AOC is prescribed for primary nests based on the distance required to mitigate potential effects of disturbance during the *critical breeding period* (see below). |
| *Standards* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions (see below) and the following conditions: … | Naylor (2009) found little evidence that partial or clearcut harvesting had a long term influence on the occupancy or productivity of nests and thus suggested that the guidelines proposed by both Penak (1983) and Szuba and Naylor (1998) were effective but conservative. Naylor's (2009) work led to the modifications proposed by OMNR (2006).<br>Two further modifications are prescribed to the direction in OMNR (2006). There is little evidence that habitat alterations associated with forest management operations reduce habitat suitability as long as nests, alternate nests, perch sites, and roosts sites are provided and a buffer of live trees is retained to screen nests from predators, competitors, and wind (Ewins 1997, Saurola 1997). Saurola (1997) recommends as little as 50 m of uncut forest around nests. Thus, the 150 m uncut buffer proposed by OMNR (2006) is likely adequate when the surrounding forest is being harvested using clearcut or shelterwood systems but can likely be reduced to 75 m for primary nests when harvesting conducted will retain dense mature forest (e.g., selection harvest)(see also Melo 1975, Scott and Adams 1979). Thus, harvest that retains ≥60% canopy closure is permitted within 76-150 m of primary nests.<br>Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <60% within 150 m of primary nests.<br>In the event that a nest is located or established after harvesting has occurred, but prior to renewal and tending, these treatments can occur within that portion of the AOC where harvesting would normally not be permitted, but only outside the *critical breeding period* (see below). |
| *Guideline* - If harvest that retains <60% relatively uniform canopy closure occurs within 150 m of a primary nest prior to its discovery, an additional patch of unharvested forest equivalent to the area harvested will be | This direction ensures at least 7 ha of dense mature forest associated with primary nests. |

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<tr>
<td>retained, preferably attached to the remaining unharvested forest surrounding the nest (to provide a supply of potential nest and roost trees).</td>
<td></td>
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<tr>
<td>Guideline - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. Wildlife trees that may function as potential nest, perch, and roost sites will be preferentially retained based on the following order of priority: 1) supercanopy trees, 2) veteran trees, 3) cavity trees and 4) other live dominant or codominant trees that are windfirm. White pines, red pines, and poplars will be favored when available.</td>
<td>The number of residual trees required within harvested parts of the AOC is unknown. Thus, direction defers to that for bald eagles for consistency.</td>
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<tr>
<td>Guideline - Harvest, renewal, and tending operations are not permitted within 75 to 300 m of occupied primary nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td>
<td>Forest management operations in the vicinity of occupied nests during the critical breeding period may result in nest abandonment or lost productivity (see above).<br><br>The model in Appendix 4 suggests the following temporal buffers:<br>
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>300 m</td></tr>
<tr><td>Moderate</td><td>150 m</td></tr>
<tr><td>Low</td><td>75 m</td></tr>
</table>
These buffers are generally supported by the literature. Pedestrian activities produced flushing responses at a distance of 50 to 150 m (Mullen 1985, Cuthbert and Rothstein 1988). Numerous sources (cited in Cline 1990, Vana-Miller 1987, D’Eon and Watt 1994) suggest that human activity should be prohibited within 200 to 400 m of nests during the breeding season.</td>
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<tr>
<td>Guideline - The critical breeding period is</td>
<td>Typically returns to breeding range in Ontario in late April; median egg dates are May 22 to June 7 (Peck and James 1983, James 1991). Based</td>
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| defined as April 15 to August 31 for Northwest and Northeast Regions, and April 1 to August 15 for that portion of Southern Region within the AOU. Local knowledge of breeding chronology may be used to adjust these dates. | on an incubation period of 38 days and nestling period of 53 days (Poole et al. 2002), most fledging likely occurs by mid-August. Thus the *critical breeding period* is likely about April 15 to August 31 for most areas in Northwest and Northeast Regions and April 1 to August 15 in Southern Region. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 150 m of primary nests. | The effects of roads on nesting ospreys in equivocal (see above). However, roads landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and aggregate pits are not permitted within 150 m of primary nests. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 151-300 m of primary nests. | Roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009). Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within 151-300 m of primary nests. |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 75-300 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations (see above discussion of habituation in ospreys). |

Ospreys usually have one or more alternate nests that are in trees adjacent to the primary nest, but may occasionally be as much as 1.6 km away (Postupalsky 1977). Protection of alternate nests is also important; since ospreys show a strong preference for dead trees, it is not unusual to lose >10% of nests each year to blowdown (Poole 1989b). If alternate nests are not available, construction of new nests delays nesting and may result in reduced clutch size and number of young fledged (Steeger and Ydenberg 1993). Thus, some protection is prescribed for all nests within active nesting areas.

Direction for primary and alternate nests is similar (with the exception of restrictions on the timing of operations) since alternate nests are considered to have a high likelihood of reuse. Direction for inactive nests is less restrictive since these nests are considered to have a low likelihood of reuse.

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#### 4.2.2.3 Colonial-nesting birds (great blue heron, Bonaparte's gull, bank swallow)

**Background**

| **Species** | **Great blue heron** |
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| S-rank | S5B/G5 |
| Designation | Not at risk; not a conservation concern (NAWCP 2002). |
| Trend – CDN | Unknown |
| Trend - ON | Decreasing? In the early 1980s, Dunn et al. (1985) estimated a provincial population of at least 13,000 breeding pairs. By the early 1990s, there were over 17,000 breeding pairs (Collier et al. 1992). However, Ontario BBS data from 1981-2005 suggest a significant decreasing trend (-2%/yr). Moreover, the probability of observation during BBAs declined significantly (>20%) from the 1980s to 2000s in the GLSL forest; an even larger decrease (>40%) in the boreal forest was not significant (Naylor 2007). |
| Distribution | Breeds from Cape Breton Island to central Alberta, south to Florida and Texas. Also breeds along the Pacific coast from southern Alaska to the Baja Peninsula (Butler 1992). Widely distributed across Ontario but most abundant in the GLSL forest (Naylor 2007). NRVIS data from 2001 contains records of 818 colonies in Southern Region, 609 colonies in Northeast Region, and 176 colonies in Northwest Region. |
| Nesting | Builds large bulky nests of sticks in living or dead trees over or close to water (Peck and James 1983). May nest singly, but >99% of 12,211 nests in the Ontario Nest Records Scheme were in colonies (Peck and James 1983). Colony size averages about 35 nests, with some colonies (in southern Ontario) exceeding 150 nests (Dunn et al. 1985). Individual nests may be reused for years (Butler 1992), but not necessarily by the same birds (Simpson et al. 1987). Colonies may be very stable and can exist for 20 to 50 years (Moseley 1936, Bjorklund 1975, Sullivan and Payne 1988), but the average lifespan of heronries in Ontario is only about 9 years (Collier et al. 1992). Nesting typically occurs from April through August. |
| Habitat | Colonies are found in wet or dry forest, sparsely treed islands, beaver ponds, and marshes (Peck and James 1983).<br><br>Colony size has been correlated with the supply of suitable feeding habitat (Gibbs 1991, Butler 1997, Gibbs and Kinkel 1997). Small fish (<25 cm in length) comprise the majority of the diet, but herons also consume amphibians, rodents, aquatic insects, crayfish, snails, and carrion (Short and Cooper 1985, Butler 1992). Feeding is generally conducted in the shallow water (<50 cm deep) of marshes, ponds, lake and river shorelines, and forested wetlands (Short and Cooper 1985, Gibbs 1991). Feeding areas are typically within 4 to 5 km of colonies, but herons may fly up 25 km to feed (Short and Cooper 1985).<br><br>Dispersion of colonies across the landscape appears to be related to two main factors. Colonies tend to be located in areas with a low level of human disturbance (Gibbs et al. 1987, Gibbs and Kinkel 1997). Colonies also tend to be located centrally with respect to feeding areas, likely as a strategy to |

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| | minimize travel costs associated with feeding (Gibbs 1991, Gibbs and Kinkel 1997). |
| Effects of forest management | Human activity may disturb nesting herons, potentially resulting in reduced productivity or site abandonment (Bjorklund 1975, Mark 1976, Werschkul et al. 1976, Markham and Brechtel 1978, Kelsall and Simpson 1980, Quinney 1983, Drapeau et al. 1984, Forbes et al. 1985, Koonz and Rakowski 1985, Simpson et al. 1987, Parnell et al. 1988, Carlson and McLean 1996, Carney and Sydeman 1999, Vennesland 2000, Skagen et al. 2001; but see Nisbet 2000). Reduced productivity may result from increased predation on eggs or young, mortality of chicks due to exposure or falling from nests, or interruption of feeding activities (Bowman and Siderius 1984, Rodgers and Smith 1995).<br><br>Only two studies have looked at the influence of forest management operations during the breeding season on occupancy or productivity. Agro and Naylor (1994) found no significant relationship between proximity of timber harvest during the breeding season and longevity of 98 colonies in Ontario. However, all summer cuts in their study were >300 m from colonies. In a more recent study of 150 colonies in Ontario that included cutting close to nests, Naylor (2009) similarly found no relationship between the proximity of timber harvest conducted during the breeding season and long term occupancy or productivity.<br><br>Thus, disturbance associated with forest management operations conducted during the breeding season appears to have little effect on the long term use or productivity of colonies. However, heavy equipment operating close to colonies during the breeding season may have an immediate effect on reproductive performance. For example, land-clearing equipment operating within 50 m of one colony in British Columbia during the breeding season did cause herons to abandon their nesting attempt (Vennesland 2000). In contrast, Taylor et al. (1982) reported that farm machinery routinely operated within 85 m of a colony in Indiana with no apparent effect.<br><br>Pedestrian activity 100 to 200 m from heronries caused herons to flush from nests during the most sensitive periods of the breeding season in British Columbia (Butler 1991). In Colorado, Skagen et al. (2001) noted that pedestrian activity within 200 m of a colony caused a reduction in nest occupancy; activity within 100 m resulted in reduced nest success.<br><br>Proximity of roads has been linked to the location (Watts and Bradshaw 1994, Gibbs and Kinkel 1997), size (Parker 1980), and occupancy of heronries (Naylor 2009). Corely et al. (1997) suggested that optimal nesting habitat was >150 m from unimproved dirt roads in Oklahoma. Short and Cooper (1985) recommended that suitable nesting habitat had no roads (type not specified) within 250 m. Naylor (2009) found no effect of temporary roads on herons in Ontario. However, permanent roads within 200 to 300 m of colonies affected occupancy. In Virginia, Watts and Bradshaw (1994) found a lower density of unimproved roads within 400 m of colonies and a lower density of secondary roads within 800 m of colonies compared to unused sites. Parker (1980) suggested that ideal nesting habitat in Montana was >750 m from roads (type not specified). Some of the variability in the reported effects of roads on herons likely reflects study-specific context. For example, Parker (1980) and Watts and Bradshaw (1994) studied herons in highly developed landscapes where roads were associated with a variety of sources of human disturbance (e.g., permanent homes). In contrast, Naylor (2009) studied herons in continuously forested landscapes, disturbed by timber harvest but with relatively little other human development.<br><br>There is considerable evidence that some herons may habituate to repeated, |

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| | non-threatening activities (Parker 1980, Webb and Forbes 1982, Vos et al. 1985, Carlson and McLean 1996, Vennesland 2010).<br><br>Numerous studies have shown that the location or size of heronries may be positively influenced by the supply of suitable nesting or feeding habitat and negatively affected by human activities such as residential or agricultural development or water impoundment (Henny and Kurtz 1978, Parker 1980, Gibbs et al. 1987, Gibbs 1991, Agro and Naylor 1994, Watts and Bradshaw 1994, Corley et al. 1997, Gibbs and Kinkel 1997).<br><br>Information on the effects of timber harvest on heronries is more limited. Much of what is suspected about the impact of timber harvest is based on anecdotal evidence and a small number of correlative studies.<br><br>For example, clearcutting along the edge of a large mixed species heronry in Illinois conducted during 4 successive winters apparently lead to a reduction in colony size from 820 nests to 332 nests (Bjorklund 1975). In Montana, Parker (1980) cites an example of unrestricted cutting that appeared to have caused a heronry to relocate.<br><br>In a study of 12 heronries in Oregon, clearcutting within 500 m of colonies apparently caused a decrease in occupancy rate of nests compared to undisturbed colonies (67 versus 93% of nests occupied) (Werschkul et al. 1976). In one colony affected by cutting, occupied and unoccupied nests averaged 220 m and 150 m, respectively, from the nearest clearcut, suggesting that herons shifted their distribution within the colony in response to cutting.<br><br>In a study of 98 heronries in Ontario, Agro and Naylor (1994) found no apparent effect of clearcutting or partial cutting (selection and shelterwood pooled) at any distance (up to 2 km) on the longevity of colonies over a 10 year period. However, few colonies had experienced partial cutting within 150 m or clearcutting within 300 m.<br><br>In the most comprehensive study to date, Naylor (2009) studied the effects of forest management operations on 150 heronries in central and northeastern Ontario. No significant difference in colony size, occupancy, or productivity was found among colonies that had experienced cutting that followed Ontario's guidelines (Szuba and Naylor 1998), had been cut in a way that was not consistent with the guidelines, or had not experienced any cutting (although colonies cut without the guidelines tended to have a lower rate of occupancy and chick production). However, Naylor (2009) did find that colony size, occupancy, and productivity were all influenced by the amount of timber harvest within 250 to 500 m of colonies. Clearcutting appeared to have a slightly greater impact than selection or shelterwood cutting. Overall, cutting appeared to have little effect when beyond 100 to 200 m of colonies. |
| Past direction | Bowman and Siderius (1984) prescribed a 1 km AOC. This direction was modified for use in the GLSL forest (300 m AOC) circa 1990 (see Szuba and Naylor 1998).<br><br>Two studies have partially tested the effectiveness of this direction. Both Agro and Naylor (1994) and Naylor (2009) found that the buffers proposed for the GLSL (Szuba and Naylor 1998) were effective in maintaining long term occupancy of colonies (in both boreal and GLSL colonies). However, neither study evaluated the effect of forest management operations during the breeding season on productivity in the year of disturbance. |

**Rationale for direction**

A common species but perceived sensitivity of colonial-nesting birds to disturbance has resulted in it being classified as a regionally featured species within the context of forest management operations. Moreover, species may be declining in Ontario. Thus, direction identifies colonies as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Protection of colonies is important because of site fidelity (see above). Large colonies likely deserve more protection than small colonies. Individual large colonies represent a greater proportion of the regional breeding population than do small colonies and may produce disproportionately more young (Forbes et al. 1985, Vennesland 2000). Moreover, large colonies may be more stable (Bjorklund 1975, Werschkul et al. 1976, Parker 1980, Butler 1997; and see below) and may be indicative of a large supply of feeding habitat (Gibbs et al. 1987, Gibbs and Kinkel 1997).

OMNR (2000) suggests that colonies with ≥25 nests represent significant wildlife habitats in southern Ontario. This threshold may not be appropriate for the AOU, where colonies are typically smaller (see Dunn et al. 1985). To define an appropriate threshold for the AOU, the Ontario Heronry Inventory (OHI), which contains data on 799 colonies within the AOU, was consulted (see Dunn et al. 1985, Collier et al. 1992 for a description of the OHI). Mean colony size (number of occupied nests) is similar among heronries in Northeast Region (15.4 nests/colony, N = 242 colonies), Northwest Region (15.7 nests/colony, N = 153 colonies) and that part of Southern Region within the AOU (14.2 nests/colony, N = 404 colonies). Colonies with ≥4 nests contained >95% of all occupied nests. Moreover, colonies with ≥4 nests had twice (30.0 vs 14.7%) the likelihood of remaining occupied from circa 1980 to 1990 compared to those with <4 nests. Thus, colonies with fewer than 4 nests have relatively low significance to regional populations and are considered small colonies.

Based on the % of colonies in the OHI that remained occupied from circa 1980 to 1990 (see above), large and small colonies likely have an annual rate of reoccupancy of about 90% and 80%, respectively, suggesting that large and small colonies are used for an average of about 8 and 4 years, respectively. Thus, large and small colonies known to have been occupied within 10 and 5 years, respectively, are considered active.

Colonies may be temporarily unoccupied for a year and then subsequently reoccupied. Colonies unoccupied for 2 or more consecutive years generally have a low probability of being reoccupied (Dunn et al. 1985, Collier et al. 1992). Thus, colonies documented as unoccupied for ≥5 years for large colonies or ≥3 years for small colonies are considered inactive.

Rationale for direction for active colonies is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 300 m radius AOC measured from peripheral nests. | An AOC of 300 m is prescribed for both large and small colonies based on the distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions: … | Agro and Naylor (1994) and Naylor (2009) suggest that past direction that recommended no cutting within 150 m and no clearcutting within 300 m of active colonies was effective in sustaining long term occupancy. Thus, no conventional clearcutting within 300 m is prescribed for large active colonies. However, Naylor (2009) suggested that past direction may have been slightly conservative. Thus, conventional clearcutting is permitted within 151-300 m of small active colonies (thus small active colonies receive the same protection as active osprey nests).<br><br>Partial cutting (selection, shelterwood) did not appear to have as much |

<table>
<tr><td></td><td>influence on reoccupancy of colonies as did clearcutting (Naylor 2009). Thus, a 150 m reserve may be overly conservative and some partial harvesting is permitted within 150 m of large and small colonies. However, herons appear to require sufficient suitable habitat to permit movement of colonies as nest trees are killed by defecation and eventually fall (see Custer et al. 1980, Parker 1980). Moreover, dense tree cover surrounding colonies is important to minimize the impact of severe wind events (see Taylor et al. 1982, Burkholder and Smith 1991). Thus, some amount of unharvested forest should likely remain around heronries. Consequently, no harvest is permitted within 75 m of colonies.<br><br>Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <60% within 150 m of colonies.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 75-300 m of occupied nests within colonies during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Forest management operations in the vicinity of occupied colonies during the critical breeding period may result in nest abandonment or lost productivity (see above).<br><br>The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>300 m</td></tr><tr><td>Moderate</td><td>150 m</td></tr><tr><td>Low</td><td>75 m</td></tr></table><br>These buffers are supported by a study conducted by Butler (1991) that showed that pedestrians caused adult herons to flush from nests at an average distance of 200 m prior to laying and recommended buffers within the literature that suggest no human activity during the nesting season within 100 to 300 m (Parker 1980, Vos et al. 1985, Butler 1991, Rodgers and Smith 1995, Vennesland 2000).</td></tr>
<tr><td>Guideline - The critical breeding period is defined as April 1 to August 15 for Northwest and Northeast Regions, and March 15 to July 31 for that portion of Southern Region within the AOU. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to breeding range in Ontario by early April; median egg dates are May 3 to May 23 (Peck and James 1983, James 1991). Based on an incubation period of 27 days and a nestling period of 53 days (Butler 1992), most fledging likely occurs by late July. Thus, timing restriction from April 1 to August 15 in northern Ontario and March 15 to July 31 in southern Ontario should protect colonies from initiation of nesting to fledging.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits are not</td><td>Roads may affect the location, size, and occupancy of colonies (see above). Moreover, roads landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and</td></tr>
</table>

| | |
|---|---|
| permitted within 150 m of colonies. | aggregate pits are not permitted within 150 m of colonies. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 151-300 m of colonies (especially large colonies). | Roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009). Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within 151-300 m of active colonies. |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance. Within residual forest, the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance.<br>When roads must be constructed within residual forest, the cleared corridor should be as narrow as practical and feasible, to maintain a relatively uniform canopy closure (maximum width of 20 m; see Szuba and Naylor 1998). |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 75-300 m of *occupied* nests within colonies during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the colony. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the colony. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations (see above discussion of habituation in herons). |

Inactive colonies have a low likelihood of being reused. Thus, protection of individual nests is likely sufficient.

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**4.2.2.3 Continued**

**Background**

| **Species** | **Bonaparte's gull** |
|---|---|
| S-rank | S4B/G5 |
| Designation | Not at risk; moderate conservation concern (NAWCP 2002). |
| Trend – CDN | Unknown |
| Trend - ON | Increasing? Insufficient BBS data to evaluate trend. Significant increase in the probability of observation (about 40%) between BBAs in the 1980s and 2000s (Sutherland and Pittaway 2007). |
| Distribution | Breeds from Alaska to northern Ontario and Quebec; at the southern edge of its range in Ontario (Burger and Gochfeld 2002). Scattered across the boreal portion of the AOU; most common in the Hudson Bay lowlands (Sutherland and Pittaway 2007). |
| Nesting | Builds small nests from twigs, mosses, lichens, and marsh vegetation, typically 3-7m high in conifer trees (Peck and James 1983, Burger and Gochfeld 2002). Nests singly or in loose colonies of 2-6 nests; nest site fidelity reported (Burger and Gochfeld 2002). |
| Habitat | Nests in open black spruce bogs, in scattered trees on islands, or in shoreline forest typically within 100 m of lakes, rivers, or wetlands (Peck and James 1983, Burger and Gochfeld 2002). |
| Effects of forest management | Little quantitative information on the effects of human activities. However, gull colonies generally considered to be sensitive to human activities (e.g., Carney and Sydeman 1999) and anecdotal observations suggest Bonaparte's gull is especially intolerant of human activity (Zimmerling[1], pers. comm. 2006; and see references in Burger and Gochfeld 2002). |
| Past direction | No species-specific direction. |

**Rationale for direction**

S4 colonial-nesting species without demanding habitat requirements but with nest site fidelity. Thus, direction identifies colonies as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 150 m radius AOC measured | An AOC of 150 m is prescribed for colonies based on the distance required to mitigate potential effects of disturbance during the breeding |

[1] Ryan Zimmerling, Bird Studies Canada, Port Rowan, ON

<table>
<tr><td>from peripheral nests.</td><td>period (see below).</td></tr>
<tr><td>Standard - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions: …</td><td>No information on the effects of habitat alteration associated with forest management operations on future use of nest sites. Direction follows that for small great blue heron colonies.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 40-150 m of occupied nests within colonies during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>No data on the size of temporal buffers required. Buffers of 100-200 m are generally recommended for gull and tern colonies (e.g., Erwin 1989, Rodgers and Smith 1995, Carney and Sydeman 1999). Thus, the following temporal buffers are prescribed:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>150 m</td></tr>
<tr><td>Moderate</td><td>75 m</td></tr>
<tr><td>Low</td><td>40 m</td></tr>
</table>
</td></tr>
<tr><td>Guideline - The critical breeding period is May 1 to August 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Nesting begins in early to late May (Burger and Gochfeld 2002); egg dates are May 29 – July 19 in Ontario (6 nests only) (Peck and James 1983). Limited information on incubation and fledging period (Burger and Gochfeld 2002). Timing restriction from May 1 to August 31 should likely provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits are not permitted within 150 m of active colonies.</td><td>No information on the effects of roads. Direction follows that for small great blue heron colonies.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 40-150 m of occupied nests within colonies during the critical breeding period based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the colony. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

| | |
|---|---|
| road maintenance operations (e.g., grading) if the road predates the colony. | |

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**4.2.2.3 Continued**

**Background**

| **Species** | **Bank swallow** |
|---|---|
| S-rank | S5B,SZN/G5 |
| Designation | Not at risk; Priority species for BCR 12 |
| Trend – CDN | Significant declining trend during past 20 and 40 years according to BBS data. |
| Trend - ON | Declining. BBS data suggests significant decline (about 5%/yr) over the past 40 years. Moreover, the probability of observation declined by about 50% between BBAs in the 1980s and 2000s (Sandilands 2007). |
| Distribution | Holarctic. In Ontario, occurs from the shores of Lake Erie to the coast of Hudson Bay but most abundant south of the Canadian Shield (Sandilands 2007). |
| Nesting | Nests in a burrow excavated in friable substrate in a freshly exposed vertical face (typically about 2-3 m tall) associated with eroded riverbanks, lakeshore bluffs, dunes, road cuts, aggregate pits, or man-made piles of gravel, sand, or sawdust (Peck and James 1987, Garrison 1999). In ON, generally breeds in a colony of up to 1500 pairs (solitary nests occasionally encountered) (Peck and James 1987). Typically digs new burrows each year, although some old burrows may be reused. Colonies are ephemeral, but large colonies persist longer than small colonies (Garrison 1999). |
| Habitat | In natural situations, typically associated with shoreline and riparian habitats. A large proportion of nests sites are now associated with anthropogenic features such as roads, aggregate pits, and farmland (Peck and James 1987). |
| Effects of forest management | No information on the effects of forest management operations. Generally considered to be quite tolerant of human disturbance in the vicinity of colonies (Garrison 1999). For example, 1 large colony near Blind River has persisted for many years despite aggregate extraction operations that occur within the pit during the breeding season (a few hundred meters away) (Meissner[1], pers. comm. 2008).<br><br>In the western US, main threats to nesting habitat generally considered to be flood/erosion control projects along rivers (e.g., Garrison et al. 1987, Moffatt et al. 2005) which modify the bank to a stable 2:1 or 3:1 slope and/or cover the bank with riprap (Garrison 1998).<br><br>The species has apparently benefited from the cut faces created by road construction and aggregate extraction (Erskine 1979). While road construction operations may create suitable habitat for nesting, subsequent operations, such as road widening, may, at least temporarily, displace colonies (Petersen and Mueller 1979). Moreover, since freshly exposed vertical faces are required for burrow excavation, abandoned pits may cease to provide suitable habitat (Freer 1979). In California, nest sites created specifically for bank swallows became unsuitable for nesting after 3 years with no maintenance because the vertical |

[1] Erwin Meissner, Massey Field Naturalists, Massey, ON

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| | faces slumped, they became overgrown with vegetation, and/or the soils became too hard to excavate (Garrison 1991 cited in Garrison 1998). |
| Past direction | No species-specific direction. |

**Rationale for direction**

Priority bird species for BCR 12. The Landbird Conservation Plan for BCR 12 recommends protection of sites capable of supporting large (>100 pairs) nesting colonies. Moreover, OMNR (2000) identifies nesting colonies with ≥100 pairs as significant wildlife habitat. Thus, direction identifies colonies as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 50 m radius AOC measured from peripheral nests. | An AOC of 50 m is prescribed for colonies based on the distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions. | There is no indication that forest cover is required in the vicinity of colonies. Thus, regular harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 10-50 m of *occupied* nests within colonies during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | No data on size of temporal buffers required. Buffers of 100-200 m are generally recommended for colonial gulls and terns (e.g., Erwin 1989, Rodgers and Smith 1995, Carney and Sydeman 1999). However, swallows are significantly smaller bodied birds, have concealed nests, and are generally considered to be quite tolerant of human activities (all factors suggesting smaller temporal buffers might be acceptable). Thus, the following buffers are prescribed:<br><br>**Potential impact** / **No operations within**<br>High / 50 m<br>Moderate / 25 m<br>Low / 10 m |
| *Guideline* - The *critical breeding period* is May 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates. | Nesting begins in early May (James 1991); median egg dates are June 2 – June 15 in Ontario (Peck and James 1987). The incubation period lasts 13-16 days; young fledge at about 20 days of age (Garrison 1999). Thus, timing restriction from May 1 to July 31 should likely provide protection from initiation of nesting to fledging. |
| *Standard* - New roads | For colonies associated with riverine habitats, the major concern is likely |

| | |
|---|---|
| and landings are not permitted within 50 m of active colonies. | habitat alteration associated with roads and stream crossings. Thus, new roads and landings are not permitted within 50 m of active colonies. |
| *Standard* - Aggregate extraction is permitted within the AOC subject to timing restrictions. | For colonies in aggregate pits, extraction operations may remove bank faces with existing nest tunnels, but are also necessary to create ‘fresh’ faces with slopes that are suitable for nesting. Thus, aggregate extraction is permitted within the AOC subject to timing restrictions. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of *occupied* nests within colonies during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the colony. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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#### 4.2.2.4 Uncommon stick-nesting raptors

**Background**

| **Species** | **Great gray owl** |
|---|---|
| S-rank | S3S4/G5 |
| Designation | Not at risk (formerly *special concern*) |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable? No BBS data. Nocturnal Owl Survey data for 1995-2005 suggest no trend in northern Ontario (Crewe and Badzinski 2006). Similar probability of observation during BBAs in the 1980s and 2000s (Johnson 2007). Population fluctuates in response to prey cycles (Duncan 1997). |
| Distribution | Scattered across the boreal forest of Ontario; most abundant in northwestern Ontario (Johnson 2007). |
| Nesting | Does not build a nest but uses abandoned hawk or raven nests, broken stubs, or man-made structures (Peck and James 1983); abandoned nests of goshawks appeared to be most commonly used substrates (Bull and Henjum 1990, Bull and Duncan 1993)(in some areas, old raven nests are used primarily; Osborne 1987). Nesting season ranges from early March to early July.<br><br>In Oregon, about 40% of pairs used the same nest in subsequent years and 40% used a different nest <1 km away; individual nests were used for up to 4 years (Bull and Henjum 1990). In the boreal forest of central North America, site fidelity is more variable (Duncan 1992, 1997). When prey populations are increasing or peaking, adults remain on breeding home ranges. Following a prey crash, adults may disperse to new nesting areas 100's km away. After prey populations recover, birds may reoccupy original breeding habitat. |
| Habitat | Typically nests in mature or old growth lowland conifer, hardwood, or mixedwood forest with moderate to high canopy closure (Spreyer 1987, Bull et al. 1988, Bull and Henjum 1990, Bull and Duncan 1993, Duncan and Hayward 1994, Stepnisky 1997). Does not require extensive patches of older forest for nesting (Duncan and Hayward 1994); nesting stands may be as small as 4-11 ha (Duncan 1997, Stepnisky 1997), but averaged 30 ha in Alberta (Stepnisky 1997) and 232 ha in Manitoba (Duncan 1997). Hunts in mature open stands, clearcuts, and partially harvested stands, recent burns, or non-forested habitats such as bogs, agricultural fields, and meadows (Servos 1987, Bull and Henjum 1990, Duncan and Hayward 1994, Duncan 1997, Stepnisky 1997, Whitfield and Gaffney 1997). In both Manitoba and Alberta, home ranges typically contained 40-50% open habitat (Duncan 1997, Stepnisky 1997). |
| Effects of forest management | Little information on the direct effects of forest management or other human activities. May be extremely aggressive to humans around nests (Bull and Duncan 1993).<br><br>Little information on the effects of roads or traffic. Spreyer (1987) noted a positive association between dirt roads and nest sites in Minnesota but suggested this was spurious. |

| | |
|---|---|
| | Since it nests in mature and old growth forest, timber harvest may have a negative effect on the supply of nesting habitat (Hilden and Solonen 1987, Bull and Duncan 1993, Duncan and Hayward 1994, Duncan 1997). However, does not need large patches of older forest for nesting (Duncan and Hayward 1994, Duncan 1997) and appears to be able to tolerate some harvest near nest sites (Spreyer 1987); Bull and Henjum (1990) reported that about 20% of nests were in stands that had received a partial harvest.<br><br>Clearcuts may create new hunting habitat (Hilden and Solonen 1987, Servos 1987, Franklin 1988) if they are not too large and contain perches (Duncan 1997), at least until development of dense regeneration (Duncan and Hayward 1994). Moreover, partially harvested stands were used more frequently than dense unharvested stands in Oregon (Bull and Henjum 1990). While cutting may create hunting habitat, wildfires appear to create more suitable habitat conditions than do clearcuts in boreal Ontario (Sleep 2005). |
| Past direction | James (1985) provided very vague direction for the protection of nest sites. OMNR (2004) recommended adoption of the direction used for red-shouldered hawks (i.e., 300 m AOC). This direction has not been tested. |

**Rationale for direction**

S3S4 species that was formerly a species at risk. Shows some nest site fidelity and sensitivity to forest harvesting. Thus, direction identifies primary and alternate nests as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Rationale for direction for primary nests is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 400 m radius AOC centred on primary nests. | An AOC of 400 m is prescribed for primary nests based habitat area requirements (see below) and for consistency with direction for northern goshawks and red-shouldered hawks. |
| *Standard* - Harvest is permitted within the AOC subject to timing restrictions (see below) and the following species-specific conditions: … | Average home range size is reported to vary from about 2.5 to 4.5 $km^2$ (Duncan and Hayward 1994). However, most hunting is conducted in open habitats and the species does not appear to require extensive patches of older forest for nesting (see above).<br><br>Duncan (1997) recommended retention of mature forest within 300 m of nests (potentially 28 ha of suitable habitat). Stepnisky (1997) reported that 18 stands used for nesting in Alberta averaged about 30 ha. In northwestern Ontario, 6 nests had an average of about 35 ha of mature forest within 400 m (Naylor[1], unpubl. data). In Oregon, 46 nests had ≥40 ha of forest within 500 m (Bull et al. 1988). Thus, retention of 28 ha of mature forest for nesting is prescribed.<br><br>In a uniform block of habitat, the 28 ha patch of mature forest may be retained as a circle with a radius of 300 m. However, nests are generally located <300 m from forest edges. Mean distance reported between nests and forest openings ranges from 77 to 275 m (Bryan and Forsman 1987, Franklin 1987 cited in Duncan and Hayward 1994, Bull et al. 1988, Bouchart 1991 cited in Duncan and Hayward 1994, Quintanna-Coyer et al. 2004). In northwestern Ontario, 3 of 6 nests were <100 m from recent |

[1] Brian Naylor, OMNR, Southern Science & Information Section, North Bay, ON

| | |
|---|---|
| | clearcuts (Naylor[1], unpubl. data). In Manitoba, 2 of 5 nests were <100 m from burns (Servos 1987). Thus, the 28 ha patch of mature forest does not need to be circular; the primary nest may be located anywhere within an irregularly-shaped 28 ha patch if this better incorporates primary and alternate nests, as well as suitable nesting habitat. However, to ensure that nesting habitat is not retained as a long narrow patch with excessive edge, the 28 ha patch must be retained within a circle with a radius of 400 m.<br><br>High canopy closure is generally considered to an important characteristic of nesting habitat (Duncan and Hayward 1994, Duncan 1997). Mean canopy closure was reported as >60% for 46 nests in northeastern Oregon (Bull et al. 1988), about 70% for 11 nests in Idaho/Wyoming (Whitfield and Gaffney 1997), and >75% for 18 nests in Alberta (Stepnisky 1997). However, some partial harvesting that produces moderate levels of canopy closure within nesting habitat may be acceptable since mean canopy closure was about 50% for 11 nests in southcentral Oregon (Bryan and Forsman 1987) and 30% of the nests studied by Bull et al. (1988) were located in habitat with canopy closure 10 to 60%. Thus, some partial harvest that retains mature forest with a mean canopy closure ≥50% is permitted within the 28 ha of nesting habitat. However, a 7 ha patch of uncut or lightly harvested forest (canopy closure ≥70%) must be associated with the primary nest to provide dense habitat within the vicinity of the nest site; 7 ha represents an average of the smallest patch of habitat used for nesting in Alberta and Manitoba (Duncan 1997, Stepnisky 1997). Moreover, no harvest is permitted within 50 m of primary and alternate nests to protect nests during harvest operations and provide dense habitat immediately around nests. |
| *Standard* - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. | Wildlife trees and downed woody material are retained to provide the general functions described in 3.2.3. Moreover, wildlife trees may provide potential nest and perch sites (see above). |
| *Standard* - Within the entire AOC, renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted; all other renewal and tending operations are permitted subject to timing restrictions. | Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <70% in the 7 ha patch of uncut or lightly harvested forest or <50% in the remaining 21 ha patch of suitable nesting habitat. |
| *Guideline* - When mature forest is retained as *suitable nesting habitat* within | In a block of uniform habitat, the 28 ha of suitable nesting habitat may be retained as a circular patch with a radius of 300 m. However, this patch does not necessarily need to be circular or centred on the primary nest. It should encompass the primary nest and alternate nests and represent |

<table>
<tr><td>the AOC, to the extent practical and feasible, …</td><td>suitable habitat to the extent practical and feasible. However, the 28 ha of suitable nesting habitat must be retained within a radius of 400 m of the primary nest to ensure nesting habitat is not retained as a long narrow patch with excessive edge.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 50-200 m of occupied primary nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>No data on size of temporal buffers required. The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>200 m</td></tr><tr><td>Moderate</td><td>100 m</td></tr><tr><td>Low</td><td>50 m</td></tr></table></td></tr>
<tr><td>Guideline - The critical breeding period is defined as March 15 to July 15 for all of Ontario. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Permanent resident (James 1991) but exhibits mobility in years of low prey availability (Duncan 1987); egg laying typically initiated in early April in northwestern Ontario (Gilmore and MacDonald 1996). Based on a 30 day incubation period and a 38 day period to nest departure (Bull and Duncan 1993), most fledging likely occurs by mid-July. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests.</td><td>The effect of roads on nesting great gray owls is equivocal (see above). However, roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as suitable nesting habitat. If roads are constructed, temporary roads and/or water crossings</td><td>Roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Moreover, roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009).<br><br>Thus, reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as suitable nesting habitat. Moreover, when roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance and the cleared corridor should be as narrow as practical and feasible to maintain a relatively uniform canopy closure (maximum width of 20 m; see Szuba and Naylor 1998).</td></tr>
</table>

| | |
|---|---|
| will be used whenever practical and feasible to limit future access and disturbance and the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 50-200 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

Unharvested buffers around more than 1 nest are likely prudent since multiple nests may be used in a territory (see above). Thus, no harvest is permitted within 50 m of alternate nests. Inactive nests presumably have a lower likelihood of reuse than do primary or alternate nests. However, they may be used by other stick nesters (e.g., barred owl). Thus, no harvest is permitted within 20 m if in good repair (CRO).

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**4.2.2.4 Continued**

**Background**

| **Species** | **Northern goshawk** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable or declining? Insufficient BBS data to estimate trend. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about 50% decline in the boreal forest (Bush 2007). |
| Distribution | Widespread in the GLSL forest; scattered across the boreal forest (Bush 2007). |
| Nesting | Builds large stick nests in the main fork of hardwood or conifer trees (Peck and James 1983). Regular reuse of nest sites; up to 7 alternate nests within a nesting area (Squires and Reynolds 1997). Nesting typically occurs from late March to early July. |
| Habitat | Typically nests in moderately dense patches of mature and old growth hardwood, conifer, or mixedwood forest ranging from at least 3 to 26 ha in size (Reynolds et al. 1982, Kennedy 1988, Woodbridge and Detrich 1994, Squires and Ruggiero 1996, Squires and Reynolds 1997, Schaeffer 1998, Finn et al. 2002b, Bush 2006) but may also nest in conifer plantations and forest fragments in agriculturally-dominated landscapes (Rosenfield et al. 1998). Nest sites are embedded within a 600 to 3,500 ha home range (Squires and Reynolds 1997) that may be a heterogeneous mosaic of forest types and ages (McGrath et al. 2003). However, hunting for their primary prey species (hares, grouse, and squirrels) tends to occur selectively within habitats that have high prey availability; in western North American this generally means forest with structural features characteristic of mature and old growth forests (Greenwald et al. 2005). |
| Effects of forest management | Generally considered to be sensitive to human disturbance during the nesting season but evidence is limited and equivocal. Forest management operations conducted within 100 m of nests during the nesting season have caused nest failures (Boal and Mannan 1994, Squires and Reynolds 1997, Toyne 1997, Penteriani and Faivre 2001), although this type of disturbance may not affect use of sites in subsequent years (e.g., Crocker-Bedford 1990). May be extremely aggressive to human intruders around nests but short duration pedestrian activities may have few negative consequences (Squires and Reynolds 1997). Viewing nests for short periods of time and even trapping nesting adults to attach radio transmitters does not appear to cause desertion (Squires and Reynolds 1997). When silent pedestrians approached to within 100 m of nests in New Mexico, they elicited a reaction 50% of the time during the fledgling-dependency period and only 25-30% of the time during courtship or the nesting period (Kennedy and Stahlecker 1993). In contrast, pedestrians loudly broadcasting goshawk calls had >50% chance of eliciting a response when 150 to 250 m from nests. Anecdotal accounts report cases where goshawks have tolerated housing construction, snowmobiles, motorcycles, |

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| | hikers, and horseback riders within 100 m of nests (Lee 1981).<br>Roads and associated traffic are generally thought to have a negative effect on habitat suitability. In Ontario, Bush (2006) found nests were on average >500 m from all-weather and >250 m from seasonal roads. However, there seems to be little research suggesting that goshawks actually avoid roads. Studies by Speiser and Bosakowski (1987), Penteriania et al. (2001), and McGrath et al. (2003) found that goshawks nested closer to roads or trails than expected by chance. In Ontario, proximity of roads was not related to the likelihood of nest occupancy (Bush 2006). In Wales, a logging road 60 m from a nest appeared to cause nest failure (Toyne 1997). However, other anecdotal observations suggest that nesting goshawks may not be disturbed by truck traffic associated with construction (Lee 1981) and logging activities (Grubb et al. 1998). The frequency of noise emitted by heavy equipment such as logging trucks is below the range most sensitive to raptors (Grubb et al. 1998).<br>Timber harvest is frequently cited as a primary threat to breeding populations (Squires and Reynolds 1997, Widen 1997). Since goshawks prefer moderately dense mature and old growth forest for nesting, harvest may change the suitability of individual patches of nesting habitat. However, empirical results are somewhat equivocal. For example, clearcutting within 200 and 400 m of nests in Oregon appeared to reduce the likelihood of reoccupancy (Desimone and DeStefano 2005). Conversely, clearcutting in the vicinity of nests had no detectable effect on reoccupancy or productivity in British Columbia (Mahon and Doyle 2005) or Idaho (Moser and Garton 2009). Moreover, goshawks appear quite tolerant of light partial harvesting around nest sites (Penteriani and Faivre 2001, Bush 2006), although partial canopy removal can result in replacement by red-tailed hawks or great horned owls (Crocker-Bedford 1990, Erdman et al. 1998). Occupancy of nest sites and home ranges may also be related to the supply of suitable foraging habitat (Crocker-Bedford 1990, 1995; Finn et al. 2002a; Greenwald et al. 2005); Crocker-Bedford (1990, 1995) found dramatically reduced reuse of nest sites when surrounding foraging habitat had been rendered unsuitable by timber harvest even when nests were embedded within large uncut buffers (16 to 200 ha). |
| Past direction | James (1984) provided the first direction for Ontario. He recommended the establishment of an 8 ha reserve around known nest sites, based on early recommendations from the western U.S. (Reynolds et al. 1982). This direction was modified circa 1990 for use in the GLSL forest; active nests received a 50 m circular reserve and an additional 100 m wide modified zone where partial harvest was permitted outside the nesting season (March 1 to July 31) but residual canopy closure had to be at least 70% (see Szuba and Naylor 1998). The latter direction was recently evaluated by Bush (2006). Nest sites in uncut forest appeared to have twice the frequency of reuse (72% vs 36%) as those in areas receiving selection or shelterwood cuts that followed the direction, although the difference was not statistically significant (P = 0.16). |

**Rationale for direction**

S4 species; current trend uncertain but data from BBA suggest possible decline. High nest site fidelity, apparent sensitivity to forest harvesting, and nest sites may be occupied by species formerly at risk such as great gray owl and red-shouldered hawk. Thus, direction identifies primary and alternate nests as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Nesting areas may contain multiple nests; alternate nests are typically within 300 m of the primary nest (Squires and Reynolds 1997).

Nesting areas may be occupied for >10 years (Squires and Reynolds 1997); in the eastern US, nesting areas were occupied for an average of about 4 years (Speiser and Bosakowski 1991). Thus, nests known to have been occupied within 5 years are considered either primary or alternate nests.

Rationale for direction for primary nests is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 400 m radius AOC centred on primary nests. | An AOC of 400 m is prescribed for primary nests based on habitat area requirements (see below). |
| *Standard* - Harvest is permitted within the AOC subject to timing restrictions and the following species-specific conditions: … | Bush's (2006) results suggest that direction in Szuba and Naylor (1998) may be only marginally adequate to sustain occupancy of goshawk nests subject to harvesting (primarily selection and shelterwood) in the GLSL forest. Effectiveness of direction in mitigating effects of clearcuts, especially in the boreal forest, is unknown. However, the goshawk's apparent greater tolerance of partial harvesting than of clearcutting (see above), suggests that current direction may not be adequate in clearcut situations.<br><br>Bush (2006) found that mature and older forest accounted for about 65% of the area within a 50 ha window surrounding nests. In the US, the amount of older dense forest surrounding nests averaged about 20 to over 60 ha (Daw and DeStefano 2001, Finn et al. 2002a, McGrath et al. 2003, DeSimone and DeStefano 2005, Moser and Garton 2009). Retention of 28 ha of mature and older forest is prescribed.<br><br>Average canopy closure within nesting habitat typically ranges from as little as 40% to over 90% (see reviews by Penteriani 2002, Greenwald et al. 2005). Moreover, 'dense' forest used by goshawks is typically defined as that with > or ≥50% canopy closure (e.g., Daw and DeStefano 2001, McGrath et al. 2003, Desimone and DeStefano 2005). Thus, some harvest within mature and older forest retained as nesting habitat is permitted if it maintains a canopy closure of dominant and co-dominant trees ≥50%.<br><br>Canopy closure should be relatively uniform across the 28 ha patch to the extent practical and feasible. Harvest operations such as commercial thinning, single-tree or group selection cuts, and regeneration cuts in the uniform shelterwood system likely retain an adequate distribution of canopy cover. Thus, average canopy gap size is prescribed as ≤ 0.1 ha (typical size of group selection openings; see OMNR 2004:155).<br><br>Canopy closure immediately surrounding nests is generally higher than that observed on average within the stand used for nesting (Penteriani 2002) and the likelihood of nest reuse may be correlated with canopy closure (Finn et al. 2002b). Thus, retention of some forest with higher canopy closure surrounding primary nests is prescribed.<br><br>There is typically about 6 to 8 ha of unharvested forest within the immediate vicinity of nests (i.e., within a radius of about 200 m) (Daw and DeStefano 2001, McGrath et al. 2003, Desimone and DeStefano 2005, Bush 2006). However, goshawks may tolerate removal of about 30% of the tree cover around nests (Petty 1996 cited in Penteriani 2002, Widen 1997, Penteriani and Faivre 2001, Penteriani et al. 2001). Thus, a 7 ha patch of unharvested or lightly harvested (i.e., ≥70% canopy closure) |

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| | forest must be retained within 200 m of primary nests. Moreover, nests are typically >150 m from forest openings (Bosakowski and Speiser 1994, Rosenfield et al. 1998, Penteriani 2002). Thus, harvest that changes development stage, reduces canopy closure <50%, or creates canopy gaps >0.1 ha must not be conducted within 200 m of primary nests. |
| *Standard* - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. | Wildlife trees and downed woody material are retained to provide the general functions described in 3.2.3. |
| *Standard* - Within the entire AOC, renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted; all other renewal and tending operations are permitted subject to timing restrictions (see below). | Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <70% in the 7 ha patch of uncut or lightly harvested forest or <50% in the remaining 21 ha patch of suitable nesting habitat. |
| *Guideline* - When mature forest is retained as *suitable nesting habitat* within the AOC, to the extent practical and feasible, … | In a block of uniform habitat, the 28 ha of suitable nesting habitat may be retained as a circular patch with a radius of 300 m. However, this patch does not necessarily need to be circular or centred on the primary nest. It should encompass the primary nest and alternate nests and represent suitable habitat to the extent practical and feasible. However, the 28 ha of suitable nesting habitat must be retained within a radius of 400 m of the primary nest to ensure nesting habitat is not retained as a long narrow patch with excessive edge. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 50-200 m of *occupied* primary nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Effects of human activities on nesting birds are equivocal. The model in Appendix 4 suggests the following temporal buffers which are generally consistent with studies such as those by Kennedy and Stahlecker (1993) (see above):<br><br>**Potential impact** / **No operations within**<br>High / 200 m<br>Moderate / 100 m<br>Low / 50 m |

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| *Guideline* - The *critical breeding period* is defined as March 15 to July 15 for all of Ontario. Local knowledge of breeding chronology may be used to adjust these dates. | Permanent resident; median egg dates April 30 – May 6 (Peck and James 1983, James 1991). Based on a 32 day incubation period and about a 41 day period to nest departure (Squires and Reynolds 1997), most fledging likely occurs by early July. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests. | The effect of roads on nesting goshawks is equivocal (see above). However, roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as *suitable nesting habitat*. If roads are constructed, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance and the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | Roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Moreover, roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009).<br><br>Thus, reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as *suitable nesting habitat*. Moreover, when roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance and the cleared corridor should be as narrow as practical and feasible to maintain a relatively uniform canopy closure (maximum width of 20 m; see Szuba and Naylor 1998). |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 50-200 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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| or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | |

Unharvested buffers around more than 1 nest are likely prudent since multiple nests are typically built and used in a territory; Squires and Reynolds (1997) reported 1 to 8 nests. Thus, no harvest is permitted within 50 m of alternate nests. Inactive nests presumably have a lower likelihood of reuse than do primary or alternate nests. However, they may be used by other stick nesters (e.g., barred owl). Thus, no harvest is permitted within 20 m if in good repair (CRO).

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**4.2.2.4 Continued**

**Background**

| **Species** | **Red-shouldered hawk** |
|---|---|
| S-rank | S4B/G5 |
| Designation | None (formerly *special concern*) |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Below historic levels (Cadman et al. 1987) but appears to be relatively stable; no significant trend from Ontario BBS data for 1981-2005 or red-shouldered hawk survey routes for 1991-2004 (Badzinski 2004). Overall, similar probability of observation during BBAs in the 1980s and 2000s, but increase of almost 100% in the GLSL forest (Badzinski 2007). |
| Distribution | Found almost exclusively in the southern portions of the GLSL forest (Badzinski 2007). |
| Nesting | Builds large stick nests in the main fork of hardwood trees (Peck and James 1983). Individual nests may be reused for many years (Crocoll 1994). Alternate nests may be built the year after a nesting failure (Crocoll 1994); consequently, nesting areas with a long history of use may have up to 7 nests (e.g., Dent 1994). Nesting typically occurs from late March to middle of July. |
| Habitat | Typically nests in relatively large patches (20 to 50 ha) of mature tolerant hardwood forest with high canopy closure (>70%) that is adjacent to lakes and wetlands where it preferentially hunts (Szuba et al. 1991; Bloom et al. 1993; Moorman and Chapman 1996; Howell and Chapman 1997; Dykstra et al. 2000, 2001a, b; McLeod et al. 2000; Naylor et al. 2004; Woodford et al. 2008). |
| Effects of forest management | No research on the direct effects of forest management operations. Generally, effects of human activities are highly variable. May react passively or aggressively to humans around nest (Crocoll 1994). A number of studies suggest nesting pairs avoid sources of human disturbance (e.g., cottages/homes) (Armstrong and Euler 1982) or that nests are located significantly further from sources of human disturbance than expected by chance (Bednarz and Dinsmore 1982, Johnson 1989, Bosakowski et al. 1992). However, in some parts of its range, appears to be very tolerant of human activity, becoming a “backyard bird” and nesting within 100 to 200 m of human habitation (Morris and Lemon 1983, Dent 1994, Dykstra et al. 2000, Rottenborn 2000).<br><br>Research on the effects of roads is equivocal. In the nests studied by Naylor et al. (2004) in central Ontario, mean distance to roads was 368 m but ranged from 16 to 2249 m; 80% of nests were at least 50 m from roads (Naylor[1], unpubl. data). In other parts of their range, mean distance to roads is equally variable; means for 7 studies range from 70 to 820 m (Bednarz and Dinsmore 1982, Johnson 1989, Bosakowski et al. 1992, Moorman and Chapman 1996, McLeod et al. 2000, Dykstra et al. 2000, Rottenborn 2000). Moreover, rate of reoccupancy was unrelated to distance to roads for the nests studied by Naylor et al. (2004) (Naylor[1], unpubl. data), Rottenborn (2000) found no significant difference in |

[1] Brian Naylor, OMNR, Southern Science & Information Section, North Bay, ON

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| | proximity of paved roads at successful and unsuccessful nests, and only Bosakowski et al. (1992) found nests significantly further from roads than expected by chance.<br><br>Harvest of large contiguous forest tracts is thought to have led to declines in breeding populations in various parts of the range (Crocoll 1994). Even partial harvest can have a negative effect on reoccupancy of individual nesting areas. For example, Bryant (1986, 1994) found that 'selective' harvest that reduced canopy closure below 70% resulted in replacement by red-tailed hawks in small woodlots in southern Ontario. In addition, Naylor et al. (2004) found that both shelterwood and heavy selection cuts within 200 m of nests dramatically reduced reuse of nesting areas in central Ontario. |
| Past direction | James (1984) provided the first guidance for Ontario. He recommended the retention of a 10 ha patch of mature forest around nests in which 'selective cutting of single trees or very small patches' was permissible. This direction was changed circa 1990 to a 28 ha AOC. This AOC was comprised of a 150 m radius (7 ha) reserve and an additional 21 ha zone where partial harvest was permitted outside the nesting season (March 1 to July 31) as long as 70% canopy closure was maintained (see Szuba and Naylor 1998). This direction was tested and found to be effective, but possibly a little conservative (Naylor et al. 2004). |

**Rationale for direction**

S4 species that was recently a species of *special concern*. High nest site fidelity and sensitivity to forest harvesting. Thus, direction identifies primary and alternate nests as AOCs and focuses on both mitigation of disturbance and retention of nesting habitat.

Nesting areas may contain multiple nests (Crocoll 1994); alternate nests are typically within 300 m of the primary nest (Szuba and Naylor 1998).

Individual nesting areas may be reused for numerous years; in Ontario, nesting areas in uncut forest were occupied for an average of about 5 years (see Fig. 2 in Naylor et al. 2004). Thus, nests known to have been occupied within 5 years are considered either primary or alternate nests. Nesting areas may be unoccupied for 1 to 3 years and then reoccupied (Naylor[1], unpubl. data). However, the probability of nesting areas being reoccupied following 3 or more consecutive years of no occupancy is <10% (see Fig 4.2a). Thus, when all nests within a nesting area are documented as unoccupied for 3 or more consecutive years, all the nests are considered inactive.

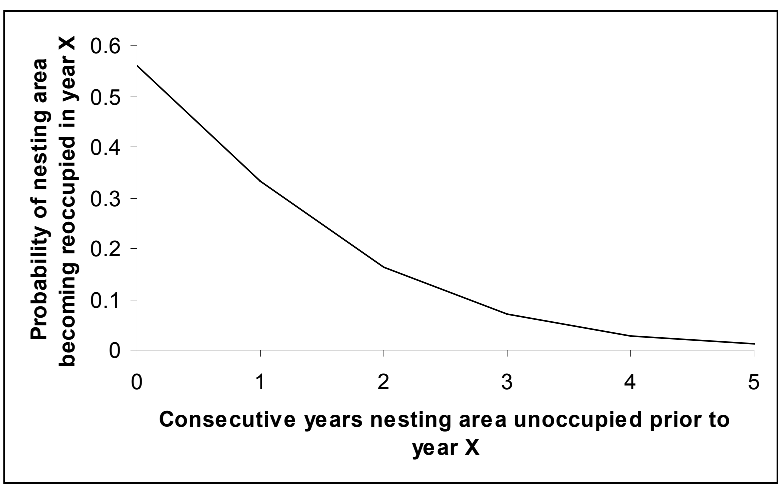


**Fig 4.2a. Probability of a nesting area becoming reoccupied based on the number of consecutive years it was previously unoccupied (Naylor, unpubl. data).**

[1] Brian Naylor, OMNR, Southern Science & Information Section, North Bay, ON

Rationale for direction for primary nests is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 400 m radius AOC centred on primary nests. | An AOC of 400 m is prescribed for primary nests based on habitat area requirements (see below). |
| *Standard* - Harvest is permitted within the AOC subject to timing restrictions and the following species-specific conditions: … | Naylor et al. (2004) found that direction in Szuba and Naylor (1998) was effective in maintaining occupancy of red-shouldered hawk nests. Thus, the general direction prescribed by Szuba and Naylor (1998) that requires the retention of 28 ha of unharvested or lightly harvested mature forest (≥70% canopy closure) associated with each primary nest is adopted with the following modifications and additions.<br><br>The red-shouldered hawk is often considered to be an area-sensitive or forest interior species. Thus, the 28 ha of unharvested or lightly harvested mature forest must be retained within a radius of 400 m of the primary nest to ensure nesting habitat is not retained as a long narrow patch with excessive edge.<br><br>Canopy closure should be relatively uniform across the 28 ha patch to the extent practical and feasible. Red-shouldered hawks appear to respond well to the small canopy gaps created by single-tree selection. Thus, average size of canopy gaps is prescribed as that reflecting individual tree crowns. However, some larger gaps are likely acceptable if required for silvicultural reasons (e.g., group selection openings) but should not exceed 0.1 ha in size.<br><br>Naylor et al. (2004) noted that shelterwood or heavy selection cuts within 200 m of nests had a dramatic negative effect on reuse. Moreover, distance to large forest openings typically ranges from about 150 to 250 m (Titus and Mosher 1981, Johnson 1989, Preston et al. 1989, Moorman and Chapman 1996). Thus, no harvesting that changes development stage, results in canopy closure <60%, or creates multi-tree gaps is permitted within 200 m of primary nests.<br><br>Naylor et al. (2004) also found no detectable effect of the amount or proximity of light selection cuts on nest reuse and suggested that a 7 ha reserve might be larger than necessary. However, numerous studies suggest that canopy closure (or BA) is higher at nests than in forest surrounding nests (Woodrey 1986, Dykstra et al. 2000, McLeod et al. 2000) and nest success or reuse has been positively related to canopy closure or BA (Dijak et al. 1990, Szuba et al. 1991, Speiser and Bosakowski 1995). Moreover, habitat suitability appears to be especially influenced by the BA of overstory trees >50 cm dbh (Titus and Mosher 1981, Morris and Lemon 1983, Woodrey 1986). Thus, the 7 ha reserve required by Szuba and Naylor (1998) is replaced by a 7 ha patch of mature forest that is unharvested or has received a light partial harvest that follows the residual stand structure target for old growth conditions (see OMNR 2004:100), which prescribes a higher BA of trees >50 cm dbh, to the extent feasible. Moreover, the reported mean distance between nests and small forest openings ranges from about 20 m (Woodrey 1986) to 100 m (Bosakowski et al. 1992). Thus, no harvest is permitted within 50 m of primary nests. |
| *Standard* - Wildlife | Wildlife trees and downed woody material are retained to provide the |

<table>
<tr><td>trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3.</td><td>general functions described in 3.2.3.</td></tr>
<tr><td>Standard - Within the entire AOC, renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted; all other renewal and tending operations are permitted subject to timing restrictions.</td><td>Renewal and tending operations that will leave a residual stand structure below the minimum described above are not permitted. For example, aerial application of herbicides would not be permitted if the application is likely to kill overstory trees and result in a residual canopy closure <70% in suitable nesting habitat.</td></tr>
<tr><td>Guideline - When mature forest is retained as suitable nesting habitat within the AOC, to the extent practical and feasible, …</td><td>In a block of uniform habitat, the 28 ha of suitable nesting habitat may be retained as a circular patch with a radius of 300 m. However, this patch does not necessarily need to be circular or centred on the primary nest. It should encompass the primary nest and alternate nests and represent suitable habitat to the extent practical and feasible. However, the 28 ha of suitable nesting habitat must be retained within a radius of 400 m of the primary nest to ensure nesting habitat is not retained as a long narrow patch with excessive edge.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 50-200 m of occupied primary nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>No data on size of temporal buffers required. The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>200 m</td></tr>
<tr><td>Moderate</td><td>100 m</td></tr>
<tr><td>Low</td><td>50 m</td></tr>
</table>
</td></tr>
<tr><td>Guideline - The critical breeding period is defined as March 15 to July 15 for all of Ontario. Local knowledge of breeding chronology may be</td><td>Typically returns to breeding range in late March; median egg dates are April 20 – 28 (Peck and James 1983, James 1991). Based on a 33 day incubation period and a 42 day nestling period (Crocoll 1994), most fledging likely occurs by late June. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging.</td></tr>
</table>

| | |
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| used to adjust these dates. | |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests. | The effect of roads on nesting red-shouldered hawks is equivocal (see above). However, roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Thus, new roads, landings, and aggregate pits are not permitted within 50 m of primary nests or within the 7 ha patch of suitable habitat retained within 200 m of primary nests. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as *suitable nesting habitat***.** If roads are constructed, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance and the width of the cleared corridor will be as narrow as practical and feasible, and will not exceed 20 m. | Roads, landings, and aggregate pits create large canopy gaps in forest surrounding nests. Moreover, roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users (Naylor 2009).<br><br>Thus, reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 51-200 m of primary nests or within forest retained as *suitable nesting habitat***.** Moreover, when roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance and the cleared corridor should be as narrow as practical and feasible to maintain a relatively uniform canopy closure (maximum width of 20 m; see Szuba and Naylor 1998). |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 50-200 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

Unharvested buffers around more than 1 nest are likely prudent since multiple nests are typically built and used in a territory; Dent (1994) reported 1 to 7 (median of 2) nests in 20 territories in Ontario. Thus, no harvest is permitted within 50 m of alternate nests. Inactive nests presumably have a lower likelihood of reuse than do primary or alternate nests. However, they may be used by other stick nesters (e.g., barred owl). Thus, no harvest is permitted within 20 m if in good repair (CRO).

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### 4.2.2.5 Common stick-nesting raptors, tree-nesting common ravens, and unknown stick nests

**Background**

| **Species** | **Barred owl** |
|---|---|
| S-rank | S4S5/G5 |
| Designation | None |
| Trend – CDN | Stable or increasing (Kirk and Hyslop 1998) |
| Trend - ON | Increasing? Ontario BBS data from 1984-2004 suggest no significant (P=0.643) trend; Nocturnal Owl Survey data for 1995-2005 suggest an increasing trend in central Ontario (Crewe and Badzinski 2006). Overall, probability of observation increased by about 70% between BBAs in 1980s and 2000s; greater increase in the boreal (100%) than the GLSL (30%) forests (Allair 2007). |
| Distribution | Widespread in the GLSL forest; scattered across the southern portion of the boreal forest (Allair 2007). |
| Nesting | Does not build a nest, but typically uses either a natural tree cavity or a nest built by a hawk, corvid, or squirrel (Peck and James 1983, Mazur and James 2000); nesting attempts in cavities are typically more successful than those on stick nests (Postupalsky et al. 1997). Nests in cavities have been reused as many as 10 times, but 50% of nests in one study were used only once (Mazur and James 2000). |
| Habitat | Nests are generally placed in extensive tracts of mature and old growth hardwood or mixedwood forest (Peck and James 1983; McGarigal and Fraser 1984; Bosakowksi et al. 1987; Johnson 1987; Van Ael 1996; Duncan and Kearns 1997; Haney 1997; Takats 1998; Mazur et al. 1997a,b). Mature and older forest also appears to be preferred for hunting and roosting (Mazur et al. 1998, Takats 1998). In Saskatchewan, mature and old mixedwood and hardwood forest accounted for about 75% of a typical 150 ha breeding season home range (Mazur et al. 1998). |
| Effects of forest management | Little information on the direct effects of forest management practices and other human activities on nesting barred owls. Highly variable response to human activity around nests (Mazur and James 2000).<br><br>Appears to be fairly tolerant of roads and trails; in Saskatchewan 4 of 15 nests were 25 to 75 m from roads (Mazur et al. 1997a).<br><br>Changes to habitat resulting from harvesting are generally thought to have a negative effect because barred owls require large patches (10-20 ha) of older forest for nesting and roosting (Mazur and James 2000, Olsen et al. 2006); older forest provides large cavity trees for nesting, dense canopy providing thermal cover and protection from mobbing, and open understory that facilitates prey capture (Duncan and Kearns 1997, Haney 1997, Mazur et al. 1997a). In northern Ontario, appears to respond similarly to landscapes created by fire or timber harvesting (Sleep 2005).<br><br>No information on the effects of partial harvesting on habitat use. However, |

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| | canopy closure of stands used for nesting is typically >70% (Duncan and Kearns 1997, Takats 1998). Moreover, Johnson (1987) found stands used for nesting in Minnesota had few recent canopy openings associated with forest harvesting. |
| Past direction | No species-specific direction. For stick nests, covered by generic prescription for stick nests of common species in OMNR (2004) which recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, and individual nest trees retained in small residual patches in clearcuts; 150 m temporal buffer around occupied nests. For nests in cavities, no specific direction for this species but Naylor et al. (1996), Watt et al. (1996) and OMNR (2001, 2004) provide general direction for retention of cavity trees. |

**Rationale for direction**

Stable or increasing S4S5 species with requirement for mature and older forest. General habitat requirements likely met by coarse filter direction if nest sites are protected. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 200 m radius AOC centred on the occupied nest.</td><td>An AOC of 200 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable or increasing S4S5 species so AOC prescription does not address retention of nesting habitat. However, individual nest sites may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 50-200 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>200 m</td></tr>
<tr><td>Moderate</td><td>100 m</td></tr>
<tr><td>Low</td><td>50 m</td></tr>
</table>
These values are supported by the experimental work of Delaney et al. (1999) who found that chainsaws operating >100 m from nests of the closely related spotted owl did not cause nesting birds to flush.</td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined</td><td>Permanent resident; median egg dates are April 4 to May 20 (Peck and James 1983). Based on a 31 day incubation period and a 42 day period to nest departure (Johnsgard 1988), most fledging likely occurs by late June.</td></tr>
</table>

| | |
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| as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates. | Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging. |
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests. | Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 50-200 m of *occupied* nests during the *critical breeding period* based on potential impact, unless …. However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Broad-winged hawk** |
|---|---|
| S-rank | S5B/G5 |
| Designation | None |
| Trend – CDN | Stable or declining (Kirk and Hyslop 1998) |
| Trend - ON | Stable. Ontario BBS data from 1981-2005 suggest no significant trend. Similar probability of observation during BBAs in the 1980s and 2000s (Szuba 2007). |
| Distribution | Widely distributed across the AOU but most abundant in the GLSL forest (Szuba 2007). |
| Nesting | Builds small stick nests that are typically placed in hardwood trees (Peck and James 1983). Old nests are reused 10-30% of the time (Goodrich et al. 1996). Nesting season runs from late April to late July. |
| Habitat | Typically nests in hardwood or mixedwood forest (Goodrich et al. 1996) but may occasionally nest in conifer plantations (Crocoll and Parker 1989); nesting habitat is usually younger and more open than that occupied by red-shouldered hawks (Titus and Mosher 1981, Armstrong and Euler 1982). Hunts in small forest openings and along roadsides (Goodrich et al. 1996). |
| Effects of forest management | Little quantitative information on the direct effects of forest management practices or other human activities. Aggressiveness toward humans around nests is uncommon (Goodrich et al. 1996). In Wisconsin, 5 of 6 nests in one area were within 50 m of roads (Rosenfield 1984).<br><br>Requires forest for nesting but openings and edges for hunting. Thus, harvesting may be beneficial as long as nest sites are provided (Nelson and Titus 1989). |
| Past direction | James (1984) mentioned broad-winged hawks but did not provide species-specific direction. Szuba and Naylor (1998) and OMNR (2004) recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, individual nest trees in clearcuts. Temporal buffer of 150 m around occupied nests during the breeding season (March 1 to July 31). This direction has not been tested. |

**Rationale for direction**

Stable S5 species without demanding habitat requirements so coarse filter direction should maintain long term supply of nesting habitat. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable S5 species so AOC prescription does not address retention of nesting habitat. In partial harvests, individual nests may be reused; in clearcuts nests unlikely to be reused or used by other species; retain nest tree if in good repair to comply with *Fish and Wildlife Conservation Act* (CRO). |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | The model in Appendix 4 suggests the following temporal buffers:<br><br>**Potential impact** — **No operations within**<br>High — 100 m<br>Moderate — 50 m<br>Low — 25 m |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates. | Typically returns to breeding range in late April; median egg dates are May 26 – June 10 (Peck and James 1983, James 1991). Based on a 30 day incubation period and a 39 day nestling period (Goodrich et al. 1996), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests. | Nests to be retained; some likelihood that nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact |

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| nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | operations. |

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Titus, K., and J.A. Mosher. 1981. Nest-site habitat selected by woodland hawks in the central Appalachians. Auk 98:270-281.

**4.2.2.5 Continued**

**Background**

| **Species** | **Common raven** |
|---|---|
| S-rank | S5/G5 |
| Designation | None |
| Trend – CDN | Unknown |
| Trend - ON | Stable. Ontario BBS data from 1984-2004 suggest an increasing but non-significant (P=0.190) trend. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but significant increase (about 10%) in the GLSL forest (Peck 2007). |
| Distribution | Widely distributed across the AOU (Peck 2007). |
| Nesting | Builds large bulky nests of sticks placed on cliff ledges, in trees, or on man-made structures (Peck and James 1987, Peck 2005). Shows strong fidelity to nesting areas and individual nests. In one study, 67% of nests were reused in consecutive years (Boarman and Heinrich 1999); individual nests have been used for >20 years (Peck 2005). |
| Habitat | Nests in a wide variety of habitats; forest, grassland, farmland, hydro transmission corridors, and even urban/suburban areas (Peck and James 1987, Boarman and Heinrich 1999). Prefers cliffs which provide secure nest sites and thermals for foraging (Boarman and Heinrich 1999) or other sites overlooking open vistas (Peck and James 1987). |
| Effects of forest management | Little quantitative information on the direct or indirect effects of forest management or other human activities. Human activities can disturb both feeding (Knight et al. 1991, DeLap and Knight 2003) and nesting birds (Knight 1984). However, ravens are extremely adaptable (Boarman and Heinrich 1999) and are frequently most abundant in human-altered habitats including along highway corridors, hydro transmission corridors, urban/suburban areas, and even open-pit mines (Knight et al. 1993, Knight and Kawashima 1993, Knight et al. 1995, Cox et al. 2003). |
| Past direction | No species-specific direction. For stick nests, covered by generic prescription for stick nests of common species in OMNR (2004) which recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, and individual nest trees retained in small residual patches in clearcuts; 150 m temporal buffer around occupied nests. |

**Rationale for direction**

Stable, highly adaptable S5 species that benefits from human altered landscapes. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 50 m radius AOC centred on the occupied nest.</td><td>An AOC of 50 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable S5 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 10-50 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Body mass alone suggests a temporal buffer of about 200 m for high potential impact operations (see Appendix 4). Where ravens are considered rare (e.g., Virginia), temporal buffers up to 200 m are recommended (Boarman and Heinrich 1999). However, given its abundance in Ontario, its apparently high tolerance of human activity relative to raptors (Knight et al. 1991, DeLap and Knight 2003), and its ability to adapt to, and exploit, human altered landscapes, the following temporal buffers are prescribed:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>50 m</td></tr>
<tr><td>Moderate</td><td>25 m</td></tr>
<tr><td>Low</td><td>10 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as February 15 to June 15. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Permanent resident; median egg dates are March 26 to April 10 (Peck and James 1987, James 1991). Based on a 23 day incubation period and a 39 day period to nest departure (Boarman and Heinrich 1999), most fledging likely occurs by late May. Thus, timing restriction from February 15 to June 15 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits will not be constructed within 20 m of nests.</td><td>Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of occupied nests</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact</td></tr>
</table>

| | |
|---|---|
| during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Cooper's hawk** |
|---|---|
| S-rank | S4B/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable? Ontario BBS data from 1981-2005 suggest no significant trend. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about a 35% decline in the GLSL forest (Gahbauer 2007). |
| Distribution | Breeds across southern Canada and the continental US (Rosenfield and Beilfeldt 1993). Within Ontario, most abundant south of the AOU; scattered records across the GLSL and boreal forest (Gahbauer 2007). |
| Nesting | Builds large stick nests in hardwood or conifer trees (Peck and James 1983); nests are only occasionally reused (Rosenfield and Beilfeldt 1993). The nesting season runs from mid-April to late July. |
| Habitat | Nests in a wide range of types and ages of forest, but appears to prefer mature conifer forest (including plantations) with moderately high crown closure (>60%) (Titus and Mosher 1981, Reynolds et al. 1982, Ploz 1990, Wiggers and Kritz 1991, Bosakowski et al. 1992a, Trexel et al. 1999).<br><br>Does not require large patches of nesting habitat. In urban/suburban environments nests may simply be placed in groves of trees (Boal and Mannan 1998). Nests in pine plantations that averaged about 4 ha in Missouri (Wiggers and Kritz 1991), 10 ha in Arkansas (Garner 1999), and ranged from 1 to 12 ha in Wisconsin (Rosenfield et al. 1995). In Oregon and New Mexico, appeared to require patches at least 6 to 10 ha in size (Reynolds et al. 1982, Kennedy 1988). Moreover, mean distance reported between occupied nests and non-forested openings is frequently <100 m (e.g., Ploz 1990, Garner 1999, Trexel et al. 1999) with individual nests within 10 to 20 m of edges (Ploz 1990, Bosakowski et al. 1992a). |
| Effects of forest management | Little research on the direct effects of forest management operations. Human disturbance is thought to have a negative effect (Bosakowski et al. 1993). Reaction of nesting birds to humans is variable but generally passive (Rosenfield and Bielefeldt 1993). Moreover, reaches highest densities in urban/suburban environments (Rosenfield et al. 1995, Mannan and Boal 2000). In these environments, nest-site selection is not related to intensity of human activity (Boal and Mannan 1998) and hawks clearly habituate to human disturbance (Boal and Mannan 1999).<br><br>The effects of roads and associated traffic is equivocal. Nests in extensive forest in New Jersey and New York averaged about 500 m from paved roads but 5 of 21 nests were <100 m from roads, nests were not significantly further from roads than were random points (Bosakowski et al. 1992a), and nests were closer to roads than were those of northern goshawks (Bosakowski et al. 1992b). Moreover, Bosakowski et al. (1992a) described Cooper's hawks in their study area as remarkably tolerant of vehicular traffic. In urban/suburban habitat |

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| | in Arizona, nests were further from roads (mean = 43 m) than random points (mean = 29 m) but Boal and Mannan (1998) felt this difference was simply an artifact of the location of suitable nesting habitat. In southern Ontario, Ploz (1990) found that 28 nests were significantly further from roads than were random points in potentially suitable habitat (mean of 318 m vs 46 m).<br><br>Timber harvest is thought to affect the suitability of nesting and/or hunting habitat at local or regional scales but magnitude of effects is uncertain (Rosenfield and Bielefeldt 1993). |
| Past direction | James (1984) proposed a 6 ha uncut buffer around active nests based on Reynolds et al. (1982). Circa 1990, revised direction for nests of red-shouldered hawks (300 m AOC) was applied to Cooper's hawks (see Szuba and Naylor 1998). This direction was applied by default because the 2 species were both species at risk at the time and were often encountered nesting in similar forest conditions (i.e., mature tolerant hardwood forest). The effectiveness of this direction for Cooper's hawks was never tested. |

**Rationale for direction**

Stable(?) S4 species that is sensitive to forest harvesting. However, limited nest site fidelity, flexible habitat requirements, and apparent high adaptability to human-altered landscapes (see above) suggest coarse filter direction is likely adequate to maintain habitat supply. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable(?) S4 species so AOC prescription does not address retention of nesting habitat. However, individual nest sites may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25 - 100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC | The model in Appendix 4 suggests the following temporal buffers: |

| **Potential impact** | **No operations within** |
|---|---|
| High | 100 m |
| Moderate | 50 m |
| Low | 25 m |

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| planning process. | |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates. | Typically returns to breeding range in early April; median egg dates are May 13 – June 2 (Peck and James 1983, James 1991). Based on a 35 day incubation period and a 32 day nestling period (Rosenfield and Bielefeldt 1993), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging. |
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests. | Nest to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Great horned owl** |
|---|---|
| S-rank | S5/G5 |
| Designation | None |
| Trend – CDN | Increasing (Kirk and Hyslop 1998) |
| Trend - ON | Stable or declining? Ontario BBS data from 1984-2004 suggest no significant (P=0.710) trend. Nocturnal Owl Survey data for 1995-2005 suggest no trend in northern Ontario but a possible recent decline in central Ontario (Crewe and Badzinski 2006). Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about a 40% decline in the GLSL forest (Sleep 2007). |
| Distribution | Scattered across the AOU; most abundant in southern Ontario (Sleep 2007). |
| Nesting | Does not build a nest, but typically uses old hawk, corvid, heron, or squirrel nests. Occasionally nests in cavities, broken stubs, or on witches' brooms or man-made structures (Peck and James 1983, Houston et al. 1998). Nests are infrequently reused; in one study of 367 old red-tailed hawk nests used by great horned owls, 72% were used once, 21% twice, 7% 3 times, and <1% more than 3 times (Holt 1996). |
| Habitat | Nests are generally in forested areas although will also nest in fields and pastures, along fence rows, in wooded residential parks, suburban, and urban areas (Peck and James 1983, Houston et al. 1998). Home ranges generally include some open habitats such as fields, wetlands, pastures, or croplands where it hunts (Morrell and Yahner 1994, Laidig and Dobkin 1995, Houston et al. 1998). |
| Effects of forest management | Little information on the direct effects of forest management operations or other human activities. Generally considered to be remarkably tolerant of human activity near nests, even early in incubation (Houston et al. 1998).<br>Little information on the effects of roads and traffic. However, in Pennsylvania, high-use and low-use areas did not differ in the density of roads (Morrell and Yahner 1994); in New Jersey, occupied and unoccupied habitat did not differ in proximity to roads (Bosakowski and Smith 1997).<br>The great horned owl is considered to be remarkably adaptable to changes in habitat as long as nest sites are available (Houston et al. 1998). In Pennsylvania, great horned owls were equally abundant in areas dominated by forest, farmland, and a mixture of the two (Morrell and Yahner 1995); habitat suitability was directly related to the amount of open agricultural land and inversely related to the total amount of forest (Morell and Yahner 1994). Thus, forest harvesting likely has a positive effect on great horned owls as long as nest sites are maintained. Patches of forest used for nesting can be small (Morrell and Yahner 1994). In Wisconsin, woodlots >4 ha in size were considered suitable (Craighead and Craighead 1959); in Kansas, windbreaks 1-4 ha in size were used (Cable et al. 1992). Moreover, partial harvest of mature forest may result in replacement of more interior forest raptors (e.g., northern |

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| | goshawk) by great horned owls (e.g., Crocker-Bedford 1990). |
| Past direction | No species-specific direction. For stick nests, covered by generic prescription for stick nests of common species in OMNR (2004) which recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, and individual nest trees retained in small residual patches in clearcuts; 150 m temporal buffer around occupied nests. For nests in cavities, no specific direction for this species but Naylor et al. (1996), Watt et al. (1996) and OMNR (2001, 2004) provide general direction for retention of cavity trees. |

**Rationale for direction**

Stable (possibly declining) S5 species that benefits from forest harvesting as long as nest sites are provided. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 100 m radius AOC centred on the occupied nest.</td><td>An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable (possibly declining) S5 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 25 - 100 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Body mass alone suggests a temporal buffer of about 200 m for high potential impact operations (see Appendix 4). However, given the apparently high tolerance to human activity and high adaptability to human altered landscapes (Houston et al. 1998), the following temporal buffers are prescribed:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>100 m</td></tr>
<tr><td>Moderate</td><td>50 m</td></tr>
<tr><td>Low</td><td>25 m</td></tr>
</table>
</td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as February 1 to May 31. Local knowledge of breeding chronology may be used to adjust</td><td>Permanent resident; median egg dates are March 1 to March 18 (Peck and James 1983). Based on a 33 day incubation period and a 49 day period to nest departure (Houston et al. 1998), most fledging likely occurs by late May. Thus, timing restriction from February 1 to May 31 should provide protection from initiation of nesting to fledging.</td></tr>
</table>

| | |
|---|---|
| these dates. | |
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests. | Nest to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Long-eared owl** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Declining (Kirk and Hyslop 1998) |
| Trend - ON | Stable? No BBS data. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but more than a 2 fold increase in the GLSL forest and 6 fold increase in the boreal forest (Konze 2007). |
| Distribution | Found primarily in the GLSL forest; scattered records across the boreal forest (Konze 2007). |
| Nesting | Does not build a nest but uses abandoned corvid, hawk, or squirrel nests, and even natural platforms created by abnormal branch clusters (brooms) (Peck and James 1983, Bull et al. 1989, Marks et al. 1994). Nests may be reused in subsequent years (Marks et al. 1994). Marks (1986) noted a 48% reoccupancy rate; successful nests were reused more frequently (74%) than unsuccessful ones (28%). Nesting season runs from about mid-March to mid-June. |
| Habitat | Nests are typically found in dense coniferous forest (including plantations) but may even be placed in shelterbelts, hedgerows, or scattered trees (Peck and James 1983, Johnsgard 1988, Marks et al. 1994). Throughout most of its range, nesting habitat is typically close to habitats with abundant prey (small mammals) such as open forest, clearcuts, forest edges, meadows, marshes, grasslands, or shrublands (Johnsgard 1988, Marks et al. 1994, Holt 1997). When nesting in larger blocks of forest, nests are typically located close to an edge (Mikkola 1983). However, in some parts of the species' range, it may nest and hunt in fairly extensive tracts of mature forest (Bull et al. 1989). |
| Effects of forest management | There is little information on the direct effects of forest management operations or other human activities. Variable reaction to humans at nests; incubating females will often remain on nest until humans approach to within a few meters (Marks et al. 1994). In Idaho, females flushed from nests generally returned within 10 min and productivity did not differ between disturbed and undisturbed nests (Marks 1986).<br><br>In Idaho, nests averaged 550 m from roads, but proximity of roads (and agricultural activities) did not influence productivity (Marks 1986).<br><br>Generally most habitat-related conservation issues focus on the loss of riparian forest in the west or open areas to urbanization and forest succession in the east (Marks et al. 1994). This species is not typically considered to be a forest-dependent owl, may be negatively affected by too much forest cover, and presumably benefits from openings and forest edges when found in or near forest habitats (see review in Holt 1997). However, in Oregon long-eared owls avoided nesting in partially harvested forest and near forest openings (Bull et al. 1989). |

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| Past direction | No past direction specific to this species. Covered by generic prescription for stick nests of common species in OMNR (2004) which recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, and individual nest trees retained by themselves or in small residual patches in clearcuts; 150 m temporal buffer around occupied nests. |

**Rationale for direction**

Stable(?) S4 species that shows fidelity to nest sites but apparently a species of forest edges. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable(?) S4 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species.<br>Most references suggest that long-eared owls do not require large patches of forest for nesting (see review in Holt 1997). For example, in a lightly forested landscape in Idaho, 112 nests were found in riparian forest and isolated patches of trees that ranged from 5 to 99 m in width (average about 25 m) (Marks 1986). Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>100 m</td></tr><tr><td>Moderate</td><td>50 m</td></tr><tr><td>Low</td><td>25 m</td></tr></table> |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as March 15 to July 15. Local knowledge of | Median egg dates are April 15 – May 5 (Peck and James 1983). Based on a 27 day incubation period and a 35 day period to nest departure (Marks et al. 1994), most fledging likely occurs by late June. Thus, timing restriction from March 15 to July 15 should provide protection from |

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| breeding chronology may be used to adjust these dates. | initiation of nesting to fledging. |
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests. | Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Merlin** |
|---|---|
| S-rank | S4B/G5 |
| Designation | None |
| Trend – CDN | Stable/increasing (Kirk and Hyslop 1998) |
| Trend – ON | Increasing. Ontario BBS data from 1981-2005 suggest significant increasing trend (16%/yr). Probability of observation more than doubled between BBAs in the 1980s and 2000s; similar magnitude increase in the boreal forest but about a 6 fold increase in the GLSL forest (Gahbauer 2007). |
| Distribution | Widely distributed across the AOU (Gahbauer 2007). |
| Nesting | Does not build a nest, but typically uses old corvid or hawk nests in conifer trees; occasionally nests on cliffs or in tree cavities (Peck and James 1983, Warkentin et al. 2005). Nests are rarely reused (Warkentin et al. 2005). Nesting season runs from late April to late July. |
| Habitat | Extremely adaptable, nesting in a wide variety of habitats from extensive forests, to open prairies, to urban environments (Warkentin et al. 2005). In prairie conditions, typically nests in small patches of coniferous or deciduous forest and hunts in grassland habitat (Warkentin et al. 2005). In extensively forested areas, nests in mature or immature coniferous forest (including plantations), typically near forest openings such as rivers, lakes, or bogs that are used for hunting; nests are commonly on islands in large lakes (Peck and James 1983, Warkentin et al. 2005). |
| Effects of forest management | There is little quantitative information on the direct effects of forest management practices or other human activities but, when free from human persecution, appears to habituate readily to human activity (Warkentin et al. 2005); in Saskatoon, merlins nested an average of 57 m from buildings and 22 m from roads (Warkentin and James 1988). In Montana, used sites were not significantly further from roads than were unused sites (Sieg and Becker 1990).<br>Habitat changes caused by forest management operations likely have relatively little effect. Requires patches of forest for nesting but these patches can be relatively open (e.g., Sieg and Becker 1990) and can represent <1% of their home range (e.g., Becker and Sieg 1987). |
| Past direction | James (1984) mentioned merlins but did not provide specific direction. Szuba and Naylor (1998) and OMNR (2004) recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, individual nest trees in clearcuts. Temporal buffer of 150 m around occupied nests during the breeding season (March 1 to July 31). This direction has not been tested. |

**Rationale for direction**

Increasing S4 species without demanding habitat requirements; forest harvesting likely has little impact as long as nest sites are available. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 50 m radius AOC centred on the occupied nest.</td><td>An AOC of 50 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Increasing S4 species so AOC prescription does not address retention of nesting habitat. In partial harvests, individual nests may be reused; in clearcuts nests unlikely to be reused or used by other species; retain nest trees if in good repair to comply with Fish and Wildlife Conservation Act (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 10-50 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>50 m</td></tr>
<tr><td>Moderate</td><td>25 m</td></tr>
<tr><td>Low</td><td>10 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Median egg dates are May 30 – June 13 (Peck and James 1983). Based on a 30 day incubation period and a 29 day nestling period (Warkentin et al. 2005), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; some likelihood that nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations</td><td>See rationale for restrictions on harvest, renewal, and tending operations</td></tr>
</table>

| | |
|---|---|
| associated with roads, landings, and aggregate pits are not permitted within 10-50 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Red-tailed hawk** |
|---|---|
| S-rank | S5B/G5 |
| Designation | None |
| Trend – CDN | Increasing (Kirk and Hyslop 1998) |
| Trend - ON | Stable or increasing? Ontario BBS data from 1981-2005 suggest no significant trend. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about a 45% increase in the boreal forest (Szuba 2007). |
| Distribution | Widely distributed across the AOU (Szuba 2007). |
| Nesting | Builds large stick nests that are placed in either hardwood or conifer trees (Peck and James 1983). Old nests are regularly reused (Peck and James 1983, Preston and Beane 1993); 75% of nests were reused in consecutive years in Georgia (Moorman et al. 1999). Nesting season runs from mid-March to early July. |
| Habitat | Nesting habitat is highly variable. Nest trees may be in open forest, along forest edges, in fence rows, or even in fields and pastures (Howell et al. 1978, Peck and James 1983, Preston and Beane 1993). |
| Effects of forest management | There is little quantitative information on the direct effects of forest management operations or other human activities. Generally aggressive around nests (Andersen 1988, Preston and Beane 1993) but tends to be tolerant of human development (Ferris 1974, Minor et al. 1993, Bosakowski and Smith 1997, Tietje et al. 1997, Stout et al. 1998), tends to nest closer to sources of human disturbance than other species (e.g., Bednarz and Dinsmore 1982), and appears to habituate readily to some types of human disturbance (e.g., Andersen et al. 1986, 1989). In Washington, nested as close as 18 m from primary roads, 12 m from secondary roads, and 9 m from human habitation (Bechard et al. 1990). In Wisconsin, nests were as close as 24 m from roads and 30 m from human habitation (Stout et al. 1998).<br><br>Habitat changes caused by forest management practices likely benefit red-tailed hawks as long as nest sites are retained (Nelson and Titus 1989). Does not require large patches of forest for nesting; amount of forest within 1.5 km of nests in Wisconsin ranged from 0.3 to 45 ha (Stout et al. 1998). At the scale of individual patches of nesting habitat, partial harvesting can result in replacement of both red-shouldered hawks and northern goshawks by red-tailed hawks (Bryant 1994, Crocker-Bedford 1990). At the home range scale, decreases in the amount of mature forest and increases in the amount of open areas make habitat more suitable for red-tailed hawks than red-shouldered hawks or northern goshawks (Bednarz and Dinsmore 1982, LaSorte et al. 2004) and increase the productivity of nests (Howell et al. 1978). |
| Past direction | James (1984) did not mention red-tailed hawks. Szuba and Naylor (1998) and OMNR (2004) recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, and individual nest trees retained in |

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| | small residual patches in clearcuts. Temporal buffer of 150 m around occupied nests during the breeding season (March 1 to July 31). This direction has not been tested. |

**Rationale for direction**

Stable or increasing S5 species without demanding habitat requirements; forest harvesting improves habitat quality as long as nest sites are available. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable or increasing S5 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees and protects nests from potential wind or felling damage. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Body mass alone suggests a temporal buffer of about 200 m for high potential impact operations (see Appendix 4). However, given the apparent high tolerance of human activity and high adaptability to human altered landscapes, the following temporal buffers are prescribed:<br><br>**Potential impact** — **No operations within**<br>High — 100 m<br>Moderate — 50 m<br>Low — 25 m |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates. | Median egg dates are April 5 – April 23 (Peck and James 1983). Based on a 32 day incubation period and a 44 day nestling period (Preston and Beane 1993), most fledging likely occurs by late June. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging. |
| *Standard* - New roads, landings, and aggregate pits will not be constructed within | Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate |

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| 20 m of nests. | future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.5 Continued**

**Background**

| **Species** | **Sharp-shinned hawk** |
|---|---|
| S-rank | S5B/G5 |
| Designation | None |
| Trend – CDN | Increasing or stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable. Ontario BBS data from 1981-2005 suggest no significant trend. Similar probability of observation during BBAs in the 1980s and 2000s (Gahbauer 2007). |
| Distribution | Widespread across the GLSL forest; scattered across the boreal forest (Gahbauer 2007). |
| Nesting | Builds a small stick nest in conifer trees (Peck and James 1983). Individual nests are rarely reused (Bildstein and Meyer 2000). Nesting season runs from mid-April to late July. |
| Habitat | Nests are typically in dense patches of immature (or mature) conifer (or mixed) forest (including plantations), frequently close to forest openings (Peck and James 1983, Wiggers and Kritz 1991, Garner 1999, Trexel et al. 1999, Bildstein and Meyer 2000, Coleman et al. 2002); nesting habitat is typically younger and denser than that occupied by Cooper's hawks and/or northern goshawks (Moore and Henny 1983, Siders and Kennedy 1996, Trexel et al. 1999). |
| Effects of forest management | There is little quantitative information on the effects of human activities on sharp-shinned hawks (Bildstein and Meyer 2000). Can be aggressive at nest but no detectable effect of short term research activities on success (Bildstein and Meyer 2000). Moreover, at least some populations appear to habituate to human activity; near Montreal, nests were close (~20 m) to areas of considerable human activity including cycling and hiking trails and golf courses (Coleman et al. 2002). Forest management practices that protect nest sites may generally improve overall habitat suitability (Nelson and Titus 1989). |
| Past direction | James (1984) provided the first guidance for Ontario. He recommended the retention of a 4 ha patch of mature forest around nests. Szuba and Naylor (1998) and OMNR (2004) recommended retention of nest trees and trees with touching crowns in selection and shelterwood cuts, individual nest trees in clearcuts. Temporal buffer of 150 m around occupied nests during the breeding season (March 1 to July 31). This direction has not been tested. |

**Rationale for direction**

Stable S5 species without demanding habitat requirements so coarse filter direction should maintain long term supply of nesting habitat. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 50 m radius AOC centred on the occupied nest.</td><td>An AOC of 50 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable S5 species so AOC prescription does not address retention of nesting habitat. In partial harvests, individual nests may be reused; in clearcuts nests unlikely to be reused or used by other species; retain nest trees if in good repair to comply with Fish and Wildlife Conservation Act (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 10-50 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>50 m</td></tr>
<tr><td>Moderate</td><td>25 m</td></tr>
<tr><td>Low</td><td>10 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to breeding range in early April; median egg dates are May 30 – June 12 (Peck and James 1983, James 1991). Based on a 31 day incubation period and a 24 day nestling period (Bildstein and Meyer 2000), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; some likelihood that nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of occupied nests during the critical</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

| | |
|---|---|
| *breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | |

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### 4.2.2.6 Cavities used by nesting raptors or nesting/communally-roosting chimney swifts

**Background**

| **Species** | **American kestrel** |
|---|---|
| S-rank | S5B/G5 |
| Designation | None |
| Trend – CDN | Stable or increasing (Kirk and Hyslop 1998) |
| Trend - ON | Stable or declining? Ontario BBS data from 1981-2005 suggest significant declining trend (-3%/yr). Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about a 25% decline in the GLSL forest (Gahbauer 2007). |
| Distribution | Widely distributed across the AOU (Gahbauer 2007). |
| Nesting | Nests in old woodpecker nest cavities or natural cavities, typically in dead trees (Peck and James 1983, Smallwood and Bird 2002). Nest cavities may be reused, especially if previous nesting attempts are successful (Smallwood and Bird 2002). |
| Habitat | Prefers to nest in large patches (>20 ha) of open habitat (fields, pastures, meadows, roadsides, bogs, marshes, swamps, clearcuts) with short ground cover and perches for hunting (Peck and James 1983, Smallwood and Bird 2002). |
| Effects of forest management | There is little quantitative information on the direct effects of forest management practices but are generally considered to be tolerant of human activity (Smallwood and Bird 2002). Hunting birds appears to be very tolerant of vehicular traffic (Ferris 1974).<br>Effects of forest harvesting are likely beneficial as long as nest sites are provided (Smallwood and Bird 2002). In Pennsylvania, reuse of nest boxes was inversely related to tree density; the most frequently reused sites had an average of 24 trees/ha (Rohrbaugh and Yahner 1997). |
| Past direction | James (1984) mentioned kestrels but did not provide specific direction. Maintenance of supply of habitat for pileated woodpeckers (Naylor et al. 1996) as well as specific direction for retention of cavity trees and snags (Watt et al. 1996, OMNR 2001) likely provided potential nest sites. |

**Rationale for direction**

Stable (possibly declining) S5 species without demanding habitat requirements; forest harvesting improves habitat quality as long as nest sites are available. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 25 m radius AOC centred on the occupied nest.</td><td>An AOC of 25 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable (possibly declining) S5 species so AOC prescription does not address retention of nesting habitat. Nest trees may be reused or occupied by other secondary cavity users in any type of cut; retain as a cavity tree if not a safety concern (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>25 m</td></tr>
<tr><td>Moderate</td><td>10 m</td></tr>
<tr><td>Low</td><td>0 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to breeding range in early March; median egg dates are May 18 – June 6 (Peck and James 1983, James 1991). Based on a 30 day incubation period and a 30 day nestling period (Smallwood and Bird 2002), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 0-25 m of occupied nests during the critical</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

| | |
|---|---|
| *breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | |

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**4.2.2.6 Continued**

**Background**

| | |
|---|---|
| **Species** | **Barred owl** – see 4.2.2.5 for background information |

**Rationale for direction**

Stable or increasing S4S5 species with requirement for mature and older forest. General habitat requirements likely met by coarse filter direction if nest sites are protected. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable or increasing S4S5 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch (CRO). This provides some concealment for nest trees, protects trees from potential felling damage, and ensures dead trees can be retained without creating a potential risk to the safety of workers. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | The model in Appendix 4 suggests the following temporal buffers:<br><br>**Potential impact** — **No operations within**<br>High — 100 m<br>Moderate — 50 m<br>Low — 25 m |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates. | Permanent resident; median egg dates are April 4 to May 20 (Peck and James 1983). Based on a 31 day incubation period and a 42 day period to nest departure (Johnsgard 1988), most fledging likely occurs by late June. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging. |

| | |
|---|---|
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests of the barred owl. | Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.6 Continued**

**Background**

| **Species** | **Boreal owl** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable but fluctuating? Nocturnal Owl Survey data for 1995-2005 suggest high annual variation and recent declines in northern Ontario that may be part of a 4 year 'cycle' (Crewe and Badzinski 2006). Overall, similar probability of observation during BBAs in 1980s and 2000s, but about a 2.5 fold increase in the boreal forest (Badzinski 2007). |
| Distribution | Scattered across the AOU but most abundant in northwestern Ontario (Badzinski 2007). |
| Nesting | Nests in cavities created by pileated woodpeckers or northern flickers or in natural tree cavities. Nests rarely reused by the same pair; may be used by different pairs but rarely in consecutive years (Hayward and Hayward 1993). |
| Habitat | Nests are typically located in mature and older deciduous or mixed forest (Hayward and Hayward 1993, Hayward 1994, Lane et al. 1997a,b). May require mature and older cool conifer-dominated forest for roosting during summer to reduce heat stress (Hayward et al. 1993). Foraging for the primary prey (red-backed voles) usually occurs in mature spruce or spruce-fir forest (Hayward 1994), although clearcuts may also be used in some areas (Herren et al. 1996). |
| Effects of forest management | Little information on the effects of forest management or other human activities. Considered to be tolerant of human activity, noise created by machinery, and traffic (Hayward 1994). Because it prefers mature and older forest and is a secondary cavity user, practices that reduce the supply of older forest or remove cavity trees may negatively affect supply of nesting habitat (Hayward 1994). However, patches of suitable nesting habitat may not need to be large, and in Wyoming, breeding density was higher in watersheds containing a mix of mature and recently clearcut forest than in watersheds without any cutting (Herren et al. 1996). In northern Ontario, appears to be equally abundant in landscapes created by fire or timber harvesting (although habitats used may differ between burned and harvested landscapes) (Sleep 2005). |
| Past direction | No species-specific direction. Maintenance of supply of habitat for pileated woodpeckers (Naylor et al. 1996) as well as specific direction for retention of cavity trees and snags (Watt et al. 1996, OMNR 2001) likely provided potential nest sites. |

**Rationale for direction**

Stable S4 species; general habitat requirements likely met by coarse filter direction at landscape and stand scales. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 25 m radius AOC centred on the occupied nest.</td><td>An AOC of 25 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable S4 species so AOC prescription does not address retention of nesting habitat. Nest trees may be reused or occupied by other secondary cavity users in any type of cut; retain as a cavity tree if not a safety concern (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>25 m</td></tr>
<tr><td>Moderate</td><td>10 m</td></tr>
<tr><td>Low</td><td>0 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Permanent resident; median egg dates are May 14 to May 27 (James 1991). Based on a 29 day incubation period and a 32 day period to nest departure (Hayward and Hayward 1993), most fledging likely occurs by mid-July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 0-25 m of occupied nests</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact</td></tr>
</table>

| | |
|---|---|
| during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | operations. |

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**4.2.2.6 Continued**

**Background**

| **Species** | **Chimney swift** |
|---|---|
| S-rank | S4B/G5 |
| Designation | Listed as not at risk by COSSARO (but listed as *threatened* by COSEWIC); identified as a priority species in the Landbird Conservation Plan for BCR 12. |
| Trend – CDN | Declining (COSEWIC 2007) |
| Trend - ON | Declining. BBS data suggest about a 9% annual decline from 1968 to 2005. Probability of observation declined between BBAs in the 1980s and 2000s by about 50% in the province and >50% in the GLSL portion of the AOU (Cadman 2007). Declines may be primarily related to loss of preferred nest and roost sites (i.e., chimneys and abandoned buildings) (COSEWIC 2007). |
| Distribution | In Ontario, occurs from the southern edge of the boreal forest south. Most abundant south of the Canadian shield (Cadman 2007). |
| Nesting | Builds a small nest of twigs affixed to the interior wall of a natural or man-made hollow structure. Nests singly but roosts communally in similar types of structures. Prior to European colonization, large (>50 cm dbh) hollow living or dead trees (especially those with a broken top) were used. Today, large hollow trees or other types of tree cavities such as those excavated by the pileated woodpecker are used infrequently. Most nests and communal roosts are in chimneys or buildings (Peck and James 1983, Cink and Collins 2002, Graves 2004, COSEWIC 2007). |
| Habitat | Forages for insects on the wing over a wide variety of habitats where insects are abundant and there are suitable nest sites, but most often associated with urban and suburban areas (Clink and Collins 2002, COSEWIC 2007). |
| Effects of forest management | Little detailed information on the direct effects of forest management or other human activities.<br>Removal of large hollow living or dead trees during forest management operations could potentially reduce the supply of natural nest and roost sites. |
| Past direction | No species-specific direction. Retention of pileated woodpecker nest and roost trees likely provided some potential sites for nesting and roosting (see Naylor et al. 1996). |

**Rationale for direction**

Declining S4 species. Priority species in BCR 12. General habitat requirements likely met by coarse filter direction at landscape and stand scales. Thus, direction identifies only occupied nests/communal roosts as AOCs and focuses on mitigating disturbance; CROs address nest/roost retention.

Rationale for direction is described below:

<table>
<tr><th>Direction</th><th>Rationale</th></tr>
<tr><td>Standard - 50 m radius AOC centred on the occupied nest or roost tree.</td><td>An AOC of 50 m is prescribed for occupied nests or roosts based on distance required to mitigate potential effects of disturbance during the breeding/roosting period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests/communal roosts subject to timing restrictions and: …</td><td>Declining S4 species but habitat requirements generally addressed by coarse filter direction. Thus, AOC prescription does not address retention of nesting/roosting habitat. However, individual nests/roosts may be reused or occupied by other species. Thus, nest/roost trees are retained in a 20 m radius unharvested residual patch (CRO). This provides some concealment for nest/roost trees, protects trees from potential felling damage, and ensures dead trees can be retained without creating a potential risk to the safety of workers.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 10-50 m of occupied nests/communal roosts during the critical breeding/roosting period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Little information to define appropriate buffers. The following temporal buffers are prescribed based on direction for colonies of the bank swallow:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>50 m</td></tr>
<tr><td>Moderate</td><td>25 m</td></tr>
<tr><td>Low</td><td>10 m</td></tr>
</table>
</td></tr>
<tr><td>Guideline - The critical breeding/roosting period for all of Ontario is defined as May 1 to September 30. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Nests may contain eggs from late May to early August (Peck and James 1983) but the species is typically in ON (and potentially using roosts) from late April to early October (James 1991) (these dates are likely more representative of the population in southern Ontario). Thus, the critical breeding/roosting period is defined as May 1 to September 30.</td></tr>
<tr><td>Standard - New roads, landings, and aggregate pits will not be constructed within 20 m of nests/communal roosts.</td><td>Nests/roosts to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance.</td></tr>
</table>

| | |
|---|---|
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of *occupied* nests/communal roosts during the *critical breeding/roosting period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding/roosting period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest/roost. This direction assumes that birds that nest/roost adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.6 Continued**

**Background**

| **Species** | **Eastern screech-owl** |
|---|---|
| S-rank | S5/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable or increasing? Overall, about a 20% increase in the probability of observation between BBAs in the 1980s and 2000s, but no change in the GLSL forest (Kopysh 2007). |
| Distribution | Found primarily in southern Ontario; scattered records across the AOU (Kopysh 2007). |
| Nesting | Nests in natural cavities, to a lesser extent in old woodpecker nest cavities, in living or dead trees (Peck and James 1983, Gehlbach 1995). Nesting season March through June. |
| Habitat | Extremely variable; wide range of forest types and ages used (even orchards, and urban parks and yards) as long as cavity trees or nest boxes are available (Peck and James 1983, Gehlback 1995). No apparent minimum area required (Gehlback 1995). |
| Effects of forest management | Little detailed information on the direct effects of forest management or other human activities. |
| Past direction | No species-specific direction. Maintenance of supply of habitat for pileated woodpeckers (Naylor et al. 1996) likely provided potential nest sites. |

**Rationale for direction**

Stable or increasing S5 species. General habitat requirements likely met by coarse filter direction at landscape and stand scales. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 25 m radius AOC centred on the occupied nest. | An AOC of 25 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests | Stable or increasing S5 species so AOC prescription does not address retention of nesting habitat. Nest trees may be reused or occupied by other secondary cavity users in any type of cut; retain as a cavity tree if not a safety concern (CRO). |

<table>
<tr><td>subject to timing restrictions and: …</td><td></td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>25 m</td></tr><tr><td>Moderate</td><td>10 m</td></tr><tr><td>Low</td><td>0 m</td></tr></table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Permanent resident; median egg dates are April 16 to May 3 (Peck and James 1983, James 1991). Based on a 30 day incubation period and a 28 day period to nest departure (Gehlback 1995), most fledging likely occurs by mid-late June. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest.</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

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**4.2.2.6 Continued**

**Background**

| | |
|---|---|
| **Species** | **Great horned owl** – see 4.2.2.5 for background information |

**Rationale for direction**

Stable (possibly declining) S5 species that benefits from forest harvesting as long as nest sites are provided. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - 50 m radius AOC centred on the occupied nest. | An AOC of 50 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: … | Stable (possibly declining) S5 species so AOC prescription does not address retention of nesting habitat. However, individual nests may be reused or occupied by other species. Thus, nests are retained in a 20 m radius unharvested residual patch if in good repair (CRO). This provides some concealment for nest trees, protects trees from potential felling damage, and ensures dead trees can be retained without creating a potential risk to the safety of workers. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 10-50 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Body mass alone suggests a temporal buffer of about 100 m for high potential impact operations (see Appendix 4). However, given the apparently high tolerance to human activity and high adaptability to human altered landscapes (Houston et al. 1998), the following temporal buffers are prescribed:<br><br>**Potential impact** – **No operations within**<br>High – 50 m<br>Moderate – 25 m<br>Low – 10 m |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as February 1 to May 31. Local knowledge of breeding chronology may be used to adjust these dates. | Permanent resident; median egg dates are March 1 to March 18 (Peck and James 1983). Based on a 33 day incubation period and a 49 day period to nest departure (Houston et al. 1998), most fledging likely occurs by late May. Thus, timing restriction from February 1 to May 31 should provide protection from initiation of nesting to fledging. |

| | |
|---|---|
| *Standard* - New roads, landings, and aggregate pits will not be constructed within 20 m of nests. | Nests to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of *occupied* nests during the *critical breeding period* based on potential impact, unless …However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

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**4.2.2.6 Continued**

**Background**

| **Species** | **Northern hawk owl** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend – ON | Increasing? Overall, the probability of observation increased by about 5 times between BBAs in the 1980s and 2000s; no change in the GLSL forest but about a 3.5 fold increase in the boreal forest (Escott 2007). |
| Distribution | Scattered across the northern portions of the boreal forest (Escott 2007). |
| Nesting | Nests in natural cavities or abandoned woodpecker holes. Nests may be reused, but likely not by the same pair (Duncan and Duncan 1998). |
| Habitat | Typically nests in moderately dense coniferous or mixed forest adjacent to open areas such as wetlands, clearcuts, or burns where it forages (Duncan and Duncan 1998). May also nest in recently burned, clearcut, or defoliated forest (Lauff 1997, Hannah and Hoyt 2004, Sleep 2005). |
| Effects of forest management | Little detailed information on the direct effects of forest management or other human activities (Duncan and Harris 1997). Hunting birds may be very tame but nesting birds may be very aggressive toward human intruders (Duncan and Duncan 1998). Does not appear to avoid roads and traffic (Duncan and Duncan 1998).<br>Forest harvesting may remove nesting habitat but may create hunting and/or nesting habitat if residual patches, perches, cavities trees, and downed woody material are retained in cutovers and cuts are not too large (Duncan and Harris 1997, Sonerud 1997, Duncan and Duncan 1998, Sleep 2005). Recent burns may support higher breeding densities than either mature forest or recent clearcuts; thus fire suppression and post-fire salvage may have negative population consequences (Hannah and Hoyt 2004). |
| Past direction | No species-specific direction. Direction for retention of cavity trees and snags (Watt et al. 1996, OMNR 2001) likely provided potential nest and perch sites. |

**Rationale for direction**

Increasing(?) S4 species. General habitat requirements likely met by coarse filter direction at landscape and stand scales. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 50 m radius | An AOC of 50 m is prescribed for occupied nests based on distance |

<table>
<tr><td>AOC centred on the occupied nest.</td><td>required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Increasing(?) S4 species so AOC prescription does not address retention of nesting habitat. Nests may be reused or occupied by other secondary cavity users in any type of cut; retain as a cavity tree if not a safety concern (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 10-50 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>50 m</td></tr><tr><td>Moderate</td><td>25 m</td></tr><tr><td>Low</td><td>10 m</td></tr></table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Permanent resident; median egg dates from Alberta are April 13 to April 28 (Johnsgard 1988)(no data for Ontario). Based on a 27 day incubation period and a 30 day period to nest departure (Duncan and Duncan 1998), most fledging likely occurs by mid-July at the latest (young fledged from two nests on Manitoulin Island about the middle of June; Campbell et al. 1998). Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of occupied nests during the critical breeding period based on potential impact, unless … However, there is no timing restriction on hauling</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

| | |
|---|---|
| or low potential impact road maintenance operations (e.g., grading) if the road predates the nest. | |

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**4.2.2.6 Continued**

**Background**

| **Species** | **Northern saw-whet owl** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Stable (Kirk and Hyslop 1998) |
| Trend - ON | Stable but fluctuating? Nocturnal Owl Survey data for 1995-2005 suggest high annual variation; recent decline in northern Ontario and possible longer term decline in central Ontario (Crewe and Badzinski 2006). Overall, the probability of observation increased by about 2.5 fold between BBAs in the 1980s and 2000s; no change in GLSL forest but about a 10 fold increase in the boreal forest (Badzinski 2007). |
| Distribution | Found primarily in the GLSL forest; scattered across the southern portion of the boreal forest (Badzinski 2007). |
| Nesting | Nests primarily in old pileated woodpecker and northern flicker cavities. Nests rarely reused by the same pair; nests may be used by different pairs but usually after an interval of 1 or 2 years (Cannings 1993). |
| Habitat | Nests in a variety of forest types, with lowland forests often preferred (Cannings 1993). |
| Effects of forest management | Little information on the effect of forest management or other human activities. Harvest of mature forest thought to have a negative effect (Cannings 1993). In northern Ontario, appears to be equally abundant in landscapes created by fire or timber harvesting (Sleep 2005). |
| Past direction | No species-specific direction. Maintenance of supply of habitat for pileated woodpeckers (Naylor et al. 1996) as well as specific direction for retention of cavity trees and snags (Watt et al. 1996, OMNR 2001) likely provided potential nest sites. |

**Rationale for direction**

Stable S4 species. General habitat requirements likely met by coarse filter direction at landscape and stand scales. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance; CROs address nest retention.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 25 m radius AOC centred on the occupied nest. | An AOC of 25 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |

<table>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted around nests subject to timing restrictions and: …</td><td>Stable S4 species so AOC prescription does not address retention of nesting habitat. Nests may be reused or occupied by other secondary cavity users in any type of cut; retain as a cavity tree if not a safety concern (CRO).</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>The model in Appendix 4 suggests the following temporal buffers:
<table>
<tr><th>Potential impact</th><th>No operations within</th></tr>
<tr><td>High</td><td>25 m</td></tr>
<tr><td>Moderate</td><td>10 m</td></tr>
<tr><td>Low</td><td>0 m</td></tr>
</table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to breeding range in early March; median egg dates are April 10 – May 17 (Peck and James 1983, James 1991). Based on a 27 day incubation period and a 33 day nestling period (Johnsgard 1988), most fledging likely occurs by early July. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 20 m of nests.</td><td>Nests to be retained; nests may be reused (see above). Thus, reasonable efforts will be made to avoid constructing new roads, landings, or aggregate pits within 20 m of nests since these features modify habitat and facilitate future disturbance.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 0-25 m of occupied nests during the critical breeding period based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g.,</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

| | |
|---|---|
| grading) if the road predates the nest. | |

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#### 4.2.2.7 Ground-nesting raptors

**Background**

| **Species** | **Northern harrier** |
|---|---|
| S-rank | S4B/G5 |
| Designation | None |
| Trend – CDN | Stable or decreasing (Kirk and Hyslop 1998) |
| Trend - ON | Stable? Ontario BBS data from 1981-2005 suggest no significant trend. Overall, similar probability of observation during BBAs in the 1980s and 2000s, but about a 25% decline in the GLSL forest (Sandilands 2007). |
| Distribution | Widely distributed across the AOU but most abundant in GLSL forest and areas north and south of the AOU (Sandilands 2007). |
| Nesting | Builds a nest of grasses, marsh vegetation, and/or sticks and twigs on or near the ground in a wide variety of open habitats with tall dense cover (Peck and James 1983, MacWhirter and Bildstein 1996). Nests are not reused (MacWhirter and Bildstein 1996). |
| Habitat | Typically nests and hunts in marshes, bogs, swales, swamps, beaver meadows, and marshy edges of lakes or rivers, but may also use agricultural fields and plantations (Peck and James 1983, MacWhirter and Bildstein 1996). |
| Effects of forest management | There is little quantitative information on the direct effects of forest management practices or other human activities. May be aggressive around nests (MacWhirter and Bildstein 1996). Agricultural activities can destroy nests or cause nest abandonment (MacWhirter and Bildstein 1996); forest renewal and tending operations may potentially have similar effects on nests in cutovers.<br>Most research on the effects of management actions consider grassland habitat (e.g., Herkert et al. 1999, Murray and Best 2003). Major threats to habitat for this species in eastern North America are thought to be aforestation and urban/industrial development (MacWhirter and Bildstein 1996). Forest harvesting can presumably create potentially suitable hunting and nesting habitat for a short period of time. |
| Past direction | James (1985) mentioned northern harriers but did not provide specific direction. |

**Rationale for direction**

Stable S4 species that does not nest or hunt in mature forest. Forest harvesting improves habitat supply as long as occupied nests on cutovers are not disturbed during renewal and tending operations. Nests not reused. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 50 m radius AOC centred on the occupied nest. | An AOC of 50 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted with timing restrictions. | Stable S4 species so AOC prescription does not address retention of nesting habitat. Nests not reused so no direction for retention of nest sites. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 10-50 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | The model in Appendix 4 suggests the following temporal buffers:<br>**Potential impact** — **No operations within**<br>High — 50 m<br>Moderate — 25 m<br>Low — 10 m |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as April 1 to July 31. Local knowledge of breeding chronology may be used to adjust these dates. | Typically returns to breeding range in early April; median egg dates are May 21 – June 7 (Peck and James 1983, James 1991). Based on a 31 day incubation period and a 35 day nestling period (MacWhirter and Bildstein 1996), most fledging likely occurs by late July. Thus, timing restriction from April 1 to July 31 should provide protection from initiation of nesting to fledging. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 10-50 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

| | |
|---|---|
| predates the nest. | |

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**4.2.2.7 Continued**

**Background**

| **Species** | **Short-eared owl** |
|---|---|
| S-rank | S3S4/G5 |
| Designation | *Special concern* |
| Trend – CDN | Declining (Kirk and Hyslop 1998) |
| Trend - ON | Stable? Insufficient Ontario BBS data. Overall, the probability of observation about doubled between BBAs in the 1980s and 2000s but no change in the GLSL or boreal forests (Gahbauer 2007). |
| Distribution | Scattered across the AOU; most abundant in southern Ontario and along the coasts of James Bay and Hudson Bay (Gahbauer 2007). |
| Nesting | Builds a scrape on the ground that may be lined with grasses or down feathers (Peck and James 1983, Holt and Leasure 1993). Nest sites generally not reused. |
| Habitat | Nests and hunts in a wide range of open habitats from grasslands and agricultural fields to marshes and bogs to recent clearcuts and young plantations, but nests are usually on dry sites (Peck and James 1983, Holt and Leasure 1993). Habitats used are similar to those used by northern harriers, although short-eared owls generally prefer shorter vegetation (Herkert et al. 1999). |
| Effects of forest management | Little information on the direct effects of forest management practices or other human activities. Forest renewal and tending operations could presumably have negative effects on nests in cutovers. For example, site preparation operations could destroy nests and tree planters could disturb nesting birds. However, short-eared owls generally are not thought to be sensitive to human activities; females rarely flush until humans are within a few meters of a nest (Holt and Leasure 1993).<br>Major threats to habitat for this species thought to be conversion of open habitats with low vegetation to agricultural, recreational, and urban development and aforestation (Holt and Leasure 1993). Little known about the effects of forest management practices. Harvesting can presumably create potentially suitable hunting and nesting habitat, at least for a short period of time. |
| Past direction | James (1985) mentioned short-eared owls but did not provide specific direction. |

**Rationale for direction**

Stable(?) S3S4 species that does not nest or hunt in mature forest. Forest harvesting improves habitat supply as long as occupied nests on cutovers are not disturbed during renewal and tending operations. Nests not reused. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 100 m radius AOC centred on the occupied nest. | An AOC of 100 m is prescribed for occupied nests based on distance required to mitigate potential effects of disturbance during the breeding period (see below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted with timing restrictions. | Stable(?) S3S4 species so AOC prescription does not address retention of nesting habitat. Nests not reused so no direction for retention of nest sites. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | The model in Appendix 4 suggests the following temporal buffers:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>100 m</td></tr><tr><td>Moderate</td><td>50 m</td></tr><tr><td>Low</td><td>25 m</td></tr></table> |
| *Guideline* - The *critical breeding period* for all of Ontario is defined as March 15 to July 15. Local knowledge of breeding chronology may be used to adjust these dates. | Typically returns to breeding range in early March; median egg dates are May 6 – May 19 (Peck and James 1983, James 1991). Based on a 30 day incubation period and a 34 day nestling period (Holt and Leasure 1993), most fledging likely occurs by early July. Thus, timing restriction from March 15 to July 15 should provide protection from initiation of nesting to fledging. |
| *Guideline* - Operations associated with roads, landings, and aggregate pits are not permitted within 25-100 m of *occupied* nests during the *critical breeding period* based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road | See rationale for restrictions on harvest, renewal, and tending operations during the *critical breeding period*.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations. |

| | |
|---|---|
| predates the nest. | |

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**4.2.2.7 Continued**

**Background**

| **Species** | **Turkey vulture** |
|---|---|
| S-rank | S4/G5 |
| Designation | None |
| Trend – CDN | Increasing or stable (Kirk and Hyslop 1998) |
| Trend - ON | Increasing. Major population increase since the 1920s (Cadman et al. 1987). Ontario BBS data for 1984-2004 suggest significant (P = 0.007) increasing trend. Overall, the probability of observation more than doubled between BBAs in the 1980s and 2000s; about a 50% increase in GLSL forest and 4.5 fold increase in the boreal forest (Peck 2007). |
| Distribution | Widespread throughout the GLSL forest; scattered across the southern portions of the boreal forest (Peck 2007). |
| Nesting | Does not build a nest; lays eggs in caves and crevices on cliffs and rock outcrops, in hollow logs and stumps in forested habitats, and even in abandoned buildings (Peck and James 1983, Kirk and Mossman 1998). Shows strong nest site fidelity; individual nests have been used for up to 15 years (Kirk and Mossman 1998). |
| Habitat | Typically nests in forested habitats containing nest sites (e.g., cliff or rock outcrop) embedded within a mosaic of open habitats (e.g., farmland) and forest (Kirk and Mossman 1998). Home ranges in Pennsylvania and Maryland average about 15% forest cover (Coleman and Fraser 1989). |
| Effects of forest management | Little information on the direct or indirect effects of forest management or other human activities. However, isolation from human disturbance considered one of the key attributes of good nest sites (Kirk and Mossman 1998).<br>Nesting birds may avoid roads (e.g., Coleman and Fraser 1989) but roads may be important to foraging birds because they provide thermal updrafts (Coleman and Fraser 1989) and a source of carrion (Palmer 1988). |
| Past direction | No species-specific direction. |

**Rationale for direction**

Increasing S4 species that benefits from human altered landscapes as long as nest sites are provided and nesting birds are relatively free from human disturbance. Nests in caves and crevices on cliffs unlikely to be affected by forest management operations. Thus, direction identifies only occupied nests as AOCs and focuses on mitigating disturbance.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 150 m | An AOC of 150 m is prescribed for occupied nests based on distance |

<table>
<tr><td>radius AOC centred on the occupied nest.</td><td>required to mitigate potential effects of disturbance during the breeding period (see below).</td></tr>
<tr><td>Standard - Regular harvest, renewal, and tending operations are permitted with timing restrictions.</td><td>Increasing S4 species so AOC prescription does not address retention of nesting habitat. Nest sites reused but nests typically in caves and crevices on cliffs so unlikely to be affected by forest management operations.</td></tr>
<tr><td>Guideline - Harvest, renewal, and tending operations are not permitted within 40-150 m of occupied nests during the critical breeding period based on potential impact of the operation, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process.</td><td>Body mass of turkey vultures similar to ospreys, suggesting a temporal buffer of about 300 m for high potential impact operations (see Appendix 4) but given the species' status and inaccessible location of most nests, the buffer can likely be reduced to 150 m. Thus, the following temporal buffers are prescribed:<br><table><tr><th>Potential impact</th><th>No operations within</th></tr><tr><td>High</td><td>150 m</td></tr><tr><td>Moderate</td><td>75 m</td></tr><tr><td>Low</td><td>40 m</td></tr></table></td></tr>
<tr><td>Guideline - The critical breeding period for all of Ontario is defined as May 1 to August 31. Local knowledge of breeding chronology may be used to adjust these dates.</td><td>Typically returns to Ontario by late March; median egg dates are May 17 – June 1 (Peck and James 1983, James 1991). Based on incubation period of 39 days and nestling period of about 70 days (Kirk and Mossman 1998), most fledging likely occurs by late August. Thus, timing restriction from May 1 to August 31 should provide protection from initiation of nesting to fledging.</td></tr>
<tr><td>Guideline - Operations associated with roads, landings, and aggregate pits are not permitted within 40-150 m of occupied nests during the critical breeding period based on potential impact, unless … However, there is no timing restriction on hauling or low potential impact road maintenance operations (e.g., grading) if the road predates the nest.</td><td>See rationale for restrictions on harvest, renewal, and tending operations during the critical breeding period.<br><br>There is no restriction on hauling or low potential impact road maintenance operations if the road predates the nest. This direction assumes that birds that nest adjacent to existing roads are tolerant of low potential impact operations.</td></tr>
</table>

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#### 4.2.2.8 Forest-nesting birds not covered by direction in previous sections

**Background**

| **Species group** | **Waterfowl** |
|---|---|
| Description | Twenty species of waterfowl (swans, geese, and ducks) breed within the AOU (Cadman et al. 2007) (see Table 4.2a). Some species are ubiquitous (e.g., mallard) while others have very restricted distributions (e.g., ruddy duck). No species is considered to be 'at risk' in Ontario or Canada, although 4 species (mallard, American black duck, lesser scaup, northern pintail) are considered to be high priorities for conservation planning across North America and 3 additional species (common goldeneye, ring-necked duck, hooded merganser) are considered to be high priorities for conservation planning within the AOU in Ontario (NAWMP 2004). |
| Habitat | Waterfowl are associated with aquatic and semi-aquatic habitats and associated shoreline areas for feeding and nesting.<br>*Feeding habitat* - Waterfowl are quite diverse in their food habits (see Bellrose 1976). Swans are primarily aquatic grazers. Geese are largely terrestrial grazers. Dabbling ducks (e.g., black duck, mallard, green-winged teal, wood duck) feed on a variety of aquatic invertebrates and plants in the shallow waters of wetlands, ponds, small lakes, streams, and rivers. These species have a strong affinity for wetlands with a mix of open water and emergent vegetation, especially beaver ponds (Rempel et al. 1997, Gabor et al. 2002). Diving ducks (e.g., ring-necked duck, lesser scaup, bufflehead, common goldeneye) feed largely on fish caught in deeper water, and thus tend to be more associated with lakes than are dabbling ducks.<br>*Nesting habitat* (see Table 4.2a for summary) - Some species nest almost exclusively over water in wetland vegetation (e.g., readhead, ruddy duck). Others nest either over water or within grassy or shrubby habitat adjacent to water (e.g., lesser scaup, northern shoveler, ring-necked duck). Some species typically nest on the ground in shrubby or forested habitat adjacent to water (e.g., black duck, green-winged teal, red-breasted merganser). Five of 20 species nest in tree cavities (see Table 4.2a); 2 are conservation priorities. These species generally use large living or dead trees (typically hardwoods) with cavities that either formed from branch mortality or that were excavated by woodpeckers (northern flicker or pileated woodpecker) (some will nest in hollows or 'buckets' formed at the top of broken trees) (see Table 4.2a). The latter group is most likely to be directly affected by forest management operations. |
| Effects of forest management | Compared to agriculture, forest management operations are rarely cited as a significant factor influencing waterfowl populations (e.g., Longcore et al. 2000, Drilling et al. 2002, Rowher et al. 2002). Moreover, there is little quantitative information on the effects of forest management operations on waterfowl (Nicoll and Zimmerling 2006). In one study in boreal Alberta, Pierre (2001) noted a decrease in the density of some waterfowl on lakes after forest harvesting (e.g., bufflehead, lesser scaup) but an increase in the density of other species (e.g., ring-necked duck, blue-winged teal) and an overall increase in species richness. In boreal Quebec, most waterfowl showed little response (with the exception of Canada goose and green-winged teal which both increased) to clearcut |

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|---|---|
| | harvesting (Lemelin et al. 2007).<br>Potential effects of forestry operations on water quality and hydrologic regime (see Section 4.1 for discussion) presumably could lead to changes in the supply of aquatic plants and/or aquatic vertebrate or invertebrate prey for dabbling or diving ducks (Pierre 2001). Because many dabbling ducks are dependent on beaver-controlled wetlands (Gabor et al. 2002) and disturbance appears necessary to maintain shoreline habitat suitable for beavers (Barnes and Mallik 2001), lack of harvesting around wetlands could have negative consequences for long term use by waterfowl.<br>Harvesting of shoreline forest could potentially remove nest sites for cavity-nesting waterfowl (Pierre 2001), although Lemelin et al. (2007) could detect no short-term effect of forest harvesting on the cavity-nesting waterfowl. Forest management operations in shoreline areas during the nesting season may also directly disrupt nesting activities. |
| Past direction | Hickie (1985) provided recommendations for protecting water quality, retaining cavity trees, and restricting operations within riparian areas during the waterfowl nesting season. OMNR (1988) provided more formal direction for the protection of fish habitat and water quality. Naylor et al. (1996) and Watt et al. (1996) provided more formal direction for the retention of cavity trees. |

**Table 4.2a. Summary of status, habitat, nest sites, and egg dates for waterfowl found in the AOU in Ontario.**

| Species | Status | Feeding habitat | Nest site | Median egg dates | References |
|---|---|---|---|---|---|
| Trumpeter swan | S2S3/ G4 | Marshes, ponds, lakes, rivers. | Over water. | No data for Ontario | Mitchell 1994 |
| Canada goose | S5B/ G5 | Lakes, rivers, streams, ponds, bogs, marshes. | Frequently on islands or within 45 m of water (ON) – shores of lakes, rivers, ponds, marshes – open grassy or shrubby areas. | 28 April – 19 May | Peck and James 1983, Mowbray et al. 2002 |
| Wood duck | S5B/ G5 | Marshes or marshy areas of lakes, rivers, streams, ponds, and wooded swamps | Tree cavities – entrance hole about 10 cm in diameter, either natural or excavated by a woodpecker, usually in dead or decadent hardwood trees >30 cm dbh. Nests typically over or near water but up to 200 m (ON) (up to 2 km from water outside ON); averaged 80 m in MN. | 9 May – 25 May | Peck and James 1983, Hepp and Bellrose 1995 |
| Green-winged teal | S4B/ G5 | Marshes, bogs, ponds. | Grassy, shrubby, or forested areas usually within 40-60 m of water | 27 May – 4 June | Peck and James 1983, Johnson 1995 |

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|---|---|---|---|---|---|
| | | | (ON); maximum distance 200 m (BC), average distance about 20 m (AB). | | |
| American black duck | S5B/ G5 | Shallow lakes, marshy rivers, ponds, bogs and wooded and thicket swamps. | Highly variable – from directly over water to islands to open or forested habitat 800 m from water (ON). | 12 May – 2 June | Peck and James 1983, Longcore et al. 2000 |
| Mallard | S5B/ G5 | Marshes, bogs, shallow lakes, rivers, ponds. | Highly variable - from directly over water to open or forested habitat 1.6 km from water (ON). | 16 May – 3 June | Peck and James 1983, Drilling et al. 2002 |
| Northern pintail | S5B/ G5 | Marshes, bogs, ponds. | Grassy or shrubby areas 1-2 m to 90 m from water (ON) (up to 3 km from water in AB). | 28 May – 22 June | Peck and James 1983, Austin and Miller 1995 |
| Blue-winged teal | S5B/ G5 | Marshes, bogs, ponds, swamps. | Nests may be over water but usually in grassy open (sometimes forested) habitat from 5 to 230 m from water (ON). | 24 May – 16 June | Peck and James 1983, Rowher et al. 2002 |
| Northern shoveler | S4B/ G5 | Marshes, ponds. | Over water or in grassy areas up to 90 m from water (ON); average distance 50 m (AB). | 31 May – 18 June | Peck and James 1983, DuBowy 1996 |
| Gadwall | S4B/ G5 | Marshes, ponds, marshy areas of lakes, rivers. | Grassy or shrubby areas 1-2 m to 180 m from water (ON). | 19 June – 24 June | Peck and James 1983, LeSchack et al. 1997 |
| American wigeon | S4B/ G5 | Marshes, ponds, small lakes, rivers. | Over water to grassy or shrubby areas up to 180 m from water (ON); averaged 20 m (AB) and 40 m (SK) from water. | 17 June – 26 June | Peck and James 1983, Mowbray 1999 |
| Redhead | S2B/ G5 | Marshes, ponds, bogs. | Usually over water or within 1-2 m of water (AB, SK). | 24 May – 21 June | Peck and James 1983, Woodin and Michot 2002 |
| Ring-necked duck | S5B/ G5 | Marshes, fens, bogs. | Over water or within grassy or shrubby habitat within 200 m of | 10 June – 18 June | Peck and James 1983, Hohman and |

| | | | | | |
|---|---|---|---|---|---|
| | | | water. | | Eberhardt 1998 |
| Lesser scaup | S4B/ G5 | Marshes, ponds, shallow lakes. | Over water or within grassy or shrubby habitat up to 150 m from water; most nests within 20 m (ON, MB). | 5 June – 17 June | Peck and James 1983, Austin et al. 1998 |
| Common goldeneye | S5B/ G5 | Marshes, lakes, rivers. | Tree cavities or hollow tops - entrance hole typically >10 cm in diameter, either natural or excavated by a woodpecker, in either large dead or decadent trees. Nests typically from edge of water to up to 90 m from water (ON) (up to 1.3 km from water outside ON). | 19 May – 4 June | Bellrose 1976, Peck and James 1983, Eadie et al. 1995 |
| Bufflehead | S3B/ G5 | Ponds, small lakes. | Tree cavities - entrance hole typically <10 cm in diameter, excavated by a woodpecker (usually flicker), in either living or dead hardwood trees, especially poplars. Nests usually within about 25 m from water; up to 425 m in AB. | No data for Ontario | Bellrose 1976, Gauthier 1993 |
| Hooded merganser | S5B/ G5 | Marshes, small lakes, ponds, streams, rivers, swamps. | Tree cavities - entrance hole about 10 cm in diameter, either natural or excavated by a woodpecker, in either large living or dead trees. Nests from over water to up to 15 m from water (ON) (up to 500 m from water outside ON). | 12 May – 25 May | Peck and James 1983, Dugger et al. 1994 |
| Common merganser | S5B/ G5 | Lakes and rivers. | In tree cavities or hollow tree tops – cavity entrance hole typically >10 cm in diameter, either natural or excavated by a woodpecker, in either living or dead trees or on the ground in shrubby or forested | 29 May – 20 June | Peck and James 1983, Mallory and Metz 1999 |

| | | | | | |
|---|---|---|---|---|---|
| | | | habitat from edge of water to up to 180 m from water (ON) (up to 500 m from water outside ON). | | |
| Red-breasted merganser | S4B/ G5 | Lakes and rivers. | Nests in shrubby or forested habitat from edge of water up to 70 m from water (ON); average about 10 m from water in NB. | 17 June – 29 June | Peck and James 1983, Titman 1999 |
| Ruddy duck | S2B/ G5 | Marshes, ponds, marshy areas of lakes. | Over water. | 4 June – 28 June | Peck and James 1983, Brua 2001 |

**Rationale for direction**

Seven of 20 species of waterfowl have been identified as conservation priorities. General direction intended to protect water quality, hydrological function, shoreline forest, and provide residual shoreline trees (Section 4.1) and beaver-specific direction for ponds (Section 4.2.3) will address general habitat conditions needed by waterfowl for feeding and nesting. Nests are protected from destruction by the *Migratory Birds Convention Act 1994.* Thus, direction focuses on protecting individual nests containing eggs encountered during operations.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - Known nests of waterfowl containing eggs encountered during operations will not be destroyed. | The *Migratory Birds Convention Act 1994* prohibits the destruction of waterfowl nests. Thus, forest management operations will not destroy known nests containing eggs. In this context, destruction is interpreted to mean the complete or partial damage of the nest structure or its contents (i.e., attendant birds or eggs). |
| *Guideline* - Reasonable efforts will be made to minimize disturbance of known nests of waterfowl containing eggs encountered during operations. | The *Migratory Birds Convention Act 1994* prohibits the disturbance of waterfowl nests. In this context, disturbance is interpreted to mean the incidental interference with breeding activities such as egg laying and incubation.<br><br>There is no information on how nesting waterfowl react to different forest management operations, or the consequences of disturbance. Reactions and consequences are likely highly context-specific. Thus, direction to minimize disturbance is a *Guideline* rather than a *Standard. Best management practices* that are likely to minimize the risk of disturbing nesting waterfowl are provided. |
| *Best management practices* | Both ground-nesting waterfowl such as mallards and wigeons and cavity-nesting waterfowl such as common goldeneyes and hooded mergansers typically do not flush from nests until human intruders are very close to nests (average reported flushing distance ranges from about 1 to 6 m) (Jessen et al. 1964, Mallory and Weatherhead 1993, Forbes et al. 1994, Mallory et al. 1998, Gunness and Weatherhead 2002). Thus, it is assumed |

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|---|---|
| | that disturbance of nesting waterfowl will normally be minimized if forest management operations can avoided within 10 m of occupied nests. |

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**4.2.2.8 Continued**

**Background**

| **Species group** | **Upland game birds** |
|---|---|
| Description | Three grouse (ruffed, sharp-tailed, and spruce) and the wild turkey breed within the AOU (Cadman et al. 2007) (see Table 4.2b). Some species are ubiquitous (e.g., ruffed grouse) while others have very restricted distributions (e.g., sharp-tailed grouse). No species is considered to be 'at risk' in Ontario or Canada; all 4 species are harvested as small game. |
| Habitat | All 3 species of grouse and the wild turkey are dependent on forests for some of their life requisites. However, preferred habitat is typically described as young, immature, or open, and activity is frequently associated with forest openings and edges (Boag and Schroeder 1992, Eaton 1992, Connelly et al. 1998, Rusch et al. 2000; see Table 4.2b). |
| Effects of forest management | Forest management operations are rarely cited as principle threats to grouse or wild turkey populations (e.g., Boag and Schroeder 1992, Eaton 1992, Connelly et al. 1998, Rusch et al. 2000). Because all species either use young forest, open forest, forest openings, or edges, forest harvesting is generally viewed as a tool for habitat improvement (e.g., Gullion 1984).<br><br>Forest management operations conducted during the breeding season have the potential to unintentionally disturb or destroy nests. However, no research has documented the effects of forest management operations on the fate of individual nests nor attempted to quantify subsequent population effects. Moreover, because preferred nesting habitat tends to be young or non-forested, a small proportion of nests is likely to be disturbed in any year and effects on population viability are likely minimal. |
| Past direction | No species-specific direction. |

**Table 4.2b. Summary of status, habitat, nest sites, and egg dates for upland gamebirds found in the AOU in Ontario.**

| **Species** | **Status** | **Breeding habitat** | **Nest site** | **Median egg dates** | **References** |
|---|---|---|---|---|---|
| Ruffed grouse | S5/G5 | Young & immature hardwood or mixedwood forest. | Scrape at base of tree or shrub or beside/beneath stumps, logs, or other woody debris. Not reused. | May 14 - 28 | Peck and James 1983, Rusch et al. 2000 |
| Sharp-tailed grouse | S4/G4 | Open habitats dominated by herbaceous cover and shrubs, typically cutovers and bogs. | Scrape lined with vegetation under shrubs or small trees. Not reused. | No data for Ontario | Connelly et al. 1998 |
| Spruce grouse | S5/G5 | Conifer forest of | Scrape at base of tree | May 29 – | Peck and |

| | | | | | |
|---|---|---|---|---|---|
| | | various ages, especially young jack pine. | or beneath logs or other woody debris. Not reused. | June 13 | James 1983, Boag and Schroeder 1992 |
| Wild turkey | S4/G5 | Open hardwood forest, especially with mast-producing trees and scattered openings. | Scrape at base of tree or under woody debris. Not reused. | No data for Ontario | Eaton 1992 |

**Rationale for direction**

Grouse and wild turkeys are valued as game animals. Coarse filter direction in the *Landscape Guide* and Section 3 of this guide ensures a continuous supply of habitat. Nests are protected from destruction by the *Fish and Wildlife Conservation Act 1997*. Thus, direction focuses on minimizing disturbance of individual nests containing eggs encountered during operations.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Known nests of grouse and wild turkeys containing eggs encountered during operations will not be destroyed. | The *Fish and Wildlife Conservation Act 1997* prohibits the destruction of grouse and wild turkey nests. Thus, forest management operations will not destroy known nests containing eggs. In this context, destruction is interpreted to mean the complete or partial damage of the nest structure or its contents (i.e., attendant birds or eggs). |
| *Guideline* - Reasonable efforts will be made to minimize disturbance of known nests of grouse and wild turkeys containing eggs encountered during operations. | There is no information on how nesting grouse or wild turkeys react to different forest management operations, or the consequences of disturbance. Reactions and consequences are likely highly context-specific. Thus, direction to minimize disturbance is a *Guideline* rather than a *Standard. Best management practices* that are likely to minimize the risk of disturbing nesting grouse or wild turkeys are provided. |
| *Best management practices* | There is little published information on flushing distance for grouse or wild turkeys. One study in Vermont found that wild turkeys typically flushed from nests when pedestrians approached to within 5 m (Wallin 1983). Anecdotal information suggests most grouse and turkeys remain on their nests until closely approached, relying on their cryptic plumage to avoid detection (Atwater and Schnell 1989, Dickson 1992). Even if flushed by humans, reoccupation rate of nests, or frequency of renesting, tends to be high (e.g., Wallin 1983, Hannon et al. 1993, Westemeier et al. 1998). Thus, grouse and turkeys appear to behave very much like ground-nesting waterfowl so it is assumed that disturbance of nesting birds will normally be minimized if forest management operations can avoided within 10 m of occupied nests. |

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**4.2.2.8 Continued**

**Background**

| **Species group** | **Songbirds and other small birds** |
|---|---|
| Description | About 100 species of passerines (songbirds) and other small (body mass typically <250 g) non-passerine birds ranging from hummingbirds to woodpeckers nest within forested habitats found within the AOU (see Cadman et al. 2007). |
| Habitat | Passerines and small non-passerines nest within all types and development stages of forest within the AOU (see D'Eon and Watt 1994, Bellhouse and Naylor 1997).<br><br>Nests may be located on the ground, in burrows, in/on root wads, stumps, or coarse woody material, in shrubs or trees, or in cavities (Peck and James 1983, 1987). Most nesting activity occurs during May through July. |
| Effects of forest management | Forest management operations conducted during the breeding season have the potential to unintentionally disturb or destroy nests. However, no research has documented the effects of forest management operations on the fate of individual nests nor attempted to quantify subsequent population effects. Moreover, only about 1.5% of the productive forest within the AOU is disturbed by harvest, renewal, or tending operations each year (e.g., see OMNR 2004) and the majority of this area is disturbed outside the nesting season. When considering the complete suite of activities (including fire suppression), forest management operations may actually have a net positive effect on the survival of individual nests since more occupied nesting habitat would presumably be affected by uncontrolled wildfires on an annual basis than by harvest, renewal, and tending operations.<br><br>Forest management operations also affect populations of birds by altering the composition and structure of habitats used by birds. At fine scales, harvest (and to a lesser extent, renewal and tending) immediately modifies individual patches of habitat, leading to changes in the composition of the local bird community. Species of younger forest typically increase while those of older forest typically decrease, regardless of silvicultural system (e.g., selection, Jobes et al. 2004; shelterwood, Kingsley and Nol 1999; clearcut, Welsh 1981). The magnitude of these changes is generally proportional to the intensity of harvest (Annand and Thompson 1997, Costello et al. 2000, King and DeGraaf 2000). Local bird communities tend to respond in a relatively similar manner to harvest and agents of natural disturbance, with some significant differences (Schulte and Niemi 1998, Hobson and Schieck 1999, Imbeau et al. 1999). At broader scales, the frequency and pattern of harvest, and subsequent silvicultural activity, influences the mosaic of habitats created across landscapes that support populations of birds (Drapeau et al. 2000, Lichstein et al. 2002, Thompson et al. 2003). Preliminary results from a recent study across boreal Ontario suggest that the bird communities in harvested and naturally disturbed landscapes are remarkably similar (Zimmerling 2004). Moreover, population trends of forest-dwelling birds in Ontario are generally stable or increasing at large landscape scales (Blancher et al. 2009). |
| Past direction | No species-specific direction. |

**Rationale for direction**

The *Landscape Guides* provide direction to create landscapes that have a composition and structure within the range of variation produced by natural disturbance regimes. Direction in Section 3 of this guide attempts to provide structural habitat features that are required by many species of birds and that might be produced by natural disturbance but not by standard silvicultural practices (e.g., cavity trees for woodpeckers). This type of *coarse filter approach* to the conservation of habitat for most songbirds is advocated by the draft Landbird Conservation Plans for boreal and GLSL forest regions. Moreover, habitat requirements of songbirds that are *species at risk* receive special recognition in Section 4.3 of this guide.

Nests are protected from destruction by the *Migratory Birds Convention Act 1994*. Thus, direction focuses on protecting nests containing eggs or young encountered during operations.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Known nests of songbirds or other small birds containing eggs or young encountered during operations will not be destroyed. | The *Migratory Birds Convention Act 1994* prohibits the destruction of migratory bird nests. Thus, forest management operations will not destroy known nests containing eggs or young. In this context, destruction is interpreted to mean the complete or partial damage of the nest structure or its contents (i.e., attendant birds, eggs, or young). |
| *Guideline* - Reasonable efforts will be made to minimize disturbance of known nests of songbirds or other small birds containing eggs or young encountered during operations. | There is no information on how nesting songbirds or other small birds react to different forest management operations, or the consequences of disturbance. Reactions and consequences are likely highly context-specific. Thus, direction to minimize disturbance is a *Guideline* rather than a *Standard. Best management practices* that are likely to minimize the risk of disturbing nesting songbirds or other small birds are provided. |
| *Best management practices* | There is little published information on flushing distance for nesting songbirds or other small birds. One study in Missouri found that most songbirds remain on their nests unless approached to within a few meters (Burhans and Thompson 2001). Moreover, incidental non-destructive disturbance of songbird nests does not appear to adversely affect reproductive success or site fidelity (e.g., Mayer-Gross et al. 1997, Farnsworth and Simons 1999, Perkins et al. 2004). Thus, it is assumed that disturbance of nesting birds will normally be minimized if forest management operations can avoided within 3 m of occupied nests. |

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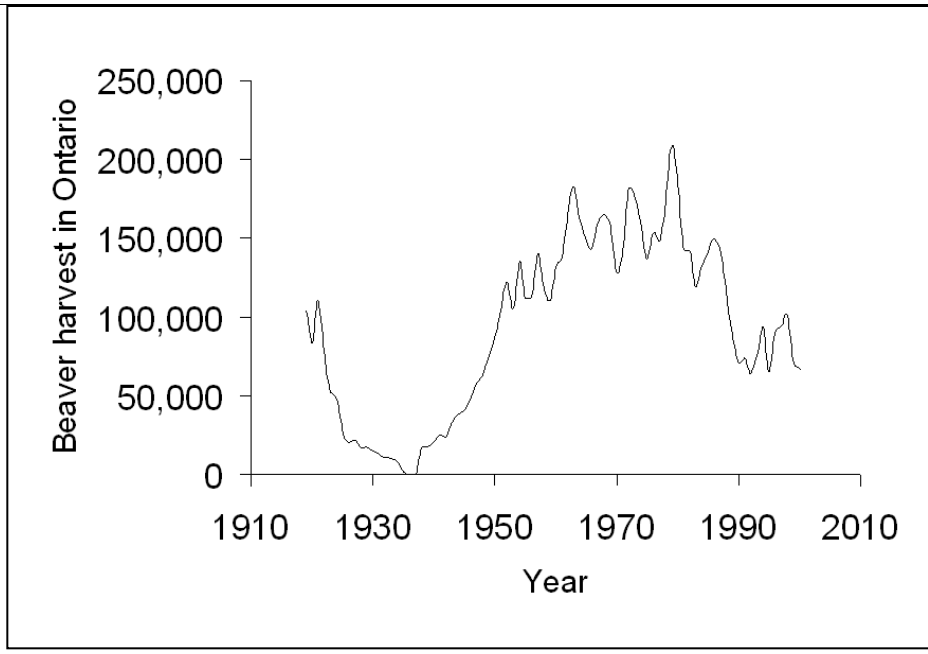
### 4.2.3 Beaver habitat

**Background**

| **Value** | **Beaver habitat** |
|---|---|
| Description | Beaver habitat is characterized by a stable, permanent body of water adjacent to a supply of suitable and accessible forage (Allen 1983, Novak 1987). Although beavers will occupy large lakes with irregular shorelines and slow moving rivers, small bodies of water (<8 ha in size) are generally considered to represent optimal habitat (Allen 1983, Novak 1987). Suitable impoundments are frequently created by damming small streams (Novak 1987). Beavers feed on a wide range of herbaceous and woody vegetation (Novak 1987), but the supply of preferred woody vegetation that can be cached for winter feeding may be limiting (Allen 1983). In northeastern North America, both trembling and large-toothed aspens are typically preferred species (e.g., Johnston and Naiman 1990, Barnes 1997, Gallant et al. 2004). Most foraging occurs within about 50 m of water (Allen 1983, Novak 1987, Martell et al. 2006), likely in response to energy required to transport cut trees and the risk of predation (Basey and Jenkins 1995, Barnes and Mallik 2001).<br><br>Ponds created by beavers cycle through a predictable successional pathway that is directly linked to food supply (Novak 1987, Snodgrass 1997, Schlosser and Kallemeyn 2000). Beavers initially establish ponds where there is an adequate supply of forage (Slough and Sadleir 1977). Newly flooded ponds are characterized by an interspersion of open water and emergent, floating and submerged plants (newly flooded phase). As beavers begin to remove accessible shoreline forage, they raise the water level of the pond to access additional riparian vegetation. Higher water levels lead to reduced aquatic plant production; ponds become characterized by primarily open water (stagnant phase). As beavers continue to feed selectively on woody vegetation in the riparian zone, they remove preferred forage species such as aspen, gradually causing an increase in the amount of less palatable and more shade tolerant woody plants such as balsam fir (Johnston and Naiman 1990, Donkor and Fryxell 1999, Barnes and Mallik 2001). As food supply is exhausted, ponds are abandoned. Dams eventually break and ponds drain (de-watering phase). Drained ponds become invaded by grasses, sedges, herbs, and shrubs, forming a ‘beaver meadow’. If shorelines are disturbed and preferred forage species are regenerated, the site may be reoccupied; the cycle may take from decades to centuries (see references in Martell et al. 2006).<br><br>There is a growing concern among many biologists and trappers that beavers may be declining in Ontario, although the evidence is not conclusive. For example, provincial harvest of beavers has shown a huge decline since the 1970s (Fig. 4.2b) and roughly a 2% decline per year since about the mid 1990s (OMNR fur harvest data). Since harvest may be influenced by many factors, this trend is not unequivocal proof of a population decline. However, beaver quota, which is based on estimates of the number of active lodges on traplines, has also declined by a roughly similar rate since the mid 1990s (OMNR fur harvest data). Moreover, in Algonquin Park, where aerial beaver surveys have been replicated through time, sharp declines in the density of active beaver lodges have been noted over the past 30-40 years (Quinn 2004). |

| | |
|---|---|
| | <br><br>**Fig. 4.2b. Harvest of beavers in Ontario from circa 1920 to 2000 (prepared by Bowman[1], using data from Statistics Canada, catalogue 23-013-XIE).**<br>Many factors including weather, predation, and disease could potentially have contributed to this recent apparent decline (see Novak 1987 for a discussion of factors responsible for past beaver declines). However, there is increasing speculation that fire suppression, in combination with limited shoreline harvesting, has interrupted the natural cycle of beaver pond development, and may at least partly explain this decline (*sensu* Quinn 2004). |
| Ecological significance | The beaver is widely considered to be a keystone species (Collen and Gibson 2001, Martell et al. 2006); the mosaic of habitat conditions (newly flooded ponds, stagnant ponds, de-watered ponds, and beaver meadows) it creates across watersheds leads to increased species richness of both plants and animals (Snodgrass 1997). Beaver ponds are used by a wide range of vertebrates including muskrats, minks, raccoons, deer, moose, woodcocks, wild turkeys, and ruffed grouse (Novak 1987), but are especially important as breeding habitat for boreal anurans (Stevens et al. 2007), nesting habitat for herons (Peck and James 1983), and feeding habitat for dabbling ducks (Rempel et al. 1997, Gabor et al. 2002).<br>Many species that frequently inhabit beaver ponds appear to be declining. For example, in the latest Breeding Bird Atlas, American black ducks and great blue herons have shown a 22% and 37% province-wide decline in the probability of observation, respectively (Cadman et al. 2007). Similarly, rusty blackbirds and olive-sided flycatchers have shown a 32% and 35% decline in specific regions, respectively. Causes of these declines are complex and likely affected by multiple factors. While these species are not restricted to beaver ponds, a declining supply of beaver pond habitat (see above) might be a contributing factor.<br>Beaver ponds have both positive and negative effects on game fish (see review by Collen and Gibson 2001). For example, dams may obstruct movement of fish, potentially 'fragmenting' populations. Ponds created by beavers generally |

[1] Jeff Bowman, OMNR, Wildlife Research and Development Section, Peterborough, ON

| | |
|---|---|
| | have higher water temperatures than the original streams, potentially leading to replacement of cold water species by warmer water species (although ponds appear to have minimal effect on upstream and downstream temperatures; Ham et al. 2006). However, beaver ponds also can create important resting, feeding, and wintering habitat for a variety of species, including cold water fish such as brook trout. Moreover, overall productivity and diversity of fish communities in headwater streams is positively related to the mosaic of beaver ponds found in various stages of succession (Schlosser 1995, Schlosser and Kallemeyn 2000).<br><br>Beaver ponds influence many aspects of the hydrology of stream ecosystems. For example, they may stabilize stream flow and alter the dynamics of nutrient and sediment movement (Naiman et al. 1988, Snodgrass 1997, Collen and Gibson 2001).<br><br>Foraging by beavers also dramatically alters forest composition and structure adjacent to waterbodies (Johnston and Naiman 1990, Donkor and Fryxell 1999, Barnes and Mallik 2001, Martell et al. 2006). Although individual lodges affect a relatively small area of forest, through time, populations may cumulatively affect up to 15% of a forested landscape (Naiman et al. 1988). |
| Past direction | OMNR (1986) recommended that 50% of the shoreline around beaver ponds be harvested to produce beaver food using strip cuts at least 40 m wide. OMNR (1998a,b) suggested clearcutting the shoreline on one side of beaver ponds to regenerate beaver foods in a manner that more closely matches a natural pattern. |

**Rationale for direction**

The beaver is a keystone species; beaver ponds are especially important habitats for waterfowl, herons, and breeding anurans. Possible declines in beavers and beaver pond habitat may be linked to fire suppression and past retention of unharvested shoreline forest around ponds. General direction for lakes, ponds, rivers, and streams (Section 4.1) encourages management within shoreline AOCs to create early successional forest required by beavers. This section supplements the general direction in Section 4.1, providing specific direction for beaver ponds that have been identified as requiring special management and focuses on regeneration of food supply, specifically intolerant hardwoods such as trembling and large-tooth aspens.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Guideline* - Harvest, renewal, and tending operations within the AOC should promote establishment or perpetuation of intolerant hardwood or mixedwood FUs, to the extent practical and feasible, unless inconsistent with other ecological objectives. | Since both trembling and large-toothed aspens are the preferred forage species (see above), harvest, renewal, and tending operations within the shoreline AOC should promote establishment or perpetuation of intolerant hardwood or mixedwood FUs, to the extent practical and feasible (see *Best management practices* for details). |

<table>
<tr>
<td>Best management practices</td>
<td>
Clearcuting is generally recommended for the regeneration of shade intolerant hardwoods such as aspens (OMNR 1997a,b). As a minimum, Ducks Unlimited suggests regenerating a patch of intolerant hardwood or mixedwood forest (preferably dominated by aspen) that is 200 m along the shore and 50 m deep adjacent to beaver ponds (Steele[1], pers. comm. 2006).
A colony of beavers harvests about 8 tonnes of woody vegetation (mainly intolerant hardwoods) per year (Johnston and Naiman 1990). Mature intolerant hardwood-dominated forest typically contains about 50 to 120 tonnes of potential food/ha[1]. Thus, a 1 ha patch of mature intolerant hardwood-dominated forest should contain sufficient food to sustain a beaver colony for about 6 to 15 years.
When the surrounding upland forest is being clearcut, harvest can simply be extended into the riparian zone. Harvest should be conducted as close to the edge of water as practical and feasible; in Quebec clearcut harvest had little impact on beaver abundance when a 20 m strip of unharvested forest was retained along shorelines (Potvin et al. 2005). Harvest can be conducted at any time of year but winter harvest will promote slightly better poplar suckering (Burns and Honkala 1990).
Clearcut harvest should focus on sites appropriate for intolerant hardwood establishment, where there is a limited understory of shade tolerant conifers, and where there is sufficient mature intolerant hardwood (especially aspen) in the overstory to ensure a reasonable likelihood of successful regeneration. For aspen, Perala (1977) suggested a minimum of about 125 stems/ha or 5 $m^2$/ha (about 15% of the basal area).
Neither selection nor shelterwood harvest is recommended to regenerate intolerant hardwoods such as aspen (OMNR 1997a,b). Heavy partial harvesting (basal area around 12 $m^2$/ha) can produce stands with a component of intolerant hardwood regeneration but density of regeneration is significantly less than that produced by clearcuts (Palik et al. 2003). Thus, when the surrounding upland forest is being shelterwood- or selection-cut, tree markers should delineate patches of intolerant hardwood, mixedwood, other conifer, or poor quality pine or hardwood shoreline forest within 50 m of ponds that could be harvested using small patch cuts or group selection openings (>0.1 ha, and preferably >0.2 ha in size; see OMNR 2004).
In all cases, cuts created to produce food for beavers should not be chemically tended.
To maintain some existing food supply, some immature or mature intolerant hardwood or mixedwood forest should be retained if possible as residual forest. If residual forest will receive a partial harvest, as much intolerant hardwood should be retained as possible.
[1] Intolerant hardwood-dominated forest in boreal Ontario (comprised of 50 to 100% intolerant hardwoods) that is mature (50 to 100 years of age) typically supports a net merchantable volume of about 50 to 170 $m^3$/ha of intolerant hardwoods (Penner 2003). This translates to about 50 to 120 tones of biomass/ha (Song[2], unpubl. data).
</td>
</tr>
</table>

[1] Owen Steele, Ducks Unlimited Canada, Ontario Region, Barrie, ON
[2] Alex Song, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC

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### 4.2.4 Moose aquatic feeding areas and mineral licks

**Background**

| **Value** | **Moose aquatic feeding areas and mineral licks** |
|---|---|
| Description | In early summer, moose frequent aquatic habitats (*moose aquatic feeding areas;* MAFAs) where they forage on submerged and floating aquatic plants that are rich in sodium such as pondweeds and water lilies (Jordan et al. 1973, Fraser et al. 1980). Aquatic feeding areas are typically associated with shallow lakes, slow-moving rivers, shallow bays of deep lakes, and beaver ponds. Suitability of MAFAs is rated based on the type and amount of aquatic vegetation present, as well as by accessibility to moose (Ranta 1998).<br><br>Moose may also meet some of their annual sodium requirements by consuming muddy water found in mineral-rich springs called *mineral licks*. Mineral licks, muddy puddles fed by slow seeping springs, range from a few square meters to >500 m$^2$ in size (Chamberlin et al. 1977, Fraser 1980, Fraser and Reardon 1980). Moose typically visit mineral licks before sodium-rich aquatic vegetation becomes available in early summer. However, where aquatic feeding areas are limited, mineral licks may receive greater use (Jordan et al. 1973, Risenhoover and Peterson 1986, Couturier and Barrette 1988).<br><br>Known mineral licks are rare in Ontario, at least partly because they rarely occur in areas of granitic bedrock, except where overlain by calcareous glacial till (Jackson et al. 1991); natural mineral licks tend to be more common in northwestern than northeastern Ontario. |
| Ecological significance | Aquatic vegetation and the areas that provide aquatic forage appear to be important components of moose habitat. Aquatic vegetation may represent half the daily biomass consumed by moose in early summer and may provide >90% of the annual sodium requirements (Jordan et al. 1973; Belovsky and Jordan 1978, 1981). Individual MAFAs may be used by large numbers of moose (Cobus 1972, Fraser et al. 1980); moose may travel up to 30 km to reach aquatic feeding habitat (Fraser et al. 1980). Moreover, the supply of MAFAs may influence carrying capacity of landscapes (Allen et al. 1987).<br><br>In some parts of its range, mineral licks may represent a significant source of sodium and may influence the dispersion and health of moose populations (see review in Rea et al. 2004). However, given the relative rarity of mineral licks in Ontario, their significance to habitat carrying capacity is uncertain. |
| Effects of forest management | It is generally assumed that aquatic feeding areas receive more use by moose when adjacent forest provides security or thermal cover (Jackson et al. 1991) or a connection to other uncut forest (Timmerman and Racey 1989).<br><br>Preliminary analysis of a sample of 156 MAFAs used by radio-collared moose as part of the Moose Guidelines Evaluation Project (MGEP) suggests that used sites averaged between 45 and 55% residual shoreline forest within 30 to 200 m of the MAFA. However, MAFAs used by moose did not differ from those generally available within the study area (N=2251) in northwestern Ontario in the amount of residual shoreline forest (Rodgers[1], unpubl. data). |

[1] Art Rodgers, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

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| | Moreover, in the Manitou Lakes area of northwestern Ontario, Berube (2000) found no significant difference in factors such as distance to cover or density of shoreline forest among 50 MAFAs classified as high, medium, or low use by moose; although high use MAFAs did appear to be closer to cover (mean 32 m) than medium or low use MAFAs (means 42-56 m).<br><br>The results from the MGEP and Berube (2000) suggest that moose may not distinguish among MAFAs based on the amount of adjacent residual forest (although use may be influenced by availability of summer thermal cover – see Section 3.3.4). Factors such as size, depth, substrate, and amount of preferred aquatic vegetation may be as or more important in influencing intensity of moose activity at MAFAs (Joyal and Scherrer 1978, Brusnyk and Gilbert 1983, Fraser et al. 1984, Timmerman and Racey 1989, Berube 2000).<br><br>The effect of forest harvesting on use of MAFAs by moose is unclear. In a small study of 9 sites in Chapleau, Brusnyk and Gilbert (1983) found no significant difference in summer use of shorelines by moose that had been clearcut, protected by a 70-80 m reserve, or had not experienced any cutting. Buckland and O'Brien (1988) noted that summer use of shoreline reserves appeared to be inversely related to reserve width (30 to 120 m) around 10 MAFAs studied in Chapleau. In a study of 24 sites in Temagami, there was no clear relationship between number of moose or trails observed within MAFAs and width of reserve (Kennedy 1988). However, in a study of 159 MAFAs in the Algonquin Park, French-Severn, and Spanish FMUs, Chikoskie (2003) found a positive relationship between use of shoreline forest adjacent to MAFAs and reserve width in 2 of 3 FMUs. A threshold width of about 60 m was suggested by her data (Rodgers and Chikoskie 2004). However, there was no relationship between number of trails that actually entered the MAFA (one index of use of the MAFA) and reserve width (Chikoskie[1], unpubl. data).<br><br>There is little information on the effect of forest management operations on use of mineral licks by moose (see review in Rea et al. 2004). |
| Past direction | OMNR (1988) recommended a 120 m reserve around MAFAs and mineral licks. OMNR (1998a, b) modified this direction for the GLSL forest. The study by Chikoskie (2003) (see above) was a test of the effectiveness of this direction for MAFAs. |

**Rationale for direction**

Moose are provincially featured species. MAFAs and mineral licks are important habitat features and supply (of MAFAs at least) may influence carrying capacity. Thus, all mineral licks and class 2-4 MAFAs should be considered values. Evidence that some harvesting of shoreline forest adjacent to MAFAs influences use of MAFAs is equivocal (see above). There is little support for the 120 m reserve specified by OMNR (1988). Thus, no specific AOC is prescribed for individual MAFAs. Instead, direction for aquatic features (Section 4.1) encourages retention of residual shoreline forest adjacent to special habitat features such as MAFAs. Section 4.2.4 outlines factors to consider when selecting residual forest in proximity to MAFAs.

The rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Best management* | The MGEP (see above) suggests MAFAs used by moose typically had |

[1] Jennifer Chikoskie, OMNR, Northwest Region, Thunder Bay, ON

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| *practices* | about 50% residual shoreline forest surrounding the MAFA. Moreover, Chikoskie's study (see above) suggests some influence of width of shoreline forest on use by moose and a possible threshold around 60 m. Thus, general direction for aquatic habitats (30-90 m AOC with at least 50% of AOC maintained as residual forest; Sections 4.1.1 and 4.1.2) should suffice if residual shoreline forest is preferentially located adjacent to MAFAs. BMPs are provided to help determine where to locate residual shoreline forest with respect to MAFAs based on characteristics of MAFAs and associated shoreline forest that are most likely to be used by moose.<br><br>In northwestern Ontario, moose showed a preference for MAFA's ranked moderate or higher (based on the methodology described by Ranta 1998) that were large in size (>4 ha and preferably >8 ha (Rodgers[1], unpubl. data)). Features that restrict access such as steep terrain are considered to affect likelihood of MAFA use (Ranta 1988). Residual shoreline forest that provides screening from roads may affect likelihood of MAFA use. Residual shoreline forest that provides a travel corridor or connection to uncut forest may affect likelihood of MAFA use (Timmerman and Racey 1989). Proximity of residual shoreline forest to aquatic vegetation may affect likelihood of MAFA use (Berube 2000). |

There is little information on the effects of harvesting on use of mineral licks (see above). Given the potential significance, but relative scarcity, of mineral licks, the direction provided by OMNR (1988) is retained.

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**4.2.5 Dens**

**Background**

| **Species** | **Black bear** |
|---|---|
| S-rank | S5/G5 |
| Designation | Not at Risk |
| Trend – CDN | Stable |
| Trend - ON | Stable |
| Distribution | Occurs from Alaska to Newfoundland south to Florida and northern Mexico (Banfield 1974). In Ontario, common throughout the AOU (Dobbyn 1994). |
| Habits and habitat | Black bears are habitat generalists that benefit from a mosaic of forest types varying in composition and age. Home ranges are ideally a mix of lowland forest and alder swamps that provide grasses and herbaceous vegetation and thermal cover in spring, early to mid-successional forest that provides soft mast (e.g., blueberries, raspberries, cherries) during summer, and mature forest that provides hard mast (acorns, beech nuts, hazel nuts) or soft mast (berries from mountain-ash, dogwood, or viburnums) in the fall prior to hibernation (Rogers and Allen 1987, Rogers et al. 1988, Rogers and Lindquist 1991).<br><br>Within this general mosaic of habitat conditions, bears have 2 key site-specific requirements: dens and sanctuary or refuge trees.<br><br>Black bears use dens as hibernation sites. Cubs are also born within dens during the hibernation period. Black bears may use a wide variety of natural structures as dens from hollow trees to logs to caves (see review in Linnell et al. 2000). However, throughout the boreal and GLSL forest, dens are typically excavated into a mound or brush pile or under the root-mass of a fallen tree (Tietje and Ruff 1980, Kolenosky and Strathearn 1987, Brown et al. 1999). Excavated dens are infrequently reused in most areas (Tietje and Ruff 1980, Alt and Gruttadauria 1984, Kolenosky and Strathearn 1987; but see Schwartz et al. 1987).<br><br>Pregnant females tend to select den sites close to large-diameter, rough-barked trees called *sanctuary* or *refuge trees.* These trees are usually supercanopy white pines or hemlocks in the GLSL forest (Rogers et al. 1988, Rogers and Lindquist 1992) or large spruces or cedars in the boreal forest (Obbard[1], pers. comm. 2006). After emerging from dens in the spring, sows with cubs often bed at the base of sanctuary trees. If a dangerous situation arises, cubs are sent up the tree for protection. Sows will also send cubs up these trees while they are away foraging. |
| Effects of forest management | Forest management operations generally have a positive effect on habitat suitability, especially when they create a mosaic of early successional forest that provides a diversity of soft mast-producing shrubs interspersed with residual forest that functions as cover (Rogers and Allen 1987, Rogers et al. |

[1] Martyn Obbard, OMNR, Wildlife Research and Development Section, Peterborough, ON

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| | 1988).<br>There is no information on the direct effects of forest management operations on the use of dens. However, bears typically avoid roads and other sources of human activity when locating dens (although they have been known to den within 100 m of snowmobile trails; Manville 1987) and invasive human activities can cause den abandonment (see review Linnell et al. 2000).<br>Most bears disturbed by human activities will re-den, but disturbed bears may suffer increased energy costs (Linnell et al. 2000). Moreover, den abandonment may result in mortality of newborn cubs (Elowe and Dodge 1989, Graber 1990, Goodrich and Berger 1994). The likelihood of den abandonment appears to be inversely related to the length of time the bear has been denned (Beecham et al. 1983, Smith 1986, Kolenosky and Strathearn 1987). For example, Smith (1986) found that 67% of dens disturbed by observers during the first 2 weeks of use were abandoned while no dens disturbed after 1 month of use were abandoned. |
| Past direction | No species-specific direction. However, black bears were generally considered to benefit from the direction for moose (OMNR 1988) and tree marking direction for retention of mast trees and supercanopy trees (OMNR 2004). |

**Rationale for direction**

Occupied bear dens are protected by the *Fish & Wildlife Conservation Act 1997*. Dens are normally not reused. Thus, direction identifies only occupied dens as AOCs and focuses on mitigating disturbance.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - 100 m radius AOC centred on the den entrance. | Linnell et al. (2000) recommended no human activities within 1 km of occupied bear dens. However, this direction was prescribed generically for all North American bear species. For black bears, Linnell et al. (2000) suggested that disturbance thresholds were variable, but that activities within 100 m were often sufficient to cause some den abandonment. Similarly, Goodrich and Berger (1994) and Manville (1983) noted that some black bears abandoned dens when observers approached to within 75 or 125 m, respectively. Moreover, Smith (1986) suggested that bears would not abandon ground dens (the most sensitive sites in his study) if observers stayed 50 to 100 m from dens. Thus, a 100 m AOC is prescribed based on this literature and the recommendation of Obbard[1] (pers. comm. 2006). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to timing | Since dens are rarely reused, direction focuses on restriction of operations in the vicinity of dens only while occupied. |

[1] Martyn Obbard, OMNR, Wildlife Research and Development Section, Peterborough, ON

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| restrictions. | |
| *Guideline* - Harvest, renewal, and tending operations involving heavy equipment are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Noise and ground vibration created by heavy equipment are considered to have the greatest potential to disturb denning bears. Thus, harvest, renewal, and tending operations involving heavy equipment are not permitted within the AOC during the entire *denning period.* |
| *Guideline* - Other harvest, renewal, and tending operations that might potentially disturb denning bears are not permitted within the AOC during the first 4 weeks of the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Bears are likely most sensitive to disturbance during the first few weeks after entering dens (see above). Thus, additional restrictions are placed on ‘other’ activities (e.g., pedestrian activities) during the first 4 weeks of the *denning period*. |
| *Guideline* - The *denning period* generally lasts from October 15 to April 30, but exact dates vary depending on a variety of factors including latitude and weather. Local knowledge of denning chronology may be used to adjust these dates. | The timing of den entry and emergence varies among age and sex classes of bears and among years (Linnell et al. 2000). In central Ontario, bears typically enter dens in late October and emerge in mid-April (Kolenosky and Strathearn 1987). In the boreal forest, timing of entry and emergence is typically 1-2 weeks earlier (entry) or later (emergence) (Obbard[1], pers. comm. 2006). Thus, a timing restriction from October 15 to April 30 should cover the denning period for the majority of the AOU. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as | See rationale for restricting harvest, renewal, and tending activities involving heavy equipment during the *denning period*. |

[1] Martyn Obbard, OMNR, Wildlife Research and Development Section, Peterborough, ON

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| specifically identified and justified through the FMP AOC planning process. | |
| *Guideline* - Hauling and road maintenance operations are not permitted within the AOC during the *denning period*, unless the road predates the den, is required for safety reasons or environmental protection, or except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restricting harvest, renewal, and tending activities involving heavy equipment during the *denning period*.<br>There is no restriction on hauling or road maintenance operations if the road predates the den. This direction assumes that bears that den adjacent to existing roads are tolerant of these operations. |

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**4.2.5 Continued**

**Background**

| **Species** | **Grey fox** |
| --- | --- |
| S-rank | SZB?/G5 |
| Designation | *Threatened* |
| Trend – CDN | Most of the range occurs in Ontario; see Trend - ON. |
| Trend - ON | Archaeological evidence suggests the species was almost as common as the red fox in southern Ontario prior to European colonization. Apparently extirpated from its Canadian range >350 years ago. Began to reappear in Ontario in the 1930s and 1940s. Trend in Ontario uncertain but appears to be increasing in states bordering the Great Lakes (COSEWIC 2002). |
| Distribution | Occurs from Maine to Oregon, south to Colombia and Venezuela. In Canada, found primarily in 3 locations: 1) the Rainy River District of Ontario and southern Manitoba, 2) along the north shore of Lake Erie, and 3) along the northeastern shore of Lake Ontario to the eastern townships of Quebec. However, the only confirmed breeding records are from Pelee Island (COSEWIC 2002). |
| Habits and habitat | A habitat generalist (COSEWIC 2002). Little information for Ontario. In the US, makes considerable use of forested habitats (Haroldson and Fritzell 1984, Chamberlain and Leopold 2000); presence may be influenced by the amount of woodland in some areas (Harrison 1993). However, generally appears to prefer a mosaic of woodlands interspersed with open areas or farmland (Fritzell and Haroldson 1982, Frtizell 1987). May benefit from habitat fragmentation (Crooks 2002) and may occupy home ranges with no wooded habitat (Fuller 1978).<br>Uses dens as refuge sites throughout the year but makes greatest use of dens during whelping and pup rearing (Fritzell 1987). Natal and maternal dens may be associated with hollow logs or trees, rocks and rock outcrops, burrows, abandoned buildings, or brush/debris piles (Fritzell 1987), typically in brushy or wooded habitats (Fritzell and Haroldson 1982), and usually close to a permanent source of water (Sullivan 1956). Reuse of natal/maternal dens not reported. |
| Effects of forest management | No information on the effects of forest management operations.<br>Invasive human activities around dens may cause females to move litters to new sites (Nicholson et al. 1985). However, appears to be able to tolerate considerable human activity, often persisting in low density residential areas and denning close to houses and roads (Harrison 1997). In California, human-altered habitats were often used more than expected (Fuller 1978) and activity was positively associated with urban edges (Crooks 2002). |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Threatened* species. General habitat requirements likely addressed by coarse filter direction. Uses a wide array of both enduring and transient structures for denning with no evidence of fidelity to den sites. Thus, direction identifies only occupied dens as AOCs and focuses on mitigating disturbance; den structures are protected by general direction for dens of furbearing mammals (CROs).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 100 m radius AOC centred on the den entrance. | No information in the literature to suggest appropriate size of AOCs to mitigate potential effects of disturbance. However, the grey fox appears to be considerably more tolerant of human activity than are wolves. Thus, the AOC for wolves is halved. |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the general direction for the protection of dens of furbearing mammals. | Since dens are rarely reused, direction focuses on restriction of operations in the vicinity of dens only while occupied. Den structures are protected by general direction for dens of furbearing mammals. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | There is no information on how grey foxes react to different types of forest management operations. Thus, as a precautionary approach, no harvest, renewal, and tending operations are not permitted within the AOC during the *denning period.* |
| *Guideline* - The *denning period* is April 15 to September 15 in the AOU. Local knowledge of denning chronology may be used to adjust these dates. | Pups are generally born mid-April to mid-May and weaned by about 4 months of age (Fritzell and Haroldson 1982, Fritzell 1987). Thus, the *denning period* is defined as April 15 to September 15. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as specifically identified and justified through | See rationale for restrictions on harvest, renewal, and tending operations during the *denning period*. |

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| the FMP AOC planning process. | |
| *Guideline* - Hauling and road maintenance operations are not permitted within 50 m of the den during the *denning period* unless the road predates the den, is required for safety reasons or environmental protection, or except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Hauling and road maintenance operations are considered to have a relatively low potential impact on den use. Thus, hauling and road maintenance operations are only restricted within 50 m of occupied dens.<br>Hauling and road maintenance operations are not restricted if the road predates the den. This direction assumes that grey foxes that den adjacent to existing roads are tolerant of these types of operations. |

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**4.2.5 Continued**

**Background**

| **Species** | **Cougar** |
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| S-rank | SH |
| Designation | *Endangered* |
| Trend – CDN | Historic range extended across southern Canada from Nova Scotia to British Columbia (Banfield 1974). Thought to be largely extirpated from much of the eastern half of its former range (Lindzey 1987). |
| Trend - ON | Historically, ranged across southern Ontario and as far north as Lake Timiskaming. Thought to have been extirpated from the province by the 1860s. Since the 1930s, there have been hundreds of reports (mostly unconfirmed) across the province that may represent transients from the population in Manitoba or escaped zoo animals or pets (Gerson 1988, Dobbyn 1994). |
| Distribution | In the US and Canada, found primarily in western provinces and states, from the Yukon-British Columbia border to the Alberta foothills to Montana to New Mexico and west. Isolated populations in Manitoba and Saskatchewan (and possibly northwestern Ontario), southern Florida, and western Arkansas/eastern Oklahoma (Currier 1983, Lindzey 1987, Tischendorf and Henderson 1995). Scattered sightings across much of eastern North America (Bolgiano et al. 2000). |
| Habits and habitat | A habitat generalist. Occurs within a range of broad ecosystem types from deserts to montane forests to tropical rain forests (Currier 1983). Distribution and abundance generally linked to prey abundance and freedom from human interference (Berg et al. 1983, Currier 1983, Pike et al. 1999, Riley and Malecki 2001). Home ranges are large (typically >100 km$^2$) and encompass a mosaic of habitat conditions (e.g., Dickson and Beier 2002, Cox et al. 2006). Preferred vegetation types range from mixed swamp forests (Belden et al. 1988) to dry chaparral (Dickson and Beier 2002). Human-altered habitats (especially grasslands and agricultural fields) are generally avoided (Maehr and Cox 1995, Dickson and Beier 2002). Habitat selection is frequently associated with terrain ruggedness (Logan and Irwin 1985, Koehler and Hornocker 1991, Riley and Malecki 2001). Has been described as a 'forest obligate' in Florida (Meegan and Maehr 2002) but percent cover of forest was unrelated to home range size (Comiskey et al. 2002).<br><br>Reported to use caves, shallow nooks in rock cliffs, boulder piles, uprooted trees, and fallen logs as natal/maternal dens (Witmer et al. 1998). However, in a number of studies, den sites have simply been shallow depressions situated in dense (often described as 'nearly impenetrable') thickets of vegetation (Maehr et al. 1989, Beier et al. 1995, Benson et al. 2008). Dens may be selected to provide protection from rain, high ambient temperatures, or predators (Bleich et al. 1996, Witmer et al. 1998, Benson et al. 2008). Reuse of natal/maternal dens not reported. |
| Effects of forest management | Little information on the effects of forest management operations. Cougars avoided recently harvested areas in Arizona and Utah (Van Dyke et al. 1986a). Logan and Irwin (1985) speculated that clearcutting might reduce habitat |

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| | suitability by removing stalking cover, thereby reducing prey vulnerability. However, 'over-protection' of habitat resulting in development of older forest that did not support adequate densities of deer was considered to be a threat in Florida (Belden et al. 1988). Thus, forest harvesting that produces a mosaic of habitats that supports a high density of ungulates (especially deer) would presumably increase carrying capacity.<br><br>Cougars appear to avoid well-traveled roads (Van Dyke et al. 1986b, Dickson et al. 2005) and trails (Janis and Clark 2002) and place home ranges in areas of lower road density (Van Dyke et al. 1986a, Dickson and Beier 2002). However, dirt roads are not generally thought to impede movements, and may even facilitate travel (Van Dyke et al. 1986b, Dickson et al. 2005).<br><br>Cougars generally avoid areas with high human density (e.g., Pike et al. 1999). However, in some areas they appear to adapt to humans, learning to prey upon domestic livestock and pets (e.g., Torres et al. 1996).<br><br>While some human activities can influence cougar behaviour (e.g., Van Dyke et al. 1986a, Janis and Clark 2002), there is no information on the effects of human activities on occupancy of dens or reproductive performance. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Endangered* species. Coarse filter direction in the *Landscape Guide* and other sections of this guide that produces a mosaic of habitats that supports ungulate (especially deer) populations presumably beneficial to this species. Uses a wide array of both enduring and transient structures for denning with no evidence of fidelity to den sites. Thus, direction identifies only occupied dens as AOCs and focuses on mitigating disturbance; den structures are protected by general direction for dens of furbearing mammals (CROs).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - 200 m radius AOC centred on the den entrance. | Since there is no information on the effects of human disturbance on use of den sites (or appropriate mitigation), direction is based on that prescribed for wolves (see direction for wolves below). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the general direction for the protection of dens of furbearing mammals. | Since cougars appear to use a wide range of transient and permanent features as dens, and site fidelity is not reported, the direction applies to occupied dens only. Den structures are protected by general direction for dens of furbearing mammals. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the | There is no information on how cougars react to different types of forest management activities. Thus, as a precautionary approach, no harvest, renewal, and tending operations are not permitted within the AOC during the *denning period.* |

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| *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | |
| *Guideline* - Kittens are typically born between April and September, but occupied dens may be located at any time of year. Thus, the *denning period* is potentially different for each occupied den encountered and is considered to extend for 8 weeks from the date an occupied den is located, or until a den is known to be no longer occupied. | Kittens may be born throughout the year but most births occur from April to September. Den sites used for 6 to 8 weeks from birth to weaning (Currier 1983, Lindzey 1987). Thus, the *denning period* is potentially different for each occupied den encountered and is considered to extend for 8 weeks from the date an occupied den is located, or until a den is known to be no longer occupied. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *denning period*. |
| *Guideline* - Hauling and road maintenance operations are not permitted within 100 m of the den during the *denning period* unless the road predates the den, is required for safety reasons or environmental protection, or except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Hauling and road maintenance operations are considered to have a relatively low potential impact on den use. Thus, hauling and road maintenance operations are only restricted within 100 m of occupied dens.<br><br>Hauling and road maintenance operations are not restricted if the road predates the den. This direction assumes that cougars that den adjacent to existing roads are tolerant of these types of operations. |

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**4.2.5 Continued**

**Background**

| Species | Gray wolf |
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| S-rank | S4/G4 |
| Designation | The gray wolf species (*Canus lupus*) is considered to be Not at Risk. Considerable debate about the taxonomy of this species. The NHIC recognizes 2 subspecies in Ontario. The northern grey wolf (*C. l. occidentalis*) is considered to be Not at Risk. The eastern wolf (*C. l. lycaon*) is considered to be a species of *special concern*. |
| Trend – CDN | The range of the eastern wolf is considered to have declined by about 60% since presettlement times. However, genetic data suggest that the range of the eastern wolf in North America (and Ontario) is expanding while the range of the northern gray wolf may be declining (Grewal et. al. 2004). |
| Trend - ON | The population is currently estimated at about 8,850 and considered to be increasing or stable (OMNR 2005). |
| Distribution | The gray wolf occurs across Canada from Labrador to the Yukon (Banfield 1974). Within Ontario, it is found from Lake Simcoe to the shore of Hudson Bay (Dobbyn 1994).<br><br>Although the distributional boundary between northern gray and eastern wolves is poorly understood, northern gray wolves likely dominate the boreal forest and tundra regions of Ontario where deer are largely absent (OMNR 2005). The southern limit of eastern wolves seems to approximate the southern edge of the Canadian shield (Kolenosky 1983). |
| Habits and habitat | Wolves are habitat generalists (Theberge and Theberge 2004). Their distribution and abundance are determined largely by the availability of their primary prey (Carbyn 1987), which, in Ontario, includes moose, deer, caribou, and beavers (OMNR 2005), and by the level of harvest by humans (Boitani 2003). However, there are two site-specific features that appear to be important components of wolf habitat: natal/maternal dens and rendezvous sites (OMNR 2005).<br><br>Dens are characterized by one of more entrance holes and associated tunnels that lead to a nursery chamber where pups are born (Carbyn 1987). Dens are typically excavated by wolves in well-drained sandy soils on knolls or hillsides but other natural features such as rock caves, hollow logs, stumps, and beaver lodges have been used (OMNR 2005). Wolves may also take over (and enlarge) dens excavated by other animals (Carbyn 1987). Dens may be found in a broad range of habitat conditions (Ballard and Dau 1983, Carbyn 1987) but dry coniferous forests are frequently cited as preferred (Fuller 1988, Norris et al. 2002, Theuerkauf et al. 2003a). Characteristics of habitat within up to 1 km of dens may influence site selection (Norris et al. 2002).<br><br>Pups spend the first 3 weeks of their lives within the den and are associated with the den site for the first 6 to 8 weeks of life. As they get older, they spend an increasing amount of time playing around the den entrance (Carbyn 1987).<br><br>A wolf pack may have more than one den per territory so individual dens are not always re-used each year. However, re-use of den sites is common (Ballard and Dau 1983, Carbyn 1987, Ciucci and Mech 1992) and may reflect a lack of |

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| | alternative den sites (Fuller 1989, Mech and Packard 1990), individual or pack familiarity with the area (Peterson 1977, Harrington and Mech 1982), or proximity to a seasonal concentration of prey (Theberge et al. 1978, Ciucci and Mech 1992).<br><br>Den site quality apparently affects wolf fitness. A poorly selected den may be associated with low reproductive success (Mech et al. 1998).<br><br>When pups are 6 to 8 weeks old, they are moved from dens to a series of rendezvous sites (Joslin 1967, Peterson 1977). Pups remain at the rendezvous site while the pack hunts (Kolenosky and Johnson 1967). Individual sites are occupied for a period of days to weeks (Peterson 1977). In the early fall, pups begin to hunt with the pack and use of rendezvous sites decreases (Van Ballenberghe and Mech 1975, Peterson 1977).<br><br>Rendezvous sites may be found in a variety of habitats but are typically located close to water (Joslin 1967, Pimlott et al. 1969, Peterson 1977). In forested areas, rendezvous sites range from open bogs, burns, clearcuts, and beaver meadows (Joslin 1967, Pimlott et al. 1969, Theberge and Theberge 2004) to open or semi-open forest (Kolenosky and Johnson 1967, Ballard and Dau 1983, Dekker 1985). In Algonquin Park, wetlands used as rendezvous sites ranged from about 0.1 ha to 10 ha in size (Joslin 1967).<br><br>Rendezvous sites are often used by wolf packs over a number of years (Peterson 1977, Ballard and Dau 1983, Frame et al. 2007). Areas used as rendezvous sites one year may be used as den sites in subsequent years (Peterson 1977). |
| Effects of forest management | Forest management operations are generally thought to have a positive effect on wolves because they produce a mosaic of habitat conditions, including early successional habitat, that supports an abundance of key prey species such as moose, deer, and beavers (see OMNR 2005). However, wolves will modify their behaviour within up to 1.5 km of active forestry operations (Theuerkauf et al. 2003b). Moreover, access provided by roads can negatively affect wolves by facilitating harvest of wolves and their prey (Buss and de Almeida 1997) or accidental human-caused mortality (Mech et. al. 1988).<br><br>In Algonquin Park, changes in habitat composition resulting from forest harvesting did not appear to affect use of dens or rendezvous sites (Theberge and Theberge 2004).<br><br>Little quantitative information on the effects of forest management operations during the denning period on use of dens by wolves. Anecdotal information suggests that wolves can tolerate some timber harvest operations near dens (MDNR 2001, Theuerkauf et al. 2003a). However, wolves are generally assumed to be sensitive to human activities within the vicinity of occupied dens and rendezvous sites (Joslin 1967, Fuller 1989, Thiel et al. 1998, Frame et al. 2007, Argue et al. 2008), although wolves may be more resilient to some invasive human activities than previously thought (Frame et al. 2007, Argue et al. 2008). |
| Past direction | No species-specific direction. |

**Rationale for direction**

General habitat needs of wolves provided by direction in the *Landscape Guide* and Section 3 of this guide that promotes a diversity of habitat conditions to support a range of large and medium-sized prey. Natal/maternal dens and rendezvous sites are important site-specific habitat features and wolves may be relatively intolerant of human activities within the vicinity of occupied sites.

High fidelity to dens suggests they may be a limited resource. Moreover, wolf dens are protected under the *Fish & Wildlife Conservation Act 1997*. Thus, direction identifies dens as AOCs and focuses on both mitigation of disturbance and retention of habitat in the vicinity of dens.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* - 200 m radius AOC centred on the den entrance. | There is little quantitative information on the effect of forest management operations during the denning period on use of dens (see above). However, wolves are generally thought to be sensitive to disturbance during this time period (see above). Consequently, both Michigan and Wisconsin recommend no human activities such as timber harvest within 800 m of occupied dens (MDNR 1997, WDNR 1999). This direction thought to be excessive for Minnesota (MDNR 2001) and Ontario (Patterson[1], pers. comm. 2006); radio-tagged wolves being studied in Algonquin Park and near Timmins appear to tolerate human activity if >200 m from dens (Patterson[1], pers. comm. 2006). |
| *Standard* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions … | Theberge and Theberge (2004) found no relationship between timber harvest and location of dens in Algonquin Park but their analysis was fairly coarse. Wisconsin and Michigan both recommend 100 m reserves around dens (MDNR 1997, WDNR 1999). A 100 m buffer of dense mature forest (some selection harvest permitted within the buffer) was supported by Patterson[1] (pers. comm. 2008). |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | There is no information on how wolves react to different types of forest management activities. Thus, as a precautionary approach, no harvest, renewal, and tending operations are not permitted within the AOC during the entire *denning period.* |
| *Guideline* - The *denning period* for wolves is April 15 to July 15 in the boreal forest and April 1 to June 30 in the Great Lakes–St. Lawrence forest. Local knowledge of denning chronology may be used to adjust these | Denning activities begin in early April to early May in Ontario depending on latitude (OMNR 2005) and wolves are associated with dens for 2 to 3 months (see above). Thus, timing restrictions of April 1 to June 30 in the GLSL forest and April 15 to July 15 in the boreal forest are likely appropriate (Allison[2], pers. comm. 2008; Patterson[1], pers. comm. 2008). |

[1] Brent Patterson, OMNR, Wildlife Research and Development Section, Peterborough, ON
[2] Brad Allison, OMNR, Centre for Northern Forest Ecosystem Research, Thunder Bay, ON

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| dates. | |
| *Standard* - New roads, landings, and aggregate pits are not permitted within the inner 100 m of the AOC. | A 100 m buffer of dense mature forest is prescribed around dens (see above). Thus, no roads, landings, or aggregate pits are permitted within 100 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within the outer 100 m of the AOC. | Roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users. Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within the outer 100 m of the AOC. |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance. |
| *Guideline* - Road construction and aggregate extraction are not permitted within 200 m of an occupied den during the *denning period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *denning period*. |
| *Guideline* - Hauling and road maintenance operations are not permitted within 100 m of an occupied den during the *denning period* unless the road predates the den, is required for safety reasons or environmental protection, or except in extraordinary | Hauling and road maintenance operations are considered to have a relatively low potential impact on den use. Thus, hauling and road maintenance operations are only restricted within 100 m of occupied dens.<br>Hauling and road maintenance operations are not restricted if the road predates the den. This direction assumes that wolves that den adjacent to existing roads are tolerant of these types of operations. |

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| circumstances as specifically identified and justified through the FMP AOC planning process. | |

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**4.2.5 Continued**

**Background**

| **Value** | **Dens of furbearing mammals** |
|---|---|
| Description | Nineteen species of furbearing mammals (American badger, American beaver, American marten, bobcat, coyote, fisher, gray wolf, grey fox, least weasel, long-tailed weasel, lynx, mink, muskrat, raccoon, red fox, red squirrel, river otter, short-tailed weasel, striped skunk) use dens for reproduction (natal or maternal dens), as rest sites, or as winter refugia (see Table 4.2c). A number of species excavate burrows as dens; many species use existing structures such as cavities in trees or logs, burrows excavated by other animals, or structures created by other animals (e.g., beaver lodges). |
| Ecological significance | Dens are used by individual species for a variety of ecological functions (Table 4.2c). They may serve as sites for parturition (natal dens), as locations for the raising of young during lactation (maternal dens), as sites for resting by adult animals, and/or as winter refugia. In some cases, individual dens may serve multiple functions. For example, in lynx and wolves, the same den may be used during parturition and lactation (Carbyn 1987, Slough 1999).<br><br>Dens typically provide protection or concealment from predators and/or thermoregulatory advantages. Duration of use is normally related to function; maternal dens and winter dens are typically occupied for a greater period of time than dens used simply as rest sites (e.g., Lindzey 1978). Annual reuse of dens is variable and appears related to den structure; dens associated with enduring features (e.g., burrows, caves, rock crevices) tend to be reused more frequently that those associated with transient features (e.g., brush piles, tree cavities, hollow logs)(see Table 4.2c).<br><br>Reproductive success in some species may be linked to both the availability and/or quality of natal and/or maternal dens (Mech et al. 1998, Ruggiero et al. 1998, Slough 1999). Moreover, overall abundance of some species may be influenced by the supply of dens (Endres and Smith 1993). |
| Effects of forest management | Little information on the direct effects of forest management operations on the use of dens by most furbearing mammals. Human contact may cause females to abandon natal/maternal den sites (Harrison and Gilbert 1985, Slough 1999, Frame et al. 2007).<br><br>Forest management operations have the potential to remove trees with existing cavities (Paragi et al. 1996) and influence the future supply of large cavity trees and large hollow logs (Davis 1996)(but see Section 3.2.3). Construction of roads, landings, and aggregate pits has the potential to damage burrows and other ground dens. |
| Past direction | Direction for retention of cavity trees and downed woody debris (e.g., Naylor et al. 1996, Watt et al. 1996) maintained structures that provided potential denning sites. |

**Table 4.2c. Summary of status, distribution, general habitat requirements, den sites, and periods of den use for furbearing mammals in the AOU in Ontario.**

| Species | Status & Distribution | General habitat | Den description | Period of den use | References |
|---|---|---|---|---|---|
| American badger | *Endangered* S2/G5 – historic records in the AOU along the Minnesota border. | Natural or anthropogenic grassland habitats. May use forested habitats at certain times of year. | Many dens excavated throughout the summer; most are used as resting sites only once. Dens receive extended use by females with cubs or during winter. | Dens used for various purposes throughout the year.<br>Cubs born in dens in March and early April. Numerous maternal dens may be used until cubs are weaned in June. | Long 1973, Lindzey 1978, Messick 1987 |
| American beaver | S5/G5 – throughout the AOU. | Large lakes with irregular shorelines, ponds, slow moving rivers, and meandering streams represent optimal habitat. Suitable impoundments are frequently created by damming small streams. | Island-type lodges built when shallow water features occupied; lodges built on shore in deep or fast water. Lodges typically constructed from woody vegetation and mud. | Lodges used throughout the year. | Jenkins and Busher 1979, Novak 1987 |
| American marten | S5/G5 – throughout the AOU. | Mature and older coniferous or mixedwood forest. | Natal and maternal dens in tree cavities, hollow logs, rock crevices, and squirrel middens. Reuse among years not reported. | Kits born mid-March to late April. Kits fully weaned by about 6 weeks but tree cavities used until kits are about 7-8 weeks of age. | Clark et al. 1987, Strickland and Douglas 1987, Ruggiero et al. 1998 |
| Bobcat | S4/G5 – throughout the AOU south of a line running from about Kenora to Thunder Bay to Wawa to Temagami. | Habitat generalist – typically associated with open or disturbed habitats. May require dense coniferous forest during winter at northern latitudes. | Natal dens are typically in caves/crevices in rock outcrops. Up to 5 maternal dens used, also generally in rocky terrain. Natal dens frequently used for many years. | Kittens typically born in May and June. Kittens are weaned after about 2 months but may remain in natal or maternal dens until about 3 months of age. | Rolley 1987, Knick 1990, Lariviere and Walton 1997 |
| Coyote | S5/G5 – throughout the AOU. | Habitat generalist. | Natal/maternal dens typically excavated, but may use hollow logs, rock ledges, or burrows of other animals. Dens may be used for many years. | Pups born March through May. Pups leave the natal den after 2 or 3 weeks but may use maternal dens until they are 8 to 10 | Bekoff 1977, Harrison and Gilbert 1985, Voigt and Berg 1987 |

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| | | | | weeks of age. | |
| Fisher | S5/G5 – throughout the AOU. | Mature and older coniferous or mixedwood forest. | Natal and maternal dens typically in tree cavities. Reuse among years not reported. | Kits typically born in March - April. Kits fully weaned after 4 months but natal/maternal dens used until kits are typically 8-10 weeks of age. | Powell 1981, Douglas and Strickland 1987, Paragi et al. 1996, Bull et al. 2001 |
| Gray wolf | S4/G4 - throughout the AOU. | Habitat generalist - distribution and abundance determined largely by the availability of their primary prey. | Natal/maternal dens typically excavated in well-drained sandy soils on knolls or hillsides but other natural features such as rock caves, hollow logs, stumps, and beaver lodges have been used or may take over (and enlarge) dens excavated by other animals. Re-use of den sites is common. | Denning activities begin in early April to early May; dens are typically used for 2 to 3 months. | Mech 1974, Carbyn 1987 |
| Grey fox | SZB?/G5 – Crossroute, Dog River-Matawin, and Lakehead FMUs in NWR; Ottawa Valley and Mazinaw-Lanark FMUs in SR. | Mosaic of woodlands and open areas including farm fields. | Natal/maternal dens associated with a variety of structures; hollow logs or trees, rock outcrops, burrows, abandoned buildings, or brush piles. Reuse among years not reported. | Pups generally born mid-April to mid-May; weaned by about 4 months of age. | Fritzell and Haroldson 1982, Nicholson et al. 1985, Fritzell 1987 |
| Least weasel | SU/G5 - may occur throughout the AOU – range poorly documented. | Meadows, grasslands, wetlands, and riparian habitats. | Natal/maternal dens in rodent burrows or rock piles. | Breeding may occur throughout the year when prey is abundant. | Fagerstone 1987, Sheffield and King 1994 |
| Long-tailed weasel | S4/G5 - found primarily in the GLSL-transition forest within the AOU. | Habitat generalist – more frequently found in forested habitats than short-tailed weasel. | Natal/maternal dens in animal burrows, rock piles, or brush piles. | Young born in April or May. Young leave the den at 6-7 weeks of age. | Fagerstone 1987, Sheffield and Thomas 1997 |
| Lynx | S5/G5 – | Habitat use largely | Natal and maternal | Kittens typically | Quinn and |

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| | throughout the AOU, from Algonquin Park and Nipissing FMUs north. | dictated by abundance of primary prey - snowshoe hare. Ideal habitat typically an interspersion of young shrubby forest with mature dense conifer. Often uses older forest for denning. | dens typically under woody debris (e.g., blowdowns) in recent burns or older forest. Large coarse woody debris around den sites provides security and thermal cover for kittens prior to weaning. May reuse dens among years in some areas. | born in late May – early June. Dens occupied until kits are about 6 to 8 weeks of age. | Parker 1987, Tumlison 1987, Koehler and Aubrey 1994, Slough 1999 |
| Mink | S5/G5 – throughout the AOU. | Lakes, rivers, streams, wetlands, and associated riparian habitat. | A variety of sites is used for denning throughout the year; muskrat burrows are most frequently used. Fidelity to dens not reported. | Kits born April through June. Kits may occupy the natal den for about 40 days, coincident with the time to weaning. | Eagle and Whitman 1987, Lariviere 1999 |
| Muskrat | S5/G5 – throughout the AOU. | Variety of aquatic habitats with appropriate interspersion of emergent vegetation and water – marshes, ponds, lakes, ditches, streams, and rivers. | Builds conical houses from wetland vegetation or digs burrows in banks. Usually has a main house and smaller, satellite feeding houses or platforms. Houses typically last about 5 months. | Houses may be occupied throughout the year. Summer houses built in May-June; winter houses built in Oct. | Willner et al. 1980, Boutin and Birkenholz 1987 |
| Raccoon | S5/G5 – throughout the AOU. | Habitat generalist – most abundant in forest that supplies den sites near water or wetlands. | May use a wide variety of sites as natal or maternal and winter dens – burrows created by other species (e.g., red fox, skunk, woodchuck), rock crevices, brush piles, man-made structures - but dens in large trees seem to be especially important in portions of range. Winter den sites also important at northern latitudes, being used by >20 individuals. Reuse of natal/maternal dens and winter dens among years reported. | Young typically born in April – use of natal/maternal dens greatest during April through mid-June. Use of dens in winter highest from November through January. | Berner and Gysel 1967, Lotze and Anderson 1979, Sanderson 1987 |
| Red fox | S5/G5 – | Habitat generalist - | Natal/maternal dens | Pups typically born | Sheldon |

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| | throughout the AOU. | most abundant where woodlots are interspersed with croplands and grasslands. | excavated in sandy soil; >1 maternal den may be used. | in natal dens in April. Dens may be occupied until mid July. | 1950, Voigt 1987, Lariviere and Pasitschniak-Arts 1996 |
| Red squirrel | S5/G5 – throughout the AOU. | Inhabits a wide range of coniferous and mixed forests; also found in tolerant hardwood forest if conifers or mast trees present. | Natal/maternal dens and winter dens used. Tree cavities preferred but when not available, typically builds leaf nests or uses burrows. | Litters born April through June. Young leave dens after 5-6 weeks. | Obbard 1987, Steele 1998 |
| River otter | S5/G5 – throughout the AOU. | Small lakes, ponds, meandering streams, wetlands, and associated riparian habitats. | Natal dens typically in old lodges or bank dens of beavers; may also use brush piles or small caves. Will use a wide range of sites as temporary dens/resting sites: animal burrows, hollow trees and logs, and undercut stream banks. Reuse of natal dens infrequent. | Pups born March through May. Pups leave the natal den after about 2 months; remain in the vicinity of the natal den until fully weaned at about 3 months of age. | Melquist and Dronkert 1987, Lariviere and Walton 1998, Gorman et al. 2006 |
| Short-tailed weasel | S5/G5 – throughout the AOU. | Young forest, forest edges, wetlands, riparian areas. | Natal/maternal dens in rodent burrows, rock piles, rock crevices, tree cavities, or hollow logs. | Young born in April. Weaning occurs after 7-12 weeks. | King 1983, Fagerstone 1987 |
| Striped skunk | S5/G5 – throughout the AOU. | Habitat generalist – preference for open and edge habitats. | Uses burrows (typically excavated by woodchucks, badgers, foxes, muskrats) as natal/maternal dens, rest sites, and overwinter sites (may contain >20 skunks). Tree cavities and hollow logs also used as rest sites. | Young born in May or early June. Natal/maternal dens used until young are weaned at about 6-8 weeks of age. Winter dens typically occupied from Nov through March. | Houseknecht and Tester 1978, Wade-Smith and Verts 1982, Rosatte 1987 |

**Rationale for direction**

The *Fish & Wildlife Conservation Act 1997* prohibits the intentional damage or destruction of the dens or habitual dwelling places of furbearing mammals, other than foxes or skunks. Species-specific direction is provided for dens of grey foxes and wolves in Section 4.2.5 (see above). Generic direction is provided for dens of other furbearers (other than red foxes and skunks). Dens in caves, excavated burrows, or under large piles of coarse woody material (e.g., bobcat, coyote, lynx) are considered to be enduring features with a relatively high likelihood of reuse. Direction restricts forest management operations within the general vicinity of these types of dens (CROs).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Harvest, renewal, and tending operations are not permitted within 20 m of the den entrance. | Little information on the direct effects of forest management operations on the use of dens by most furbearing mammals. Human contact may cause females to abandon natal/maternal den sites (see above). Dens in enduring features generally have a relatively high likelihood of reuse. Thus, harvest, renewal, and tending operations are not permitted within 20 m of the den entrance at any time of year to avoid disturbance of denning animals, provide concealment of the den site, and minimize risk of felling damage. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 20 m of the den entrance. | Dens to be retained in an unharvested patch of forest at least 20 m in radius (see above). Thus, no roads, landings, or aggregate pits are permitted within 20 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Road construction and aggregate extraction are not permitted within 20 m of occupied dens, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations. |
| *Guideline* - Hauling and road maintenance operations are not permitted within 20 m of occupied dens unless the road predates the den, is required for safety reasons or environmental protection, or except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations.<br>Hauling and road maintenance operations are not restricted if the road predates the den. This direction assumes that animals establishing dens adjacent to existing roads are tolerant of these types of operations. |

Dens in tree cavities, hollow logs, or brush piles (e.g., fisher, marten, raccoon) are considered to be transitory features with a relatively low likelihood of reuse. Direction restricts forest management operations only within the immediate vicinity of these types of dens (CROs).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Known occupied dens encountered during operations will not be destroyed. | The *Fish & Wildlife Conservation Act 1997* prohibits the intentional damage or destruction of the dens or habitual dwelling places of furbearing mammals. Thus, forest management operations will not destroy known occupied dens. In this context, destruction means the complete or partial damage of the den structure or its contents (i.e., adults or young). |
| *Guideline* - Reasonable efforts will be made to minimize disturbance of furbearers occupying known dens encountered during operations. | There is little information on how denning furbearers react to different forest management operations, or the consequences of disturbance. Reactions and consequences are likely highly context-specific. Thus, direction to minimize disturbance is a *Guideline* rather than a *Standard. Best management practices* that are likely to minimize the risk of disturbing denning furbearers are provided. |
| *Best management practices* | There is no published information on restrictions required to minimize disturbance of denning furbearers such as fishers, martens, or raccoons. Direction follows that prescribed for songbirds and other small birds (see Section 4.2.2.8). |

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### 4.2.6 Bat hibernacula

**Background**

| **Species group** | **Bats** |
|---|---|
| Description | Eight species of bats occur within the AOU: big brown bat, eastern pipistrelle, hoary bat, little brown bat, northern long-eared bat, red bat, silver-haired bat, and small-footed bat. None is a species at risk although 3 species are considered rare or uncommon (i.e., S-rank S1-S3) (see Table 4.2d). |
| Habits and habitat | All bats in Ontario are insectivores. Prey selection and hunting strategies vary by species (Fenton and Barclay 1980; Kunz 1982; Shump and Shump 1982a,b; Fujita and Kunz 1984; Kurta and Baker 1990; Best and Jennings 1997; Caceres and Barclay 2000). However, there is considerable variation within species because hunting behaviour tends to be opportunistic (Vaughan 1980, Barclay 1991, Wunder and Carey 1996). For example, insect abundance and patterns of distribution may affect the patterns of habitat use by foraging bats (Barclay 1985, Fenton and Bogdanowicz 2002)<br><br>Hunting by most species occurs preferentially over lakes, ponds, woodland pools, streams, wetlands, associated riparian habitats, other open habitats, or along roads, trails, and other forest edges (Erickson and West 1996, Grindal 1996, Krusic et al. 1996, Grindal and Brigham 1998, Zimmerman and Glanz 2000, Swystun et al. 2001, Brooks and Ford 2005, Broders et al. 2006). However, there is considerable variability in habitat use among species. For example, large-bodied species such as the silver-haired bat may use both the edge and interior of open habitats such as clearcuts, while small-bodied species such as the little brown bat may focus activity along edges (Hogberg et al. 2002, Patriquin and Barclay 2003). Species also show variable use of forested habitats for hunting. Large-bodied species typical of open habitats (e.g., hoary bat) will frequently hunt above forest canopies or within the open canopy of old growth forests (Jung et al. 1999, Kalcounis et al. 1999, Menzel et al. 2005). The red bat is considered a habitat generalist and hunts in forested habitats almost as frequently as in open habitats (Hutchinson and Lacki 1999). The northern long-eared bat is considered a forest specialist (Jung et al. 1999, Patriquin and Barclay 2003, Broders et al. 2006) but still hunts preferentially along small openings created by streams, roads, or trails (Owen et al. 2003, Brooks and Ford 2005, Broders et al. 2006).<br><br>All species use forested habitats as sites for roosting and maternity colonies. Some species simply use tree foliage but most species roost/place maternity colonies behind exfoliating bark of dead or decadent trees or in tree hollows or cavities (Parsons et al. 1986, Campbell et al. 1996, Crampton and Barclay 1998, Kalcounis and Brigham 1998, Lacki and Schwierjohann 2001, Willis et al. 2003, Psyllakis and Brigham 2006).<br><br>Five species overwinter in Ontario (Gersen 1984), typically using caves or abandoned mines that provide above-freezing air temperature and high relative humidity (OMNR 2000). Suitable hibernacula may be a limited resource (Gersen 1984); individual sites may be used by large numbers of bats drawn from an area of several thousand $km^2$ around the hibernaculum (OMNR 2000). |
| Effects of | Because most species hunt in open habitats or along forest edges and roads |

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| forest management | (see above), forest management operations (including road construction) may increase feeding opportunities for many species (Krusic et al. 1996, Grindal and Brigham 1998, Menzel et al. 2005). Use of clearcuts by hunting bats may be increased by retention of residual patches of trees that create internal edge (Swystun et al. 2001, Hogberg et al. 2002). Partial harvest/thinning has been shown to increase use of forest by *Myotis* bats in some studies (Perdue and Steventon 1996, Humes et al. 1999), northern long-eared bats (Owen et al. 2003), and red bats (Jung et al. 1999) but not by hoary or silver-haired bats (Jung et al. 1999). Moreover, Patriquin and Barclay (2003) and Tibbels and Kurta (2003) observed little effect of partial harvest/thinning on bat communities.<br><br>Not all species prefer open habitats for hunting, and roost sites and maternity colonies are typically in large dead or decadent trees (see above). Thus, retention of large dead and decadent trees within partial harvests and some patches of older undisturbed forest may be necessary to maintain all components of habitat required by all bat species (Jung et al. 1999).<br><br>Little quantitative information on the effects of forest management operations on bat hibernacula. Harvesting may potentially remove vegetation that influences the temperature, humidity, or air flow in hibernacula (Bilecki 2003). Road construction could potentially block entrances to hibernacula or cause hibernacula to collapse (Bilecki 2003). Roads could also increase access to hibernacula; human visitation can disturb hibernating bats, leading to increased mortality due to premature depletion of fat reserves (Speakman et al. 1991, Thomas 1995, Johnson et al. 1998). |
| Past direction | Gerson (1984) provided some general direction for the protection of hibernacula that included land acquisition, signing, gating, fencing, and reducing access. |

**Table 4.2d. Information on status, distribution, summer roosts, maternity colonies, hibernation sites, and typical hunting habitat for bats found in the AOU.**

| Species | Status & Distribution | Summer roosts/Maternity colonies | Hibernation sites | Hunting habitat | References |
|---|---|---|---|---|---|
| Big brown bat | S5/G5 - GLSL, transition, and southwestern parts of boreal forest. | Roosts and maternity colonies typically found in human structures, in tree cavities, under loose bark, or in rock crevices. | Hibernates in buildings, caves, and mines (Nov – April) typically within 80 km of summer habitat. | Habitat generalist. | Gerson 1984, Van Zyll de Jong 1985, Kurta and Baker 1990, Dobbyn 1994 |
| Eastern pipistrelle | S3?/G5 - Along southern edge of AOU. | Roosts in tree foliage. Maternity colonies typically found in tree cavities, caves, or in rock crevices (rarely in human structures). | Hibernates in caves and mines (Oct – April) typically within 50 km of summer habitat. | Hunts most commonly over water or along forest edges. | Gerson 1984, Van Zyll de Jong 1985, Fujita and Kunz 1984, Dobbyn 1994 |

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| Hoary bat | S4/G5 - Across the AOU. | Roosts in tree foliage. | Migrates to the southern US and Mexico where it roosts in tree foliage and tree cavities; found in ON from May – Oct. | Considered an 'open air forager' – especially prefers lakes and ponds. | Shump and Shump 1982a, Van Zyll de Jong 1985, Dobbyn 1994, Menzel et al. 2003 |
| Little brown bat | S5/G5 - Across the AOU. | Roosts in buildings, under loose tree bark, in tree cavities, under rocks, in piles of wood, and in caves. Maternity colonies are typically found in buildings but also in hollow trees or rock crevices. | Hibernates in caves and mines (Sept – May), often 100's kms from summer habitat. | Preferentially hunts over water; also low through forest. | Van Zyll de Jong 1985, Fenton and Barclay 1980, Dobbyn 1994 |
| Northern long-eared bat | S3?/G4 - Across the AOU? | Roosts/maternity colonies under exfoliating bark, in tree crevices or cavities (rarely in human structures). | Hibernates in caves and mines (Sept – May). | Hunts under the forest canopy, over ponds, along streams, paths, and roads, and along forest edges. | Van Zyll de Jong 1985, Dobbyn 1994, Caceres and Barclay 2000 |
| Red bat | S4/G5 - Across the AOU. | Roosts in tree foliage. | Migrates to the southern US where it roosts in tree foliage, under exfoliating bark, or in tree cavities. Found in ON from May – Oct. | Habitat generalist; hunts over water or other open habitats or above forest canopies. | Shump and Shump 1982b, Van Zyll de Jong 1985, Dobbyn 1994, Menzel et al. 2003 |
| Silver-haired bat | S4/G5 - Across the AOU. | Primarily roosts in tree foliage but may also roost behind exfoliating bark or in tree cavities. | Migrates to US where it hibernates under exfoliating bark or in tree cavities, rock crevices, caves, mines, or sometimes buildings. Found in ON from April – | Typically hunts in or near coniferous or mixed forest adjacent to ponds, streams, and other bodies of water. | Kunz 1982, Van Zyll de Jong 1985, Dobbyn 1994 |

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|---|---|---|---|---|---|
| | | | Oct. | | |
| Small-footed bat | S2S3/G3 - Across GLSL forest. | Little information. Primarily found in caves and under rocks (rarely in buildings). | Hibernates in caves and mines (Nov – April) usually within 20 km of summer habitat. | Little information. | Van Zyll de Jong 1985, Dobbyn 1994, Best and Jennings 1997 |

**Rationale for direction**

It is assumed that general direction in the *Landscape Guide,* and in Section 3 of this guide will provide the diversity of forest conditions required by hunting and roosting bats. Bat-specific direction focuses on protection of bats using hibernacula and applies to hibernacula known to have been used at least once within the past 20 years by ≥50 little brown bats, ≥30 big brown bats, ≥20 eastern pipistrelles, ≥20 northern long-eared bats, or ≥1 small-footed bat (unless hibernacula are no longer suitable). A 20 year timing window was selected because hibernacula are generally enduring features (e.g., caves, abandoned mines). Minimum number of bats required to trigger application of direction is based on criteria provided in OMNR (2000). Direction for hibernacula focuses on:

- minimizing alteration of habitat in the vicinity of the hibernaculum opening,
- minimizing access to hibernacula, and
- minimizing potential sources of disturbance around hibernacula during hibernation and during periods of entry and emergence.

Rationale for direction is described below:

| Direction | Rationale |
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| *Standard* - 200 m radius AOC centred on the entrance to the hibernaculum. | Hibernating bats may be disturbed by human visitation of hibernacula, and potentially by noise associated with forest management operations. Unfortunately, there is little quantitative information to define the required dimensions of the AOC. The size of the AOC (200 m) was selected based on recommended direction in OMNR (2000) and other jurisdictions (see review in Bilecki 2003). |
| *Standard* - Harvest, renewal, and tending operations are not permitted within the inner 100 m. | Harvest, renewal, and tending operations are not permitted within the inner 100 m of the AOC in an attempt to minimize changes in microclimate that might influence temperature, humidity, or air flow in hibernacula and to ensure no movement of heavy equipment that might cause collapse of hibernacula. This 100 m buffer is at least 2 times the distance microclimate effects are generally considered to extend into forest from edges (e.g., Matlack 1993, Fraver 1994, Burke and Nol 1998). |
| *Standard* - Harvest, renewal, and tending operations that retain residual forest are permitted in the outer 100 m subject to timing restrictions. | It is assumed that harvest, renewal, and tending operations within the outer 100 m of the AOC that are conducted outside the period encompassing hibernation, entry, and emergence and that retain residual forest, will not have adverse effects on hibernating bats or result in changes in microclimate that might influence temperature, humidity, or air flow in hibernacula and are unlikely to cause collapse of hibernacula. |

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| *Guideline* - Harvest, renewal, and tending operations involving heavy equipment are not permitted within the outer 100 m of the AOC during the *hibernation and associated entrance and emergence periods*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Harvest, renewal, and tending operations involving heavy equipment are not permitted within the outer 100 m of the AOC during the *hibernation and associated entrance and emergence periods* to minimize risk of disturbing bats using hibernacula. |
| *Guideline* - The *hibernation and associated entrance and emergence periods* run from September 1 to May 30. Local knowledge about species using the hibernaculum and hibernation chronology may be used to adjust these dates. | The period encompassing hibernation, entry, and emergence (September 1 to May 30) is based on data from Table 4.2d. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within the inner 100 m of the AOC. | A 100 m buffer of unharvested forest is prescribed around hibernacula (see above). Thus, no roads, landings, or aggregate pits are permitted within 100 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within the outer 100 m of the AOC. | Roads, landings, and aggregate pits create large canopy gaps in forest surrounding hibernacula. Moreover, roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users. Thus, reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within the outer 100 m of the AOC**.** |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance. |

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| and disturbance. | |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *hibernation and associated entrance and emergence periods*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *hibernation and associated entrance and emergence periods*. |
| *Guideline* - Hauling and road maintenance operations are not permitted within the inner 100 m of the AOC during the *hibernation and associated entrance and emergence periods* unless the road predates the hibernaculum, is required for safety reasons or environmental protection, or except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Hauling and road maintenance operations are considered to have a relatively low potential impact on hibernaculum use. Thus, hauling and road maintenance operations are only restricted within 100 m of hibernacula during the *hibernation and associated entrance and emergence periods*.<br>Hauling and road maintenance operations are not restricted if the road predates the hibernaculum. This direction assumes that bats that hibernate adjacent to existing roads are tolerant of these types of operations. |

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**4.3 Protection of Species at Risk**

One hundred and seventy-two native species are designated by the MNR as extant species at risk (Ontario Regulation 230/08, February 2009) (see Table 4.3a). Sixty of these species occur within the AOU.

Designations, which apply at the provincial or sub-provincial level, are the result of complementary national and provincial review and assessment processes. The national assessment process is lead by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The provincial review process is lead by MNR's Committee on the Status of Species at Risk in Ontario (COSSARO). Designations assigned to species by COSSARO are, in most cases, in agreement with those assigned to the species by COSEWIC. However, MNR has assigned certain species a designation that differs from the national designation. For example, species whose status in Ontario is of greater concern than elsewhere in Canada have been assigned a higher designation. In Table 4.3a, any exceptions to the national designation are marked with an asterisk. Moreover, MNR may independently decide to review and assign status to species that are of special interest to the province. Species or populations that have been evaluated and assigned status by the province, but not by COSEWIC, are indicated by a letter “P” (for “provincially-designated only”) after the status code in Table 4.3a.

Definitions of status designations are:

| **MNR STATUS** | | **DEFINITION** |
|---|---|---|
| END | *Endangered* | A species facing imminent extinction or extirpation in Ontario. |
| THR | *Threatened* | A species that is at risk of becoming endangered in Ontario if limiting factors are not reversed. |
| SC | *Special Concern* (formerly Vulnerable) | A species with characteristics that make it sensitive to human activities or natural events. |

In Ontario, species at risk are protected under the provisions of several legislative and policy tools. The *Endangered Species Act 2007*, which came into effect on June 30 2008, includes prohibitions against killing, harming, harassing, capturing, or taking a species at any life stage that is listed as *endangered*, *threatened, or extirpated* on the Species at Risk in Ontario List. This Act further prohibits the damage or destruction of habitat of an *endangered* or *threatened* species (subject to the transition provisions of the Act). Habitat protection is addressed through either *general habitat protection* or species-specific *habitat regulations*. All species listed as *endangered* or *threatened* are also recognized as provincially featured species in Ontario's forest management planning process and are addressed by the *Provincial Policy Statement* of the *Planning Act 1990*.

The *Endangered Species Act* does not explicitly protect individuals or habitat occupied by species of *special concern.* However, the Act does require development of management plans for these species. As well, many species of *special concern* are either listed as *Specially Protected Wildlife* in schedules under the *Fish and Wildlife Conservation Act 1997* or are directly or indirectly addressed by the federal *Species at Risk Act 2002*, *Fisheries Act 1985*, or *Migratory Birds Convention Act 1994*. Moreover, the area of habitat for forest-dependent species at risk is one indicator of the ability of planned forest management operations to meet the criterion of conserving biological diversity in Ontario’s forests (see the *Forest Management Planning Manual*).

Within Section 4.3*,* direction is provided for species at risk that occur within the AOU, that may be negatively affected by forest management operations, and may not be fully addressed by direction within the *Landscape Guides* or other sections of the *Stand and Site Guide*. The direction generally applies to *Element of Occurrence* observation points (or other reliable observations) with a last observation date that is ≤20 years old, Quality Ranks of A to E, and an Accuracy Code of 0 to 2, unless otherwise noted (e.g., a 10-year rule has been adopted for species of *special concern*), prescribed in a species-specific *habitat regulation,* or described in a *habitat description*. Historical sightings and those with low positional accuracy should be a high priority for resurvey. Moreover, when sightings are >10 years old (>5 years for species of *special concern*), MNR will verify that habitat is still potentially suitable for occupancy before direction is applied.

The *Endangered Species Act 2007* includes provisions for the development of recovery strategies and the Ontario government's response to those strategies. It also includes provisions for the use of flexibility tools, such as agreements, permits, and instruments. MNR is developing regulations, including habitat definition regulations, and policies to assist with interpreting and implementing the requirements of the new Act, and this effort will be ongoing for several years.

With respect to forest management operations, this guide provides science-based information and direction for species within the AOU that have been designated as *endangered*, *threatened*, or *special concern*. **The direction in this guide represents science-based guidance intended to minimize the risk that forest management operations might incidentally kill, harm, or harass species that are currently on the SARO list or damage or destroy their habitat. Direction in this guide should be considered as preliminary and will be superseded by any future direction provided by the MNR with respect to measures or actions that may be required in order to comply with the ESA. Planning teams may also need to refine or enhance prescriptions and protection measures to address specific local situations.** Planning teams should consult MNR species at risk biologists for advice and direction on the implementation of ESA requirements.

**Future *habitat descriptions, habitat regulations,* or associated policy documents (e.g., statements of intended actions identified in the government's response to recovery strategies) developed under the ESA may contain additional species-specific direction that supersedes direction in this guide and that must be followed to ensure compliance with the ESA.** When completed, these documents will be available through MNR's species at risk website ( www.mnr.gov.on.ca/en/Business/Species/index.html) and should be consulted for the most recent direction. Any regulations made to prescribe areas as habitat in a species-specific *habitat regulation* will also be available on e-laws (http://www.e-laws.gov.on.ca/index.html).

The Committee on the Status of Species at Risk in Ontario (COSSARO) assesses and classifies species based on the best available scientific information (including community knowledge and Aboriginal Traditional Knowledge). The priority list of species to be assessed and classified by COSSARO is available through MNR's species at risk website. The SARO list is amended 3 months after the Minister receives COSSARO's report to reflect new classifications.

Species newly listed as *threatened* or *endangered,* and their habitat, immediately receive protection under the ESA. It is MNR's intention to post *habitat descriptions* on MNR's species at risk website as soon as possible following listing to help provide technical information on the habitat requirements of a species and guidance on identifying its habitat on the ground. Proposals for species-specific *habitat regulations* will then be developed within 2 years of listing for *endangered* species (within 3 years for *threatened* species). For newly listed species of *special concern*, relevant statements of intended actions identified in the government's response to provincial management plans (which will be prepared within 5 years of listing, unless there is a requirement to develop a recovery strategy or a management plan under the federal *Species at Risk Act*) may provide information for habitat identification and protection.

The following additional sources of information may be consulted for more information on species at risk.

COSEWIC website http://www.cosewic.gc.ca

Environment Canada's species at risk website http://www.sararegistry.gc.ca

Members of provincial recovery teams (see http://www.sararegistry.gc.ca)

Natural Heritage Information Centre website http://nhic.mnr.gov.on.ca

Regional and provincial species at risk biologists

Royal Ontario Museum/OMNR website: www.rom.on.ca/ontario/risk.php

**Table 4.3a. Species at risk in Ontario (February 2009) with rationale for including/excluding species-specific direction within this guide.**

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Mosses | Spoon-leaved moss *Bryoandersonia illecebra* | END | No | No species-specific direction. |
| Mosses | Pygmy pocket moss *Fissidens exilis* | SC | No | No species-specific direction. |
| Lichens | Flooded jellyskin *Leptogium rivulare* | THR | Yes – southern edge of AOU (Mazinaw-Lanark FMU) – historical sightings in Temagami and Wawa. | Lichen found in woodland pools and rich hardwood swamps – main threats are alteration of seasonal hydrological regime and removal of trees that are substrate for growth (COSEWIC 2004) – some forestry operations could potentially affect habitat suitability – suitable habitat maintained across potential range by direction for woodland pools and rich hardwood swamps in Section 4.1.3 – species specific direction in Section 4.3.1. |
| Vascular Plants | American chestnut *Castanea dentata* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | American columbo<br>*Frasera caroliniensis* | END | No | No species-specific direction. |
| Vascular Plants | American ginseng<br>*Panax quinquefolius* | END | Yes - occurs along southern edge of AOU (French-Severn to Ottawa Valley FMUs). | Species of rich tolerant hardwood forest - forestry operations may potentially affect habitat suitability or increase access and potential for plant harvest (see 4.3.1) - species-specific direction in Section 4.3.1. |
| Vascular Plants | Bird's-foot violet<br>*Viola pedata* | END | No | No species-specific direction |
| Vascular Plants | Bluehearts<br>*Buchnera americana* | END | No | No species-specific direction. |
| Vascular Plants | Blunt-lobed woodsia<br>*Woodsia obtusa* | END | No | No species-specific direction. |
| Vascular Plants | Butternut<br>Juglans cinerea | END | Yes – southern part of AOU (French-Severn to Ottawa Valley FMUs). | Forest species threatened by introduced pathogen (butternut canker) - harvesting may remove potentially resistant genetic material – harvesting can create appropriate conditions for regeneration (see 4.3.2) – species-specific direction in Section 4.3.2. |
| Vascular Plants | Cucumber tree<br>*Magnolia acuminata* | END | No | No species-specific direction. |
| Vascular Plants | Drooping trillium<br>*Trillium flexipes* | END | No | No species-specific direction. |
| Vascular Plants | Eastern flowering dogwood<br>*Cornus florida* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Eastern prairie fringed-orchid<br>*Platanthera leucophaea* | END | Yes – southern edge of AOU (Mazinaw-Lanark FMU). | Species of fens and wet prairies – main threat is loss of fens and prairie habitat (COSEWIC 2003a) - some forestry operations (e.g., road construction) may potentially affect habitat suitability - mitigation provided by direction for wetlands containing SARs and natural grassland remnants in Section 4.3.1. Also addressed by ONTARIO REGULATION 436/09. |
| Vascular Plants | Eastern prickly pear cactus<br>*Opuntia humifusa* | END | No | No species-specific direction. |
| Vascular Plants | Engelmann's quillwort<br>*Isoetes engelmannii* | END | Yes – southern edge of AOU (French-Severn FMU). | Aquatic fern found in shallow water of lakes and rivers – main threats are water level control and recreational activities – potentially affected by some forestry operations (e.g., road construction) (see 4.3.1) – habitat suitability maintained by general direction for lakes and ponds in Section 4.1.1 and specific direction for Atlantic coastal plain flora in Section 4.3.1. Also addressed by ONTARIO REGULATION 436/09. |
| Vascular Plants | False hop sedge<br>*Carex lupuliformis* | END | No | No species-specific direction. |
| Vascular Plants | Few-flowered club-rush<br>*Trichophorum planifolium* | END | No | No species-specific direction. |
| Vascular Plants | Forked three-awned grass<br>*Aristida basiramea* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Gattinger's agalinis *Agalinis gattingeri* | END | No | No species-specific direction. |
| Vascular Plants | Heart-leaved plantain *Plantago cordata* | END | No | No species-specific direction. |
| Vascular Plants | Hoary mountain mint *Pycnanthemum incanum* | END | No | No species-specific direction. |
| Vascular Plants | Horsetail spike-rush *Eleocharis equisetoides* | END | No | No species-specific direction. |
| Vascular Plants | Juniper sedge *Carex juniperorum* | END | No | No species-specific direction. |
| Vascular Plants | Large whorled pogonia *Isotria verticillata* | END | No | No species-specific direction. |
| Vascular Plants | Nodding pogonia *Triphora trianthophora* | END | No | No species-specific direction. |
| Vascular Plants | Ogden's pondweed *Potamogeton ogdenii* | END | Yes - southern edge of AOU (Mazinaw-Lanark FMU). | Species of slow-moving streams, beaver ponds, and lakes with alkaline waters – main threats are habitat loss (especially loss of beaver ponds) and competition from invasive species (COSEWIC 2007b) – likely benefits from direction in Section 4.2.3 – species-specific direction in Section 4.3.1. |
| Vascular Plants | Pink milkwort *Polygala incarnata* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Pitcher's thistle<br>*Cirsium pitcheri* | END | Yes – but only known site in Pukaskwa Park. | Species of sandy shorelines and old dunes - main threats are cottage development and recreational use of shorelines - not likely affected by forestry operations (COSEWIC 1999) - no species-specific direction. |
| Vascular Plants | Purple twayblade<br>*Liparis liliifolia* | END | No | No species-specific direction. |
| Vascular Plants | Red mulberry<br>*Morus rubra* | END | No | No species-specific direction. |
| Vascular Plants | Scarlet ammannia<br>*Ammannia robusta* | END | No | No species-specific direction. |
| Vascular Plants | Showy goldenrod<br>*Solidago speciosa* | END | No | No species-specific direction. |
| Vascular Plants | Skinner's agalinis<br>*Agalinis skinneriana* | END | No | No species-specific direction |
| Vascular Plants | Slender bush clover<br>*Lespedeza virginica* | END | No | No species-specific direction. |
| Vascular Plants | Small white lady's-slipper orchid<br>*Cypripedium candidum* | END | Yes? – potentially occurs along southern edge of AOU (Mazinaw-Lanark FMU). | Species of wet prairies and fens – main threats are loss of prairie habitat - some forestry operations (e.g., road construction) may potentially affect habitat suitability - mitigation provided by direction for wetlands containing SARs and natural grassland remnants in Section 4.3.1. |
| Vascular Plants | Small whorled pogonia<br>*Isotria medeoloides* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Spotted wintergreen *Chimaphila maculata* | END | No | No species-specific direction. |
| Vascular Plants | Toothcup *Rotala ramosior* | END | Yes? – potentially occurs along southern edge of AOU (Mazinaw-Lanark FMU). | Species of sandy to rocky lakeshores - main threats are cottage development and water level control - potentially affected by some forestry operations (e.g., road construction) – habitat suitability maintained by general direction for lakes in Section 4.1.1 and specific direction for shorelines supporting other species at risk in Section 4.3.1. |
| Vascular Plants | Virginia goat's-rue *Tephrosia virginiana* | END | No | No species-specific direction. |
| Vascular Plants | Western silvery aster *Symphyotrichum sericeum* | END* | Yes – Lake of the Woods area. | Species of prairies and oak savannahs - main threats are loss of prairie habitat to aggregate extraction and residential development (Harris et al. 2005) - some forestry operations (e.g., road construction) may potentially affect habitat suitability - mitigation provided by direction for natural grassland remnants in Section 4.3.1. Also addressed by ONTARIO REGULATION 436/09. |
| Vascular Plants | White prairie gentian *Gentiana alba* | END | No | No species-specific direction. |
| Vascular Plants | Wood poppy *Stylophorum diphyllum* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | American water-willow *Justicia americana* | THR | No | No species-specific direction. |
| Vascular Plants | Branched bartonia *Bartonia paniculata* ssp. *paniculata* | THR | Yes – isolated sites in French-Severn FMU. | Species of lakeshores, bogs, and fens – main threat may be unnatural water level control that promotes succession to woody vegetation - potentially affected by some forestry operations (e.g., road construction) (see 4.3.1) – habitat suitability maintained by general direction for lakes and ponds in Section 4.1.1 and specific direction for Atlantic coastal plain flora in Section 4.3.1. |
| Vascular Plants | Colicroot *Aletris farinosa* | THR | No | No species-specific direction. |
| Vascular Plants | Common hoptree *Ptelea trifoliata* | THR | No | No species-specific direction. |
| Vascular Plants | Crooked-stem aster *Symphyotrichum prenanthoides* | THR | No | No species-specific direction. |
| Vascular Plants | Deerberry *Vaccinium stamineum* | THR | No | No species-specific direction |
| Vascular Plants | Dense blazing star *Liatris spicata* | THR | No | No species-specific direction. |
| Vascular Plants | Dwarf hackberry *Celtis tenuifolia* | THR | No | No species-specific direction. |
| Vascular Plants | Dwarf lake iris *Iris lacustris* | THR | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Golden seal<br>*Hydrastis canadensis* | THR | No | No species-specific direction. |
| Vascular Plants | Hill's thistle<br>*Cirsium hillii* | THR | No | No species-specific direction. |
| Vascular Plants | Houghton's goldenrod<br>*Solidago houghtonii* | THR | No | No species-specific direction. |
| Vascular Plants | Kentucky coffee-tree<br>*Gymnocladus dioicus* | THR | No | No species-specific direction. |
| Vascular Plants | Lakeside daisy<br>*Hymenoxys herbacea* | THR | No | No species-specific direction. |
| Vascular Plants | Round-leaved greenbrier (GLSL population)<br>*Smilax rotundifolia* | THR | No | No species-specific direction. |
| Vascular Plants | Small-flowered lipocarpha<br>*Lipocarpha micrantha* | THR | Yes – isolated populations in Crossroute FMU. | Species of moist sandy shorelines of lakes and rivers – main threats are cottage development, shoreline development, recreational use of shorelines, and unnatural water fluctuations (COSEWIC 2002h) - potentially affected by some forestry operations (e.g., road construction) – habitat suitability maintained by general direction for lakes and rivers in Section 4.1 and specific direction for shorelines supporting other species at risk in Section 4.3.1. |
| Vascular Plants | White wood aster<br>*Eurybia divaricata* | THR | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Vascular Plants | Wild hyacinth<br>*Camassia scilloides* | THR | No | No species-specific direction. |
| Vascular Plants | Willowleaf aster<br>*Symphyotrichum praealtum* | THR | No | No species-specific direction. |
| Vascular Plants | American hart's-tongue fern<br>*Asplenium scolopendrium var. americanum* | SC | No | No species-specific direction |
| Vascular Plants | Blue ash<br>*Fraxinus quadrangulata* | SC | No | No species-specific direction. |
| Vascular Plants | Broad beech fern<br>*Phegopteris hexagonoptera* | SC | Yes – along southern edge of AOU (Mazinaw-Lanark FMU). | Species of mature tolerant hardwood forest – forestry operations may affect habitat suitability (see 4.3.1) – species-specific direction in Section 4.3.1. |
| Vascular Plants | Climbing prairie rose<br>*Rosa setigera* | SC | No | No species-specific direction. |
| Vascular Plants | Green dragon<br>*Arisaema dracontium* | SC | No | No species-specific direction. |
| Vascular Plants | Hill's pondweed<br>*Potamogeton hillii* | SC* | No | No species-specific direction. |
| Vascular Plants | Riddell's goldenrod<br>*Solidago riddellii* | SC | No | No species-specific direction. |
| Vascular Plants | Shumard oak<br>*Quercus shumardii* | SC | No | No species-specific direction. |
| Vascular Plants | Swamp rose-mallow<br>*Hibiscus moscheutos* | SC | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Vascular Plants | Tuberous indian-plantain *Arnoglossum plantagineum* | SC | No | No species-specific direction. |
| Molluscs | Eastern pondmussel *Ligumia nasuta* | END | No | No species-specific direction. |
| Molluscs | Kidneyshell *Ptychobranchus fasciolaris* | END | No | No species-specific direction. |
| Molluscs | Mudpuppy mussel *Simpsonaias ambigua* | END | No | No species-specific direction. |
| Molluscs | Northern riffleshell *Epioblasma torulosa rangiana* | END | No | No species-specific direction. |
| Molluscs | Rayed bean *Villosa fabalis* | END | No | No species-specific direction. |
| Molluscs | Round hickorynut *Obovaria subrotunda* | END | No | No species-specific direction. |
| Molluscs | Round pigtoe *Pleurobema sintoxia* | END | No | No species-specific direction. |
| Molluscs | Snuffbox *Epioblasma triquetra* | END | No | No species-specific direction. |
| Molluscs | Wavy-rayed lampmussel *Lampsilis fasciola* | END | No | No species-specific direction. |
| Molluscs | Mapleleaf mussel *Quadrula quadrula* | THR | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Molluscs | Rainbow mussel<br>*Villosa iris* | THR | Yes - found in the Moira and Salmon Rivers (Mazinaw-Lanark FMU). | Species of small and medium rivers and the Great Lakes - main threats are zebra mussels and sediment, nutrients, and toxic substances from urban and agricultural sources (COSEWIC 2006a) - general habitat suitability maintained by direction for rivers in Section 4.1.2 – no species-specific direction. |
| Insects | Aweme borer moth<br>*Papaipema aweme* | END | No | No species-specific direction. |
| Insects | Frosted Elfin<br>*Callophrys irus* | END* | No | No species-specific direction. |
| Insects | Monarch<br>*Danaus plexippus* | SC | Yes – across the AOU. | Butterfly of non-forested, riparian, and forest-edge habitats – not likely negatively affected by forestry operations - construction of roads and landings creates habitat for nectar-producing plants and plants used as feeding substrate by larvae (milkweeds) – standard spray buffers around water protect key nectar/food plants in riparian areas – main threats are loss of winter habitat and widespread pesticide use - no species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Insects | West Virginia white<br>*Pieris virginiensis* | SC[P] | Yes – southern part of AOU – Algoma to Ottawa Valley FMUs. | Butterfly of moist tolerant hardwood forest with toothwort in the understory (critical for larval development) - main threats are loss of habitat, fragmentation of woodlots in developed landscapes, replacement of toothwort by the invasive garlic mustard, and incidental mortality of adults during gypsy moth control programs – forestry operations may reduce suitability of, or fragment, suitable habitat, or facilitate introduction of garlic mustard (see 4.3.3) – species-specific direction in Section 4.3.3. |
| Fishes | American eel<br>*Anguilla rostrata* | END | Yes – Bancroft-Minden, Mazinaw-Lanark, & Ottawa Valley FMUs. | Found in rivers and streams feeding Lake Ontario and the Ottawa River – main threats are over-fishing, barriers created by dams (COSEWIC 2006b) - general habitat suitability maintained by direction for rivers and streams in Section 4.1.2 –- no species-specific direction. |
| Fishes | Aurora trout<br>*Salvelinus fontinalis timagamiensis* | END | Yes – endemic to 2 lakes in Nipissing FMU – introduced to 11 lakes from Nipissing to Nipigon FMUs. | Species of coldwater lakes – main threat was acid deposition from Sudbury metal smelters (COSEWIC 2000) – general habitat suitability maintained by direction for lakes in Section 4.1.1 - no species-specific direction. |
| Fishes | Northern madtom<br>*Noturus stigmosus* | END | No | No species-specific direction. |
| Fishes | Pugnose shiner<br>*Notropis anogenus* | END | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Fishes | Redside dace<br>*Clinostomus elongatus* | END | Yes – found in 1 tributary of Lake Huron in Algoma FMU. | Species of pools and slow-flowing portions of clear headwater streams – main threats are changes in water quality associated with agriculture and urban development (COSEWIC 2007c) - general habitat suitability maintained by direction for streams in Section 4.1.2 –- no species-specific direction. |
| Fishes | Shortnose cisco<br>*Coregonus reighardi* | END | Yes – may still exist in Lake Huron and Georgian Bay. | Species of deep lakes – main threat was over-fishing and possibly competition or predation from introduced species (COSEWIC 2005b) - general habitat suitability maintained by direction for lakes in Section 4.1 – no species-specific direction. |
| Fishes | Black redhorse<br>*Moxostoma duquesnei* | THR | No | No species-specific direction. |
| Fishes | Channel darter<br>*Percina copelandi* | THR | Yes – southern edge of AOU (Bancroft-Minden FMU). | Species of sandy-bottomed rivers and lakes - main threat is change in water quality associated with agriculture and urban development (COSEWIC 2002d) - general habitat suitability maintained by direction for lakes and rivers in Section 4.1 –- no species-specific direction. |
| Fishes | Cutlip minnow<br>*Exoglossum maxillingua* | THR* | No | No species-specific direction. |
| Fishes | Eastern sand darter<br>*Ammocrypta pellucida* | THR | No | No species-specific direction. |
| Fishes | Lake chubsucker<br>*Erimyzon sucetta* | THR | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Fishes | Shortjaw cisco<br>*Coregonus zenithicus* | THR | Yes – found in the Great Lakes, Lake of the Woods, Big Trout Lake, Lac Seul, Lake Nipigon, and 8 other lakes in northwestern Ontario or Algonquin Park. | Species of large deep lakes – main causes of decline were over-fishing and competition and predation from introduced fishes (COSEWIC 2003b) - general habitat suitability maintained by direction for lakes in Section 4.1.1 –- no species-specific direction. |
| Fishes | Spotted gar<br>*Lepisosteus oculatus* | THR | No | No species-specific direction. |
| Fishes | Bigmouth buffalo<br>*Ictiobus cyprinellus* | SC | Yes – isolated occurrence in Crossroute FMU. | Sucker that inhabits warm, muddy, highly enriched and poorly oxygenated waters – spawns in streams, marshes, and flooded areas - main threat is flood control operations that remove spawning habitat - general habitat suitability maintained by direction for lakes, rivers, and wetlands in Section 4.1 –- no species-specific direction. |
| Fishes | Blackstripe topminnow<br>*Fundulus notatus* | SC | No | No species-specific direction. |
| Fishes | Bridle shiner<br>*Notropis bifrenatus* | SC | No | No species-specific direction. |
| Fishes | Grass pickerel<br>*Esox americanus vermiculatus* | SC | No | No species-specific direction. |
| Fishes | Kiyi<br>*Coregonus kiyi* | SC | Yes – found in Lake Superior. | A small cisco found in the deep water of Lake Superior – main cause of decline was over-fishing (COSEWIC 2005c) - no species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Fishes | Lake sturgeon *Acipenser fulvescens* | SC | Yes – throughout the AOU. | Inhabits large freshwater lakes and rivers – main threats have been over-fishing, barriers created by dams, contamination of water, and competition/ predation from introduced fish - general habitat suitability maintained by direction for lakes and rivers in Section 4.1 – no species-specific direction. |
| Fishes | Northern brook lamprey *Ichthyomyzon fossor* | SC | Yes – FMUs with streams flowing into Lake Superior, Lake Huron, and Georgian Bay. | Non-parasitic lamprey found in warm water streams flowing into the Great Lakes – main threat is incidental mortality associated with sea lamprey control - general habitat suitability maintained by direction for streams in Section 4.1.2 –- no species-specific direction. |
| Fishes | Pugnose minnow *Opsopoeodus emiliae* | SC | No | No species-specific direction. |
| Fishes | River redhorse *Moxostoma carinatum* | SC | Yes – Ottawa River. | Sucker of fast-flowing clear rivers – spawns in fast-flowing tributary streams - main threat is change in water quality associated with agriculture and urban development – general habitat suitability maintained by direction for rivers and streams in Section 4.1.2 – no species-specific direction. |
| Fishes | Silver chub *Macrhybopsis storeriana* | SC | No | No species-specific direction. |
| Fishes | Silver shiner *Notropis photogenis* | SC | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Fishes | Spotted sucker<br>*Minytrema melanops* | SC | No | No species-specific direction. |
| Fishes | Warmouth<br>*Lepomis gulosus* | SC | No | No species-specific direction. |
| Amphibians | Alleghany mountain dusky salamander<br>*Desmognathus ochrophaeus* | END | No | No species-specific direction. |
| Amphibians | Northern cricket frog<br>*Acris crepitans blanchardii* | END | No | No species-specific direction. |
| Amphibians | Northern dusky salamander<br>*Desmognathus fuscus* | END * | No | No species-specific direction. |
| Amphibians | Small-mouthed salamander<br>*Ambystoma texanum* | END | No | No species-specific direction. |
| Amphibians | Fowler's toad<br>*Bufo fowleri* | THR | No | No species-specific direction. |
| Amphibians | Jefferson salamander<br>*Ambystoma jeffersonianum* | THR | No | No species-specific direction. |
| Reptiles | Blue racer<br>*Coluber constrictor foxii* | END | No | No species-specific direction. |
| Reptiles | Lake Erie water snake<br>*Nerodia sipedon insularum* | END | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Reptiles | Spotted turtle<br>*Clemmys guttata* | END | Yes – southern part of AOU from French-Severn to Mazinaw-Lanark FMUs. | Semi-terrestrial turtle of wetlands – main threats are illegal collection, wetland loss, and traffic-related mortality – potentially affected by some forestry operations (see 4.3.5.3) - general habitat suitability maintained by direction for wetlands in Section 4.1.3 - species-specific direction in Section 4.3.5.3. |
| Reptiles | Wood turtle<br>*Glyptemys insculpta* | END* | Yes – southern part of AOU from Algoma to Ottawa Valley FMUs. | Semi-terrestrial turtle of rivers and streams – main threats are illegal collection and traffic-related mortality (which may be facilitated by access roads) - potentially affected by some forestry operations - general habitat suitability maintained by direction for rivers and streams in Section 4.1.2 - habitat protection provided by ONTARIO REGULATION 437/09 - no species-specific direction in this guide. |
| Reptiles | Butler's gartersnake<br>*Thamnophis butleri* | THR | No | No species-specific direction. |
| Reptiles | Eastern foxsnake<br>*Elaphe gloydi* | THR | Yes – coastline of Georgian Bay in French-Severn FMU. | Primarily a species of non-forested habitats and forest edges – main causes of decline were loss of wetlands and forest-field mosaics in southern Ontario – main threats currently are increasing development and recreational land use along Georgian Bay - forestry operations may affect hibernacula or oviposition sites (see 4.3.5.2) – species-specific direction in Section 4.3.5.2. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Reptiles | Eastern hog-nosed snake *Heterodon platirhinos* | THR | Yes – southern part of AOU – Sudbury to Bancroft-Minden FMUs. | Primarily a species of non-forested habitats and forest edges – main threats are human development, persecution, traffic-related mortality, and illegal collection - forestry operations may affect hibernacula or oviposition sites (see 4.3.5.2) – species-specific direction in Section 4.3.5.2. |
| Reptiles | Eastern ratsnake *Elaphe obsoleta* | THR | Yes – Mazinaw-Lanark FMU. | Primarily a species of forest edges – main causes of decline have been traffic-related mortality, destruction of hibernacula, persecution, loss or fragmentation of habitat resulting from land development (COSEWIC 2007a) - forestry operations may affect hibernacula or oviposition sites (see 4.3.5.2) – species-specific direction in Section 4.3.5.2. |
| Reptiles | Massasauga *Sistrurus catenatus* | THR | Yes – southern part of AOU – Sudbury and French-Severn FMUs. | Primarily a species of non-forested habitats and forest edges – main threats are persecution, habitat loss and fragmentation caused by human development, and traffic-related mortality - forestry operations may potentially affect hibernacula or gestation sites (see 4.3.5.2) – species-specific direction in Section 4.3.5.2. |
| Reptiles | Queen snake *Regina septemvittata* | THR | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Reptiles | Blanding's turtle<br>*Emydoidea blandingii* | THR | Yes – southern part of AOU from Northshore and Nipissing FMUs south. | Semi-terrestrial turtle of lakes, rivers, streams, marshes, and ponds – main threats are wetland loss, traffic-related mortality, and illegal collection (COSEWIC 2005a) - potentially affected by some forestry operations (see 4.3.5.3) - general habitat suitability maintained by direction for wetlands in Section 4.1.3 - species-specific direction in Section 4.3.5.3. |
| Reptiles | Eastern musk turtle<br>*Sternotherus odoratus* | THR | Yes – southern part of AOU – French-Severn to Ottawa Valley FMUs. | Aquatic turtle of shallow lakes, ponds, and marshes and slow-moving rivers and streams – main threats are habitat loss through wetland drainage and shoreline development (COSEWIC 2002c) – general habitat suitability maintained by direction in Section 4.1. - species-specific direction in Section 4.3.5.3. |
| Reptiles | Spiny softshell<br>*Apalone spinifera* | THR | Yes – Ottawa Valley FMU adjacent to Ottawa River. | Aquatic turtle of lakes, reservoirs, rivers, and creeks – main threats appear to be development and recreational use of shorelines and environmental contaminants (COSEWIC2002a) – general habitat suitability maintained by direction in Section 4.1 - species-specific direction in Section 4.3.5.3. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Reptiles | Eastern ribbonsnake<br>*Thamnophis sauritius* | SC | Yes – southern edge of AOU from French-Severn to Mazinaw-Lanark FMUs. | Semi-aquatic snake associated with wetlands and shorelines - main threats are wetland loss, shoreline development, amphibian decline, persecution, and road mortality (COSEWIC 2002f) - forestry operations likely have little impact – general habitat suitability maintained by direction for wetlands in Section 4.1.3 - species-specific direction in Section 4.3.5.2. |
| Reptiles | Milksnake<br>*Lampropeltis triangulum* | SC | Yes – southern part of AOU below Algoma to Nipissing FMUs. | Habitat generalist – main threats are habitat loss, road mortality, and human persecution (COSEWIC 2002e) - forestry operations likely have little impact —- species-specific direction in Section 4.3.5.2. |
| Reptiles | Five-lined skink<br>*Eumeces fasciatus* | SC | Yes – southern part of AOU from French-Severn to Mazinaw-Lanark FMUs. | Lizard found primarily in non-forested habitats - forestry operations likely have little impact – main threats are cottage and shoreline development - no species-specific direction. |
| Reptiles | Northern map turtle<br>*Graptemys geographica* | SC | Yes – southern part of AOU from French-Severn to Ottawa Valley FMUs. | Aquatic turtle found in lakes and large rivers - habitat suitability generally maintained by coarse filter direction in Section 4.1 - main threats are shoreline development, water level control, and illegal collection (COSEWIC 2002b) - species-specific direction in Section 4.3.5.3. |
| Birds | Acadian flycatcher<br>*Empidonax virescens* | END | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Birds | Barn owl *Tyto alba* | END | No | No species-specific direction. |
| Birds | Eskimo curlew *Numenius borealis* | END | No | No species-specific direction. |
| Birds | Golden eagle *Aquila chrysaetos* | END* | No (winter resident but no confirmed breeding in the AOU). | No species-specific direction. |
| Birds | Henslow's sparrow *Ammodramus henslowii* | END | No | No species-specific direction |
| Birds | King rail *Rallus elegans* | END | No | No species-specific direction. |
| Birds | Kirtland's warbler *Dendroica kirtlandii* | END | Yes – recent record in Ottawa Valley FMU - historical records for GLSL forest – expected to move into ON from expanding population in MI. | Songbird of young jack pine forest – generally benefits from coarse filter direction that creates young jack pine forest but may be negatively affected by habitat alteration (e.g., juvenile spacing) – species-specific direction in Section 4.3.6. |
| Birds | Loggerhead shrike *Lanius ludovicianus* | END | Yes – southern part of AOU – Mazinaw-Lanark FMU. | Species of pasture and grassland with scattered trees and shrubs - main threats are change in agricultural practices, natural succession, and land development – crown land forestry operations likely have little effect –- no species-specific direction. |
| Birds | Northern bobwhite *Colinus virginianus* | END | No | No species-specific direction. |

| **Taxonomic group** | **Species** | **OMNR Status** | **Found in AOU?** | **Direction** |
|---|---|---|---|---|
| Birds | Piping plover<br>*Charadrius melodus* | END | Yes – Lake of the Woods area. | Shorebird restricted to beaches – main threat is recreational use of beaches, habitat loss, increased predation (Environ. Canada 2006) – forestry operations likely have little effect - no species-specific direction. |
| Birds | Prothonotary warbler<br>*Protonotaria citrea* | END | No | No species-specific direction. |
| Birds | Red knot (rufa subspecies)<br>*Calidris canutus rufa* | END | No | No species-specific direction. |
| Birds | American white pelican<br>*Pelecanus erythrorhynchos* | THR | Yes – Rainy Lake, Lake of the Woods, Lake Nipigon, Lake Nipissing. | Nests on islands in large lakes - main threats are human persecution and disturbance by recreationists - forestry operations likely have little effect –- no species-specific direction. |
| Birds | Hooded warbler<br>*Wilsonia citrina* | THR | No | No species-specific direction. |
| Birds | Least bittern<br>*Ixobrychus exilis* | THR | Yes – southern part of AOU – Algoma, Sudbury, and Nipissing FMUs south - Lake of the Woods and Eagle Lake in northwest. | Species of large cattail marshes - main threat is wetland loss to agriculture and urban development – some forestry operations may potentially affect habitat suitability or disrupt breeding (see 4.3.6) – general habitat suitability maintained by direction for wetlands in Section 4.1.3 – species-specific direction in Section 4.3.6. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Birds | Peregrine falcon<br>*Falco peregrinus* | THR | Yes – scattered across the AOU. | Cliff nesting species – direct disturbance by forestry operations or recreational activities facilitated by increased access around nest sites may have negative effects – habitat protection provided by ONTARIO REGULATION 436/09 - no species-specific direction in this guide. |
| Birds | Bald eagle<br>*Haliaeetus leucocephalus alascanus* | SC | Yes – throughout the AOU. | Nests in shoreline forest – forestry operations may affect habitat suitability or disrupt breeding – species-specific direction in Section 4.2.2.2. |
| Birds | Black tern<br>*Chlidonias niger* | SC* | Yes – scattered across the AOU. | Nests in small colonies, typically in cattail marshes – main threats are wetland loss and disturbance by recreationists – some forestry operations may potentially affect habitat suitability or disrupt breeding – most suitable habitat will be identified as fish habitat and protected by direction in Section 4.1 - species-specific direction in Section 4.3.6. |
| Birds | Cerulean warbler<br>*Dendroica cerulea* | SC | Yes – southern edge of AOU from French-Severn to Ottawa Valley FMUs. | Songbird of mature tolerant hardwood forest – forestry operations may affect habitat suitability or disrupt breeding – species-specific direction in Section 4.3.6. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Birds | Golden-winged warbler *Vermivora chrysoptera* | SC | Yes – from Algoma, Sudbury, Nipissing FMUs south – also near Lake of the Woods. | Species of wet or dry shrubby habitats such as clearcuts, utility ROWs, old fields, beaver meadows, and burns – main threats are loss of early shrubby habitats, hybridization with blue-winged warbler, and brown-headed cowbird parasitism (COSEWIC 2006c) – species-specific direction in Section 4.3.6. |
| Birds | Louisiana waterthrush *Seiurus motacilla* | SC | Yes - southern edge of AOU - Mazinaw-Lanark FMU. | Songbird of mature streamside hardwood forest – forestry operations may affect habitat suitability or disrupt breeding – species-specific direction in Section 4.3.6. |
| Birds | Red-headed woodpecker *Melanerpes erythrocephalus* | SC | Yes - southern edge of AOU - French-Severn to Ottawa Valley FMUs – also Crossroute FMU in western ON. | Species of open forest, forest edges, and non-forested habitats – forestry operations may affect habitat suitability or disrupt breeding – species-specific direction in Section 4.3.6. |
| Birds | Short-eared owl *Asio flammeus* | SC | Yes – found throughout the AOU. | Owl of grasslands and wetlands – forestry operations may affect habitat suitability or disrupt breeding – suitable habitat generally protected by direction for wetlands (Section 4.1.3) - occupied nests protected by species-specific direction in Section 4.2.2.7. |
| Birds | Yellow-breasted chat *Icteria virens virens* | SC | No | No species-specific direction. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Birds | Yellow rail<br>*Coturnicops noveboracensis* | SC | Yes – scattered across the AOU. | Waterbird of shallow marshes – main threat is wetland loss associated with agriculture and urban development – some forestry operations may potentially affect habitat suitability or disrupt breeding – most suitable habitat will be identified as fish habitat and protected by direction in Section 4.1 – species-specific direction in Section 4.3.6. |
| Mammals | American badger<br>*Taxidea taxus jacksoni* | END | Yes – southwestern part of AOU – Crossroute FMU. | Species of prairie habitats and farmland - main threat is loss of prairie habitat - not likely affected by forest management operations – no species-specific direction. |
| Mammals | Cougar<br>*Puma concolor* | END* | Scattered reports (mostly unconfirmed) across the AOU. | Habitat generalist – likely benefits from coarse filter direction that maintains a mosaic of habitats that supports abundant ungulate (especially deer) populations – historic decline related to land clearing and human interference – species-specific direction in Section 4.2.5. |
| Mammals | Grey Fox<br>*Urocyon cinereoargenteus* | THR | Yes – Crossroute, Dog River-Matawin, and Lakehead FMUs in northwest and Mazinaw-Lanark FMU in south-central (but no confirmed breeding evidence). | Species of forest and farmland mosaic - appears adaptable to human activity – main threats may be epizootics, incidental harvest, land development, and road mortality (COSEWIC 2002g) - likely benefits from coarse filter direction that maintains habitat diversity - species-specific direction in Section 4.2.5. |

| Taxonomic group | Species | OMNR Status | Found in AOU? | Direction |
|---|---|---|---|---|
| Mammals | Woodland caribou (forest-dwelling boreal population)<br>*Rangifer tarandus caribou* | THR | Yes – FMUs across northern portion of the boreal forest from Cochrane to Red Lake. | Species of large tracts of mature conifer forest - forestry operations may alter habitat suitability and/or increase human access – species-specific direction in the *Forest Management Guide for Boreal Landscapes (in preparation)*. |
| Mammals | Wolverine<br>*Gulo gulo* | THR* | Yes – northwestern part of AOU – Red Lake, Trout Lake, & Lac Seul FMUs. | Species of large tracts of mature conifer forest – forestry operations may alter habitat suitability and/or increase human access – general habitat requirements addressed in the *Forest Management Guide for Boreal Landscapes (in preparation)* - additional species-specific direction in Section 4.3.7.1. |
| Mammals | Belluga<br>*Delphinapterus leucas* | SC | No | No species-specific direction. |
| Mammals | Eastern mole<br>*Scalopus aquaticus* | SC | No | No species-specific direction. |
| Mammals | Eastern wolf<br>*Canis lupus lycaon* | SC | Yes – through GLSL and transition forest within the AOU. | Habitat generalist – forestry operations generally increase habitat suitability (by creating habitat heterogeneity that produces a diversity of prey) but may disrupt use of dens or rendezvous sites – species-specific direction in Sections 4.2.5 and 4.3.7.2. |
| Mammals | Polar bear<br>*Ursus maritimus* | SC | No | No species-specific direction. |
| Mammals | Woodland vole<br>*Microtus pinetorum* | SC | No | No species-specific direction. |

* Exception to the COSEWIC designation; P Provincially designated only.

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COSEWIC. 2002a. COSEWIC assessment and update status report on the spiny softshell turtle *Apalone spinifera* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2002b. COSEWIC assessment and update status report on the northern map turtle *Graptemys geographica* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2002c. COSEWIC assessment and update status report on the stinkpot *Sternotherus odoratus* in Canada. COSEWIC, Ottawa, ON.

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COSEWIC. 2002f. COSEWIC assessment and update status report on the eastern ribbonsnake *Thamnophis sauritus* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2002g. COSEWIC assessment and update status report on the grey fox *Urocyon cinereoargenteus* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2002h. COSEWIC assessment and update status report on the small-flowered lipocarpha *Lipocarpha micrantha* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2003a. COSEWIC assessment and update status report on the eastern prairie fringed-orchid *Platanthera leucophaea* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2003b. COSEWIC assessment and update status report on the shortjaw cisco *Coregonus zenithicus* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2004. COSEWIC assessment and update status report on the flooded jellyskin *Leptogium rivulare* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2005a. COSEWIC assessment and update status report on the Blanding's turtle *Emydoidea blandingii* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2005b. COSEWIC assessment and update status report on the shortnose cisco *Coregonus reighardi* in Canada. COSEWIC, Ottawa, ON.

COSEWIC. 2005c. COSEWIC assessment and update status report on the Lake Ontario kiyi *Coregonus kiyi orientalis* and Upper Great Lakes kiyi *Coregonus kiyi kiyi* in Canada. COSEWIC, Ottawa, ON.

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COSEWIC. 2007a. COSEWIC assessment and update status report on the gray ratsnake *Elaphe spiloides* in Canada. COSEWIC, Ottawa, ON.

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### 4.3.1 Non-woody plants

No *Standards*, *Guidelines*, or *Best Management Practices* are presented for the Pitcher's thistle (see Table 4.3a).

**Background**

| **Species** | **Flooded jellyskin** |
|---|---|
| S-rank | S1/G? |
| Designation | *Threatened* |
| Trend – CDN | Unknown. Historically known from 6 locations in Canada but currently only found in 4 of these (COSEWIC 2004). |
| Trend - ON | Unknown. Historically known from 5 locations in Ontario but currently only found in 3 of these (COSEWIC 2004). |
| Distribution | This lichen occurs in Eastern North America, Western Europe, and possibly Eurasia. Within Canada, it is only found in 1 location in Manitoba and 3 locations in Ontario. Only 2 of these sites occur within the AOU, both in Lanark County (COSEWIC 2004). |
| Habits and habitat | Grows on the base of trees, usually within or along the edge of woodland pools, where it experiences alternating periods of flooding and drying (COSEWIC 2004). Found almost exclusively on the bark of live trees (typically black ash, soft maple, American elm), only below the high water mark (COSEWIC 2004). Appears to be quite tolerant of variable light conditions; found both at the sunlit margin and in the more deeply shaded portions of woodland pools and on both shady southern edges as well as more exposed northern edges of pools (COSEWIC 2004). May be found in pools as small as 5 to 10 m across (COSEWIC 2004) but larger populations are generally associated with pools at least 20 m across (Lee[1], pers. comm. 2008). |
| Effects of forest management | Principle threats to known populations thought to be urban/suburban development, recreational activities, and the potential effects of climate change on hydrologic regime of seasonal wetlands (COSEWIC 2004). No information on the effects of forest management operations. However, loss of trees (its main substrate) and alteration of hydrologic regime in woodland pools are potential threats. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Threatened* species. Direction for woodland pools and rich hardwood swamps (Section 4.1.3) provides generic protection of potential habitat across the GLSL forest. However, the few known *Elements of Occurrence* within the AOU likely warrant special protection. Thus, direction identifies occupied habitat as AOCs and focuses on minimizing potential for changes to the hydrological regime.

[1] Robert Lee, Ottawa Field-Naturalists, Macoun Club, Ottawa, ON

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | The AOC is defined as a polygon containing 1 or more woodland pools that contain the flooded jellyskin, adjacent woodland pools that may be future habitat, and associated terrestrial habitat that influences the suitability of occupied woodland pools. This polygon will be delineated by MNR based on field survey. |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC with the following conditions … | Pools known to support flooded jellyskin are protected with a 30 m reserve. The reserve extends 30 m beyond the high water mark of the pool because the edge of the pool may be difficult to delineate during some seasons and this distance minimizes the chance that trees might be felled into the pool. Other pools with a surface area ≥200 $m^2$ also receive protection because they may support undetected populations of the flooded jellyskin or represent opportunities for population expansion. A 200 $m^2$ (15 m diameter) threshold is specified based on the midpoint between the smallest pools potentially occupied (10 m diameter) and the minimum size of pools typically occupied by larger populations (20 m diameter). Direction follows that prescribed for woodland pools in Section 4.1.3 with the following exception. No harvest of trees is permitted in or within 3 m of the pool and residual forest must be retained within 15 m of the pool in all forest types. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 30 m of the high-water mark of woodland pools known to support the flooded jellyskin. | Restrictions are placed on new roads, landings, and aggregate pits within 30 m of occupied woodland pools, assuming they have the potential to influence hydrological regime within these pools. |
| *Standard* - Direction for woodland pools (Section 4.1.3) will be applied to all other woodland pools with a surface area ≥200 $m^2$. | Restrictions are placed on new roads, landings, and aggregate pits within 15 m of potentially occupied woodland pools, assuming they have the potential to influence hydrological regime within these pools. |
| *Standard* - New all-weather roads and aggregate pits are not permitted within the AOC unless there is no practical or feasible alternative and the road or aggregate pit, including specific location, is identified and justified through the FMP AOC | Restrictions are placed on new all-weather roads and aggregate pits within the remainder of the AOC, assuming they have the potential to influence hydrological regime within occupied and potentially occupied woodland pools. |

| | |
|---|---|
| planning process. | |

**Literature cited**

COSEWIC. 2004. COSEWIC assessment and status report on the flooded jellyskin *Leptogium rivulare* in Canada. COSEWIC, Ottawa, ON.

**4.3.1 Continued**

**Background**

| **Species** | **Ogden's pondweed** |
|---|---|
| S-rank | SH/G1G2 |
| Designation | *Endangered* |
| Trend – CDN | In Canada, found only in Ontario, see Trend – ON. |
| Trend - ON | Unknown? Only known from 3 sites in Ontario; species not found at these sites when searched in the 2000's (COSEWIC 2007). |
| Distribution | Found only in scattered locations in Ontario, Connecticut, New York, Vermont, and Massachusetts (COSEWIC 2007). |
| Habits and habitat | Occurs in clear, slow-moving streams, beaver ponds, and lakes, generally where there is marble bedrock (COSEWIC 2007). |
| Effects of forest management | Primary threats considered to be habitat loss (loss of beaver ponds specifically identified) and competition from invasive aquatic plants (COSEWIC 2007). Thus, forest management practices that sustain habitat for beavers are likely beneficial (see Section 4.2.3). Activities that change hydrological regime (e.g., road building across beaver ponds, stream crossings) could potentially have a negative effect. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Endangered* species. General direction in Section 4.1 addresses water quality and direction in Sections 4.1 and 4.2.3 promote shoreline disturbance to sustain beaver pond habitat across the species' potential range. However, the few known *Elements of Occurrence* within the AOU likely warrant special protection. Thus, direction identifies occupied habitat as AOCs and focuses on minimizing potential for changes to the hydrological regime.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Activities with the potential to alter hydrological regime in occupied habitats are not permitted. | Occupied aquatic habitats are delineated as AOCs. General direction in Section 4.1 protects water quality. Additional direction is provided to ensure hydrological regime is not altered by activities such as drawdown of water in occupied beaver ponds, building roads across occupied beaver ponds, and construction of water crossings that might alter flow in occupied stream segments. |

**Literature cited**

COSEWIC. 2007. COSEWIC assessment and status report on the Ogden's pondweed *Potamogeton ogendii* in Canada. COSEWIC, Ottawa, ON.

**4.3.1 Continued**

**Background**

| **Species** | **American ginseng** |
|---|---|
| S-rank | S2/G3G4 |
| Designation | *Endangered* |
| Trend – CDN | Declining. Ginseng was evidently fairly common in the forests of southern Ontario and Quebec before European settlement (COSEWIC 1988). Circa 2000, there were only 139 records in Canada (COSEWIC 1999). |
| Trend - ON | Declining. Over a 10 year period (1988-1998), 75% of intensively studied populations either disappeared or declined. Only 7 viable populations known in Ontario (COSEWIC 1999). |
| Distribution | Widely distributed across eastern North America; Minnesota to New Hampshire south to Louisiana and Georgia (COSEWIC 1988). In Canada, Ginseng is found from southwestern Ontario across to southwestern Quebec and is generally associated with limestone or marble bedrock (COSEWIC 1988). Limited number of records within the AOU. |
| Habits and habitat | Long-lived, shade tolerant species with relatively low reproductive potential (Anderson et al. 1993, COSEWIC 1999).<br><br>Generally requires rich, moist, undisturbed and relatively mature tolerant hardwood forest in areas of circumneutral soil (COSEWIC 1988). Found on slopes or in undulating terrain often near seepage areas (COSEWIC 1988). Populations range from 2-3 plants to up to 50-60, or rarely 200 individuals (Argus and Pryer 1990). Ginseng's most common associates are sugar maple, white ash, basswood, rattlesnake fern, white baneberry, northern maidenhair-fern, false solomon's seal, and alternate-leaf dogwood (COSEWIC 1988). |
| Effects of forest management | Principle threats to the species are plant harvesting and habitat loss (Argus and Pryer 1990, COSEWIC 1999).<br><br>Forest management operations can have direct and indirect effects. Road construction may provide access to new areas and thus increase vulnerability to plant harvesters. Low levels of tree harvest alter light levels and can improve plant growth and fruit production (Coulson[1], pers. comm. 2006, Kauffman 2006). However, heavier canopy reduction can favour competing tree saplings, shrubs, and forest-floor herbs (COSEWIC 1999). Disturbance of the forest floor by heavy equipment can also negatively affect American ginseng. |
| Past direction | OMNR (2004) originally recommended a reserve that extended one tree length from the perimeter of patches. McConnell and Bjorgan (2004) developed a draft directive for Southern Region. The direction below is based largely on McConnell and Bjorgan (2004). |

[1] Daryl Coulson, OMNR, Pembroke District, Pembroke, ON

**Rationale for direction**

*Endangered* species. Coarse filter direction in the *Landscape Guide* maintains a supply of potentially suitable habitat across landscapes. However, occupied habitat may be negatively affected by both increased access and habitat alteration. Thus, direction identifies large patches (≥20 American ginseng plants) as AOCs and focuses on:

- minimizing access for collectors,
- maintaining high canopy cover, and
- minimizing disturbance of the forest floor.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | The AOC is defined as a patch of ≥20 American ginseng plants and habitat within a 120 m radius of the periphery of the patch (plants separated by no more than 40 m constitute a patch). The 120 m buffer is intended to provide protection for the existing patch, as well as suitable habitat for local population expansion (Nault et al. 1998). |
| *Standard* - Harvest, renewal, and tending operations are not permitted within 20 m of the ginseng patch. Trees will not be felled into this area. Trees accidentally felled into this area will be left where they fall. | No harvest, renewal, and tending operations are not permitted within 20 m of the ginseng patch to ensure high canopy cover and minimal disturbance of the forest floor (see above). The no-harvest buffer extends 20 m beyond the outermost individual plants because the true boundary of the patch can be difficult to determine, especially if plants are located late in the season or during drought conditions.<br>Trees may not be felled into this buffer to ensure the patch is not covered by tree tops and to minimize the risk of ground disturbance. |
| *Standard* - Within 21-120 m of the ginseng patch: i) Harvest that retains a minimum relatively uniform canopy closure of 70% (dominant and codominant trees) is permitted. Harvest will normally be restricted to single tree selection; ii) Harvest, renewal, and tending operations that leave ruts or a significant area of exposed mineral soil are not permitted (see Section 5.2); and iii) Application of herbicides is not permitted. | Within 21-120 m of the patch, light selection harvest (≥70% canopy closure) is permitted to encourage ginseng growth and fruiting but discourage development of a dense sapling and shrub understory (see above).<br>Ground disturbance must be minimized to protect the plants and seed banks. No rutting or significant mineral soil exposure is permitted.<br>Application of herbicides is not permitted to protect the patch of ginseng plants and any undetected plants that may occur within the modified area. |
| *Standard* - Following | The greatest threat to ginseng is thought to be illegal collection by plant |

| | |
|---|---|
| harvest, renewal, and tending operations, any markings that might attract collectors to the ginseng patch will be removed or hidden. | harvesters (see above). Thus, any markings that might attract collectors to the ginseng patch will be removed or hidden. |
| *Guideline* - Disturbance of the forest floor will be minimized within 21-120 m of the ginseng patch; extraction trail coverage will not exceed 10%. | Disturbance of the forest floor will be minimized within 21-120 m of ginseng patches to reduce risk of damaging undetected plants within the modified zone. To help meet this objective, the standard for extraction trail coverage (see Section 5.2.1) is halved. |
| *Guideline* - Harvest, renewal, and tending operations will be conducted during winter, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Winter operations are normally required since they typically result in less disturbance of the forest floor. |
| *Standard* - New roads are not permitted within 20 m of the ginseng patch. | Roads remove canopy cover and potentially provide access to collectors. Thus, no new roads are permitted within 20 m of patches. |
| *Standard* - Landings and aggregate pits are not permitted within the AOC. | Landings and aggregate pits create large canopy gaps and represent severe disturbance of the forest floor. Thus, no landings or aggregate pits are permitted within the AOC. |
| *Guideline* - New roads are not permitted within 21-120 m of the ginseng patch unless there is no practical or feasible alternative, the potential impact on ginseng habitat and the potential for illegal collection can be mitigated (e.g., corridor width <10 m, no grubbing, no disruption of hydrological flow, locate road as far from | Roads remove canopy cover and potentially provide access to collectors. Thus, new roads will not normally be permitted within the AOC.<br>When roads must be constructed within the AOC, winter roads are preferred since they create less potential access for collectors. |

| | |
|---|---|
| ginseng patch as possible and where patch is not visible from road), and the road, including specific location, is identified and justified through the FMP AOC planning process (subject to restrictions on the mapping of classified values). Winter roads will be used unless there is no practical or feasible alternative. | |
| *Guideline* - All roads within the AOC will be decommissioned or otherwise subject to access control measures following operations to minimize access by collectors except in extraordinary circumstances, as specifically identified and justified through the FMP AOC planning process. | The greatest threat to ginseng is thought to be illegal collection by plant harvesters (see above). Thus, roads within the AOC will normally be decommissioned or otherwise subject to access control measures following operations to minimize access by collectors. |

Small patches are assumed to be less likely to persist and expand than are large patches (Nault et al. 1998). Thus, they receive a 30 m AOC that is intended to at least partially ameliorate potential microclimate/vegetation effects associated with larger forest openings or forest edges (see Matlack 1993, Fraver 1994, Burke and Nol 1998) and reduce the risk of damage by felled trees.

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**4.3.1 Continued**

**Background**

| **Species** | **Broad beech fern** |
|---|---|
| S-rank | S3/G5 |
| Designation | *Special concern* |
| Trend – CDN | Unknown. No data on long term trend (Smith and Rothfels 2003). |
| Trend - ON | Reported to be in decline by Argus and Pryer (1990). Only 4 confirmed sightings in Ontario since 1995; but apparent decline in number of recent reports but may be an artifact of search effort (Smith and Rothfels 2003). |
| Distribution | Found throughout the eastern United States; reaches the northern edge of its range in southern Ontario and southwestern Quebec. Occurs within the deciduous and GLSL forest regions, where climate and soil conditions are suitable (Vincent 1981b). *Elements of Occurrence* within the AOU occur along the edge of the Canadian shield (Smith and Rothfels 2003). |
| Habits and habitat | In Canada, the species grows on rich moist soils in mature hardwood stands (Argus and Pryer 1990). Usually associated with telluric water movement found at the foot of slopes or seepage areas (Vincent 1981a, Smith and Rothfels 2003). Its associates include American beech, white ash, red maple, white elm, butternut, bitternut hickory, Jack-in-the-pulpit, spring beauty, trout lily, and maidenhair-fern (Vincent 1981a).<br>Shade tolerant species that does not tolerate direct exposure to sunlight (Vincent 1981b) or alteration of habitat (Smith and Rothfels 2003). |
| Effects of forest management | Little information. Degradation and loss of habitat noted as principle threats (Smith and Rothfels 2003). Recreational activities and competition from invasive species also noted as threats (Smith and Rothfels 2003). Considered to be sensitive to disturbance (Gilbert 1997). |
| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. Coarse filter direction in the *Landscape Guide* maintains a supply of potentially suitable habitat across landscapes. However, appears to be sensitive to changes in canopy cover and disturbance of the forest floor. Thus, direction identifies patches of this species as AOCs and focuses on:

- maintaining high canopy cover and
- minimizing disturbance of the forest floor.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated | The AOC is defined as a patch of any number of broad beech fern plants |

| | |
|---|---|
| habitat comprises the AOC. | and habitat within a 30 m radius of the periphery of the patch. A 30 m buffer is prescribed because the true boundary of the patch may be difficult to determine. Moreover, a 30 m no-harvest buffer (see below) reduces the risk that trees could be accidentally felled onto the patch and is of sufficient width to at least partially ameliorate microclimate/vegetation effects associated with forest edges (see Matlack 1993, Fraver 1994, Burke and Nol 1998). |
| *Standard* - Harvest, renewal, and tending operations are not permitted within the AOC. Trees will not be felled into the AOC. Trees accidentally felled into the AOC will be left where they fall. | Harvest, renewal, or tending operations are not permitted within the AOC to ensure high canopy cover and minimal disturbance of the forest floor (see above).<br>Trees may not be felled into the AOC to ensure the patch is not covered by tree tops and to minimize the risk of ground disturbance. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within the AOC. | The AOC is intended to ensure high canopy cover and minimal disturbance of the forest floor. Thus, new roads, landings, and aggregate pits are not permitted within the AOC. |

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**4.3.1 Continued**

**Background**

| **Habitat** | **Remnant natural grassland habitats (prairies, savannahs, and woodlands)** |
|---|---|
| S-rank | Dry tallgrass prairie (S1/G3)<br>Dry fescue mixedgrass prairie (S1/G?)<br>Bur oak – Saskatoon berry dry deciduous woodland (S2/G3) |
| Description | Natural grasslands are open vegetation communities dominated by herbaceous vegetation, especially grasses (Bakowsky 1999a). They generally occur on rapidly drained sites subject to summer droughts. Drought conditions encourage frequent fires that favour development of communities dominated by grasses and herbaceous vegetation (Bakowsky 1995). In Ontario, numerous types of natural grassland communities occur; those with <25% tree cover are termed prairies, those with 25-35% tree cover are savannahs, and those with 35-60% tree cover are woodlands (Lee et al. 1998).<br>In southern Ontario (primarily south of the AOU but extending into Bancroft District), the most common type of remnant natural grassland is the *Dry Tallgrass Prairie* and is characterized by grasses such as big bluestem, little bluestem, indian grass, and switchgrass (Bakowsky 1999a).<br>In northwestern Ontario, natural grasslands are represented by *Dry Fescue Mixedgrass Prairies* and *Bur Oak – Saskatoon Berry Dry Deciduous Woodlands*. The former are characterized by Hall's fescue, western ragweed, prairie sage, and rigid sunflower. The latter are characterized by open-grown bur oak trees, a tall shrub layer of Saskatoon berry and chokecherry, and grassland flora including white snakeroot, hoary puccoon, Drummond's thistle, and Richardson's alum-root. |
| Distribution | In southern Ontario, natural grassland communities were thought to cover 500 to 2000 $km^2$ prior to European settlement (Bakowsky 1995; and see Bakowsky 1998). Today, <3% of these communities remain and most remnant patches are <0.5 ha in size (Bakowsky 1999a). Most grassland remnants occur in extreme southwestern Ontario (Bakowsky 1999a). However, *Elements of Occurrence* of *Dry Tallgrass Prairie* occur along the southern edge of the AOU in Bancroft District.<br>In northwestern Ontario, the current and historic extent of grassland communities is not well understood. *Elements of Occurrence* of *Dry Fescue Mixedgrass Prairie* are found in Fort Frances, Kenora, and Thunder Bay Districts. Moreover, *Bur Oak – Saskatoon Berry Dry Deciduous Woodland Elements of Occurrence* occur in Thunder Bay District. |
| Ecological significance | Globally >99% of tallgrass prairie communities has been lost, making it one of the most threatened ecosystems in Ontario (Bakowsky 1999a).<br>Natural grassland communities provide habitat for many rare plants in Ontario. More than 10% of plants found in these communities are provincially rare (Bakowsky 1999b). Moreover, >20% of the rare vascular plants found in the province occur in grasslands (Bakowsky 1999a). This list includes 3 species at risk - eastern prairie fringed-orchid, small white lady's-slipper orchid, and western silvery aster. |

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| Effects of forest management | Main threats to grassland communities are conversion to agriculture, aggregate extraction, and natural succession to forest in the absence of fire (Bakowsky 1995, 1999b).<br>Harvest, renewal, and tending operations might potentially occur within small pockets of woodland. Some tree removal may have a beneficial effect as long as ground disturbance is minimal (e.g., winter harvest).<br>Construction of roads, landings, and aggregate pits likely has the largest potential effect on these communities. |
| Past direction | None |

**Rationale for direction**

Threatened community type in Ontario. Habitat for many rare plant species and 3 species at risk. Thus, direction identifies remnant patches of natural grassland habitat as AOCs and focuses on restricting operations that might have an adverse effect on the grassland plant community.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - The remnant patch of habitat as delineated by field survey comprises the AOC. | Remnant patches of dry tall grass prairie, dry fescue mixedgrass prairie, bur oak–Saskatoon berry dry deciduous woodland, or other natural grassland habitats containing species at risk identified by MNR comprise the AOC. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC unless required to maintain or enhance habitat suitability for grassland-dependent plant species as specifically identified in the FMP through the FMP AOC planning process (e.g., a prescribed fire might be planned to remove competing woody vegetation and release prairie plants or create a seedbed for regeneration of bur oak). | No harvest, renewal, or tending operations are permitted unless required to maintain or enhance habitat for grassland-dependent plant species. |
| *Guideline* - Harvest, renewal, and tending operations permitted within the AOC will be | If harvest, renewal, or tending operations are permitted within the AOC, they must be conducted in a manner that minimizes impact on the grassland plant community. For example, winter harvest with at least 40 cm of snow has been recommended as a mitigative technique in the |

| | |
|---|---|
| conducted in a manner that minimizes disturbance of the grassland plant community; winter operations will be used to the extent practical and feasible. | Crossroute FMU (Van den Broeck[1], pers. comm. 2006). |
| *Standard* - New landings and aggregate pits are not permitted within the AOC. | Construction of roads, landings, and aggregate pits likely has the largest potential effect. Thus, landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - New roads are not permitted within the AOC unless there is no practical or feasible alternative, the potential impact on grassland plant communities can be mitigated (e.g., corridor width <10 m, no grubbing, no disruption of hydrological flow) and the road, including specific location, is identified and justified through the FMP AOC planning process. Winter roads will be used unless there is no practical or feasible alternative. | Roads may be permitted within the AOC if no other feasible options exist and effects on plant community can be mitigated (e.g., narrow road corridor, no grubbing, winter roads preferred option). |

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**4.3.1 Continued**

**Background**

| **Habitat** | **Atlantic coastal plain plant communities (Atlantic coastal shallow marsh)** |
|---|---|
| S-rank | S3/G2? |
| Description | Rare emergent marsh plant community found along open undisturbed, gently-sloping, sandy or gravelly (relatively infertile) shorelines of small, shallow lakes and ponds with fluctuating water levels (Reznicek 1994). In Ontario, the community is comprised of 14 species typically associated with the eastern seaboard and gulf coast of the US (Reznicek 1994). Two members are species at risk (branched bartonia, Engelmann's quillwort) and 6 others are provincially rare (algae-like pondweed, carolina yellow-eyed-grass, hidden-fruited bladderwort, panic grass, ridged yellow flax, Tuckerman's quillwort).<br><br>Fluctuating water level (typically associated with beaver activity) is apparently required to maintain this plant community (Keddy 1991). The community becomes established during periods of low water (e.g., following beaver dam abandonment) from soil seed bank (Keddy and Reznicek 1982). Plants apparently require 10-15 years of low water conditions to become fully established and replenish the seed bank (Sharp and Keddy 1993). Coastal plain plants generally have low competitive ability (Wisheu and Keddy 1994) and thus are eventually replaced by woody shoreline shrubs such as sweet gale, leatherleaf, and narrow-leaved meadowsweet (Keddy and Sharp 1989). An extended period (at least 5 years) of high water (typically associated with beaver dam establishment) kills competing woody shrubs (Sharp and Keddy 1993). The cycle begins again following beaver dam abandonment. |
| Distribution | Atlantic coastal plain plants occur primarily along the eastern seaboard from Nova Scotia south to Florida and along the gulf coast to Texas (Keddy and Sharp 1989). In central Ontario, they have been found along the shore of about 50 lakes in the Bancroft, French-Severn, and Nipissing Forests (Keddy and Sharp 1989). This disjunct distribution represents a remnant of the coastal plain flora that historically occurred along the shore of post-glacial Lake Algonquin. |
| Ecological significance | The plant community contains 1 *endangered* species (Engelmann's quillwort) and 1 *threatened* species (branched bartonia) and 6 additional species that are provincially rare (S1 to S3). |
| Effects of forest management | Primary threats include shoreline development (e.g., cottages, docks), shoreline alterations (e.g., dredging, filling), beach creation and maintenance, shoreline recreation, and water level stabilization (Keddy and Sharp 1989).<br><br>Forest management operations likely have little negative effect, except in rare situations where shoreline vegetation is disturbed by roads that are constructed across ponds (especially dewatered beaver ponds) or by roads or movement of equipment within non-forested shoreline vegetation (both existing vegetation and the seed bank appear to be sensitive to vehicular traffic; Wisheu and Keddy 1991). Otherwise, forest management operations potentially have a positive effect because shoreline harvesting can help maintain the natural cycle of beaver dam construction and abandonment. |
| Past direction | None |

**Rationale for direction**

General direction for lakes and ponds (Section 4.1.1) should protect plant community from sedimentation and most direct disturbance by heavy equipment. Additional direction further restricts operations in shorelines supporting Atlantic coastal plain plant communities (or other shoreline plant communities containing species at risk).

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Guideline* - Residual forest will be retained in the AOC adjacent to portions of shorelines known to support Atlantic coastal plain plant communities or other shoreline plant communities containing species at risk. | There is no information on the effects of forest harvesting adjacent to shorelines supporting Atlantic coastal plain plant communities or other shoreline plant communities containing species at risk. In most cases, general direction for lakes and ponds (Section 4.1.1) should provide sufficient protection. However, to be conservative and minimize the potential for disturbance, residual forest will be retained in the AOC adjacent to portions of shorelines known to support Atlantic coastal plain plant communities or other shoreline plant communities containing species at risk. |
| *Guideline* - For lakes and ponds supporting Atlantic coastal plain plant communities, reasonable efforts (considering direction in Section 4.1.1) will be made to harvest forest not adjacent to portions of shorelines supporting Atlantic coastal plain plant communities to renew supplies of food for beavers to encourage the natural cycle of dam establishment, abandonment, and renewal. | Maintenance of Atlantic coastal plain plant communities appears to be linked to fluctuating water levels (see above). Thus, in beaver-controlled systems, reasonable efforts should be made to harvest shoreline forest that is not directly adjacent to shorelines supporting Atlantic coastal plain plant communities to renew supplies of food for beavers to encourage the natural cycle of dam establishment, abandonment, and renewal (see Section 4.2.3). |
| *Guideline* - Road construction is not permitted within the AOC except where no practical or feasible alternatives exist, the road is >20 m from any known patch of Atlantic coastal plain plant community or other shoreline plant | When lakes or ponds are known to support Atlantic coastal plain plant communities or other shoreline plant communities containing species at risk, roads should only be permitted across or through non-forested shoreline areas if no other feasible options exist and MNR determines that location will not negatively affect pockets of these plant communities. |

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|---|---|
| communities containing species at risk, appropriate mitigative measures are taken to minimize the risk of sediment entering the aquatic feature and the disruption of hydrological flow, and the road, including specific location, is identified and justified through the FMP AOC planning process. | |

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**4.3.1 Continued**

**Background**

| **Habitat** | **Non-forested wetlands supporting plants that are species at risk** |
|---|---|
| S-rank | Variable |
| Description | See 4.1.3 for a general description of non-forested wetlands.<br>Three species at risk are found in non-forested wetland habitats such as fens and bogs (branched bartonia, eastern prairie fringed-orchid) or marshes (small white lady's-slipper). |
| Distribution | Wetlands supporting branched bartonia, eastern prairie fringed-orchid, or small white lady's-slipper are currently found only in the French-Severn and Mazinaw-Lanark FMUs. |
| Ecological significance | See 4.1.3 for a general description of the ecological significance of non-forested wetlands. |
| Effects of forest management | See 4.1.3 for a general description of the effects of forest management operations on wetlands. No information on the effects of forest management operations on these specific species. However, the eastern prairie fringed-orchid is thought to be sensitive to changes in hydrological regime (COSEWIC 2003). |
| Past direction | None |

**Rationale for direction**

General direction (CROs) for non-forested wetlands (Section 4.1.3) should normally protect plant communities supporting species at risk from sedimentation and most direct disturbance by heavy equipment. Additional direction in this section identifies non-forested wetlands as AOCs and focuses on mitigating potential hydrological effects associated with roads, landings, and aggregate pits.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - The AOC is defined as the wetland (or portion of the wetland) delineated as containing the species at risk based on field survey. | Operations within wetlands may directly (e.g., by crushing) or indirectly (e.g., by altering hydrological regime) adversely affect plant communities containing species at risk. Thus, entire wetland polygons supporting species at risk will normally be identified as AOCs. However, in the case of large wetland complexes, portions of the wetland contributing to habitat suitability may be delineated as the AOC. |
| *Guideline* - New all weather roads, landings, and aggregate pits are not permitted within the | All weather roads, landings, and aggregate pits are considered to have the greatest potential direct and indirect effects on wetland plant communities (see 4.3.1) and are thus not permitted within the AOC. |

| | |
|---|---|
| AOC. | |
| *Guideline* - New winter roads are not permitted within the AOC unless there is no practical or feasible alternative, the potential impact on the SAR species present can be mitigated, and the road, including specific location, is identified and justified through the FMP AOC planning process. | Winter roads are thought to have less potential impact than do all weather roads. However, construction of winter roads may damage plant communities containing species at risk and will be avoided unless there is no practical or feasible alternative and the potential impact on the species at risk present can be mitigated (e.g., field survey indicates the road will not cross any portions of the wetland known or suspected to support species at risk). |

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### 4.3.2. Woody plants

**Background**

| **Species** | **Butternut** |
| --- | --- |
| S-rank | S3?/G3G4 |
| Designation | *Endangered* |
| Trend – CDN | Declining (COSEWIC 2003). |
| Trend - ON | Declining (COSEWIC 2003). |
| Distribution | Occurs in northeastern North America from Minnesota to New Brunswick, south to Tennessee (Rink 1990); reaches its northern limit in southeastern Canada. Within Ontario, found only in the Carolinian region and the extreme southeastern portion of the AOU (COSEWIC 2003). |
| Habits and habitat | A fast growing, relatively short-lived (75 years), shade-intolerant hardwood tree found on rich, moist, well-drained soils associated with riparian situations or on well-drained gravelly soils of limestone origin (Rink 1990). In Ontario, usually found as scattered individuals or in small groups in mixed hardwood stands, or as remnant or volunteer trees along fence lines or in open fields (COSEWIC 2003). Common associates include basswood, black cherry, American beech, eastern hemlock, red maple, sugar maple, white ash, and yellow birch (Rink 1990).<br>Generally windfirm, although subject to frequent storm damage (Rink 1990). Amount of suitable habitat has been severely reduced through conversion to agriculture and development in southwestern Ontario (COSEWIC 2003).<br>Produces a large nut as early as 20 years of age; optimal seed production occurs from 30 to 60 years of age (Rink 1990). Good crops every 2 to 3 years. Seeds travel only a short distance from the parent tree unless dispersed by squirrels. May also reproduce from stump sprouts from young trees (Rink 1990). |
| Effects of forest management | Butternut canker is the most serious threat to the species' persistence. Butternut canker was first reported in Ontario in 1991 (Davis et al. 1992) but may have been in the province since the early 1970s. Now found throughout the range of butternut in Ontario (COSEWIC 2003). Butternut canker can infect and cause mortality in trees of all ages and sizes. Infection can occur through buds, leaf scars, and wounds (Davis and Meyer 1997). Mortality rate in the US has been as high as 77% in some locations; little data from Ontario but similar mortality rate is expected (COSEWIC 2003). There is some evidence of potential resistance within the host.<br>Harvest of potentially resistant trees in anticipation of loss to the canker (especially on private land) could accelerate species decline and eliminate stock needed for recovery (Environ. Canada 2006). |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Endangered* species. Forest harvesting can be used to regenerate the species, but indiscriminate harvesting may remove potentially resistant genetic material. Direction for butternut focuses on:

- maintaining and reporting healthy individual trees,
- removing unhealthy trees, and
- developing stand conditions suitable for butternut regeneration.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - SGRs will specify that: i) no healthy butternut trees will be marked for removal or harvested unless authorized by a permit issued under the *Endangered Species Act, 2007*; and ii) careful logging practices will ensure that the crown, stem, and roots of healthy butternut trees will not be damaged. | Healthy butternut trees cannot be harvested without a permit issued under the *Endangered Species Act, 2007*.<br>Since infection by butternut canker can occur through wounds (Davis and Meyer 1997), logging damage to crown, stem, and roots must be avoided in order to limit the risk of infection. |
| *Standard* - Healthy trees include those with: i) more than 70% live crown and less than 20% of the combined circumference (measured at dbh) of the bole (main stem) and root flare affected by cankers, or ii) at least 50% live crown and no cankers (visible) on the bole (main stem) or root flares. | Tree health is based on the definition of retainable trees found in the current Butternut Guidelines associated with the *Endangered Species Act 2007*. |
| *Guideline* - SGRs may specify that unhealthy butternut trees may be marked for removal to meet silvicultural objectives. However, marking will be conducted by designated *Butternut* | If unhealthy trees are to be removed, they must be identified by designated *Butternut Health Assessors* (BHAs), as per current guidelines for BHAs, and will be accompanied by appropriate *Butternut Health Assessment* documentation that is required under the current Butternut Guidelines associated with the *Endangered Species Act 2007*. |

| | |
|---|---|
| *Health Assessors* (BHAs), as per current guidelines for BHAs, and will be accompanied by appropriate *Butternut Health Assessment* documentation that is required under the current Butternut Guidelines ESA 2007. | |
| *Guideline* - When consistent with other silvicultural and ecological objectives, forest management plans will identify opportunities for regeneration of butternut. | Retention of healthy trees is intended to retain potentially resistant genetic material. When consistent with other silvicultural and ecological objectives, forest management plans will also identify opportunities for regeneration of butternut (see *Best management practices* below). |
| *Best management practices* | *Best management practices* are provided that may assist in developing prescriptions for regenerating butternut.<br>Butternut is a shade-intolerant tree with limited seed dispersal capability. Thus, relatively open conditions with a relatively high density of seed trees is required for successful regeneration (Ostry et al. 1994).<br>In stands with few butternuts/ha, the focus is simply on retention of healthy trees (and removal of unhealthy trees if feasible). Likelihood of regenerating butternut in this situation is low.<br>In stands with denser pockets of healthy butternut trees, direction focuses on creating stand conditions that are potentially suitable for butternut regeneration. Pockets are defined as ≥0.5 ha in size based on practical considerations of marking and tracking treatments. Depending on the density of potential butternut seed trees and the silvicultural system being used in the stand, group selection or uniform shelterwood is prescribed.<br>There is little direction in current silviculture guides from Ontario (OMNR 1998, 2000) or elsewhere for butternut. Prescribed direction is a combination of that contained in existing guides (e.g., OMNR 2000:182) and the expert opinion of foresters in Southern Region (Reid[1], pers. comm. 2006). |

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### 4.3.3 Invertebrates

No *Standards*, *Guidelines*, or *Best Management Practices* are presented for the rainbow mussel or monarch (see Table 4.3a).

**Background**

| **Species** | **West Virginia white** |
|---|---|
| S-rank | S3/G3G4 |
| Designation | *Special concern* |
| Trend – CDN | Unknown. Generally declining across its range in eastern North America (NatureServe 2006). |
| Trend - ON | Unknown. |
| Distribution | From southern Ontario and Quebec south to Alabama and Georgia (NatureServe 2006). Within Ontario, most known locations are south of the AOU. Scattered records from Algoma, Bancroft-Minden, and Mazinaw-Lanark FMUs (see Holmes et al. 1991). |
| Habits and habitat | A butterfly of mesic deciduous forest across its range (Bess 2005). Northern populations are typically found in rich moist tolerant hardwood forest characterized by mixtures of sugar maple, American beech, basswood, and/or hemlock (Coulson 1998, Bess 2005).<br>Adults emerge in spring and feed on nectar from a variety of early-flowering plants including trilliums, spring beauties, and violets. Mating occurs in late May and early June in northern latitudes. Eggs are laid on toothworts; almost exclusively on broad-leaved toothwort in northern latitudes. Caterpillars feed on the leaves and flowers of host plants until these spring ephemerals senesce in late June-early July (Bess 2005). |
| Effects of forest management | Loss of forest cover associated with landuse conversion has likely been the key factor responsible for historic declines in the West Virginia white (Bess 2005).<br>Currently, garlic mustard appears to be a serious threat. Garlic mustard is an introduced species that tolerates a broad range of moisture, light, and soil conditions and aggressively invades hardwood forests across eastern North America, including southern Ontario. Garlic mustard affects the West Virginia white in two ways. It can outgrow and ultimately replace many native herbs, such as toothworts, leading to a reduced supply of host plants (Bess 2005). In addition, West Virginia white butterflies will lay eggs on garlic mustard but larvae are generally unable to complete development (Blossey et al. 2002).<br>Relatively little quantitative information on the effects of forest management operations on this species. Clearcutting presumably creates unsuitable habitat, at least in the short term (Bess 2005). Harvesting may also fragment remaining suitable habitat because adults have limited dispersal ability and rarely cross open habitats (Cappuccino and Kareiva 1985). Adults will generally not even fly across powerlines or unshaded roads (i.e., those without overarching tree canopies) or through forest with <50 percent canopy cover (Bess 2005).<br>Forest management operations may also potentially have adverse effects on |

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| | the supply of host plants. Old unmanaged hardwood forest typically contains a diverse community of spring ephemerals including one or more toothwort species (Keddy and Drummond 1996). While harvesting often increases the overall diversity of vascular plants in the understory of hardwood forest (e.g., Crow et al. 2002), the abundance of some spring ephemerals may be negatively affected by removal of canopy cover (Moore and Vankat 1986, Meier et al. 1995). Changes in the abundance of understory vegetation may be related to physical disturbance of the forest floor (Reader 1987, Crow et al. 2002) or increased competition from other vegetation responding to increased light availability (Scheller and Mladenoff 2002); growth and proliferation of garlic mustard is especially influenced by light availability (Meekins and McCarthy 2000). However, the effects of harvesting on broad-leaved toothwort are poorly understood. Meier et al. (1995) noted that broad-leaved toothwort was common in small patches (1-3 ha) of uncut, thinned, and even clearcut hardwood forest in North Carolina. In contrast, Scheller and Mladenoff (2002) noted average cover of the closely related cutleaf toothwort was 0.32%, 0.01%, and 0.00% in old growth, even-aged second growth, and managed uneven-aged hardwood forest, respectively, in Michigan and Wisconsin.<br><br>The larvae of the West Virginia white are thought to be very sensitive to *Btk*. Thus gypsy moth control programs are thought to have a negative effect on this species (NatureServe 2006).<br><br>Browsing of toothwort by white-tailed deer is often listed as a potential threat (NatureServe 2006) but at least cutleaf toothwort does not appear to be heavily browsed by deer (Frankland and Nelson 2003). |
| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. Coarse filter direction in the *Landscape Guide* maintains a supply of potentially suitable habitat across landscapes. Within occupied habitat, forest management operations may potentially alter suitable stand structure, affect abundance of food plants, facilitate invasion by garlic mustard, and create barriers to movement. Thus, direction identifies occupied habitat as AOCs and focuses on:

- maintaining suitable stand structure,
- minimizing soil disturbance, and
- minimizing creation of barriers to movement.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | The AOC is defined as suitable habitat known to be occupied by this species as delineated by field survey (see Coulson 1998). |
| *Standard* - Selection harvest is permitted within the AOC subject to timing restrictions; other types of harvest are not permitted | Clearcutting creates unsuitable habitat; even harvest that reduces canopy closure below 50% is thought to create barriers to movement (see above). Moreover, significant canopy removal may adversely affect toothwort abundance or may facilitate introduction or spread of garlic mustard (see above). Thus, only selection harvest is permitted within occupied habitat. |

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| within the AOC. | |
| *Standard* - Renewal and tending operations are permitted within the AOC subject to timing restrictions. | Renewal and tending operations associated with selection harvest are not likely to adversely affect habitat suitability and are thus permitted within the AOC subject to timing restrictions. |
| *Guideline* - All equipment will be thoroughly washed before use in the AOC when there is a risk of introducing garlic mustard. | Invasion of garlic mustard may be the greatest threat to habitat suitability (see above). Thus, all equipment must be thoroughly washed before use in the AOC when there is a risk of introducing garlic mustard. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *frost-free period* except in extraordinary circumstances, as specifically identified and justified through the FMP AOC planning process. | Disturbance of the forest floor may adversely affect toothwort abundance or may facilitate introduction or spread of garlic mustard (see above). Thus, all harvest, renewal, and tending operations must take place when the forest floor is frozen to minimize site disturbance. |
| *Guideline* - The *frost-free period* is defined as April 1 to December 31. Local knowledge may be used to adjust these dates to ensure operations will not be conducted when there is a significant risk of soil disturbance. | Dates for the *frost-free period* are based on discussions with local field staff. |
| *Standard* - Landings and aggregate pits are not permitted within the AOC. | Landings and aggregate pits create large canopy gaps, potentially reducing habitat suitability. They also represent a significant disturbance of the forest floor, potentially removing toothwort or permitting introduction or spread of garlic mustard. Thus, landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - New roads are not permitted within the AOC unless there is no practical or feasible alternative, the potential impact on West Virginia white habitat can be mitigated (e.g., the | To minimize creation of barriers to dispersal (and reduce the risk of introducing garlic mustard), no roads are permitted within the AOC unless there is no practical or feasible alternative. If roads are required, they should be located to minimize effects on the West Virginia white and cleared rights-of-way should be as narrow as possible. |

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| cleared right-of-way will not exceed 10 m for operational roads and 20 m for primary and branch roads), and the road, including specific location, is identified and justified through the FMP AOC planning process. | |

Since this species is apparently sensitive to *Btk*, no aerial application of insecticides should be permitted within the AOC.

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### 4.3.4 Fish

No *Standards*, *Guidelines*, or *Best Management Practices* are presented for the 11 species at risk found within the AOU. Forest management operations are generally not viewed as contributing to the decline of these species or as a principle threat to their persistence (see Table 4.3a). Thus, general direction for maintaining suitability of aquatic and wetland habitats (Section 4.1), and continuing adherence to the *Fisheries Act 1995,* the *MNR/DFO Fish Habitat Compliance Protocol* (2007), and the *Protocol for the Review of Water Crossings Proposed Through the Forest Management Planning Process* (2005) are considered sufficient. However, in Section 4.1, aquatic features containing fish that are species at risk are considered to have high potential sensitivity to forest management operations and are subject to the most restrictive direction.

Forest access roads may potentially increase the risk of introducing fish species that may prey upon or compete with fish that are species at risk. Thus, planning teams may choose to place additional restrictions on the construction, use, or decommissioning of roads around aquatic features that support fish that are species at risk, such as the redside dace, that may be adversely affected by introduced species (see discussion on strategic road planning in Section 5.1.1).

### 4.3.5 Amphibians and reptiles

#### 4.3.5.1 Lizards

No *Standards*, *Guidelines*, or *Best Management Practices* are presented (see Table 4.3a).

#### 4.3.5.2 Snakes

**Background**

| **Species** | **Eastern foxsnake, eastern hog-nosed snake, eastern ratsnake, eastern ribbonsnake, massasauga, milksnake** |
|---|---|
| Description | Six snakes designated as species at risk occur within the GLSL portion of the AOU: eastern foxsnake (*threatened*), eastern hog-nosed snake (*threatened*), eastern ratsnake (*threatened*), eastern ribbonsnake (*special concern*), massasauga (*threatened*), and milksnake (*special concern*). |
| Habits and habitat | All species may be found in the forest but generally prefer non-forested habitats (e.g., wetlands), forest openings, sparse forest, forest edges, or habitat characterized by small scale field-forest mosaics (e.g., Weatherhead and Charland 1985, Keller and Heske 2000, Blouin-Demers and Weatherhead 2001, MacKinnon 2005, Rouse 2006, Row and Blouin-Demers 2006; and see Table 4.3b).<br><br>These snakes overwinter singly or communally in traditionally-used sites known as hibernacula. Snakes typically hibernate in animal burrows, rock crevices, caverns, fissures, or within hummocks or tussocks in wetlands (see Table 4.3b). Hibernacula are located below the frost line to avoid freezing and have sufficient moisture to prevent desiccation. Eastern foxsnakes, eastern ratsnakes, and massasaugas show the greatest fidelity to communal hibernacula and may also be found concentrated (staging) in the vicinity of hibernacula for several days to weeks when snakes are entering and/or emerging from hibernacula (e.g., Reinert and Kodrich 1982; Weatherhead and Hoysak 1989; Johnson 2000; |

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| | Rouse[1], pers. comm. 2007). The other 3 species are typically less likely to use communal hibernacula, or show less fidelity, or exhibit less staging behaviour (Thompson[2], pers. comm. 2007).<br><br>The massasauga and eastern ribbonsnake give birth to live young. Gravid massasaugas restrict their activities to specific locations during summer known as gestation sites. Gestation sites are small (<1 ha), are generally found in forest openings (often rock outcrops), and are typically associated with enduring features such as large flat rocks ('table rocks') that provide basking sites and cover. Individual gestation sites may be used over many years, frequently by multiple females (Black[3], pers. comm. 2007, Rouse[1], pers. comm. 2007). Gravid ribbonsnakes do not appear to have special habitat requirements.<br><br>The other 4 species lay eggs at locations termed oviposition sites. Oviposition sites include large logs and stumps, decaying leaf piles, sandy areas, rocks, and rock crevices (see Table 4.3b). Because warm temperatures are critical for successful incubation of eggs, oviposition sites almost always occur in areas with open canopies. Sites may be used by more than one female in multiple years (e.g., Blouin-Demers et al. 2004). |
| Effects of forest management | Main threats to these species are habitat loss resulting from human development, persecution, and traffic-related mortality (COSEWIC 2000, 2002a, 2002b, 2002c, 2007a, 2007b). Even non-lethal human contact can affect behaviour (e.g., Parent and Weatherhead 2000).<br><br>There is little quantitative information on the effects of forest management operations on these species. Since these species show a strong affinity for non-forested habitats, sparse forest, and forest edges, harvest, renewal, and tending operations may actually improve habitat suitability (e.g., Johnson and Leopold 1998). However, some species may avoid roads and trails (e.g., Weatherhead and Prior 1992, Durner and Gates 1993). Moreover, forest management operations, especially road construction and aggregate extraction, have the potential to affect hibernacula and/or gestation/oviposition sites. |
| Past direction | No species-specific direction. |

**Table 4.3b. Information on status, distribution, general habitat requirements, gestation/oviposition sites, and hibernation sites for snakes that are species at risk and occur within the AOU.**

| Species | Status & Distribution | General Habitat | Gestation or Oviposition Sites | Hibernation Sites | References |
|---|---|---|---|---|---|
| Eastern foxsnake | *Threatened* (S3/G3) - mostly within 1 km of coastline of Georgian Bay in the French- | Non-forested habitats, sparse forest, and forest edges, especially coastal rock barrens and meadow marshes; usually | Eggs typically laid late June to mid-July in decaying logs or stumps. Communal nesting common. Eggs hatch from late August to | Hibernates communally in traditionally used bedrock fissures, animal burrows, and anthropogenic features from September through | COSEWIC 2000, Lawson 2005, MacKinnon 2005 |

[1] Jeremy Rouse, OMNR, Parry Sound District, Parry Sound, ON
[2] Shaun Thompson, OMNR, Kemptville District, Kemptville, ON
[3] Ron Black, OMNR, Parry Sound District, Parry Sound, ON

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| | Severn FMU. | within 150 m of the Georgian Bay shoreline. | early October. | May. | |
| Eastern hog-nosed snake | *Threatened* (S3/G5) – Algonquin Park Bancroft-Minden, French-Severn, & Nipissing FMUs. | Open grassy, sandy, or rocky habitats typically used; also uses forested habitats and forest edges. | Eggs typically laid mid-June to mid-July in excavations in sandy soil or under rocks. Communal nesting infrequent but fidelity to nest sites reported. Eggs hatch from late August to early September. | Hibernates singly in excavations in sandy soil or animal burrows from September through May. Fidelity to hibernacula not commonly reported. | COSEWIC 1996, 2007b; Cunnington and Cebek 2005; Rouse 2006 |
| Eastern ratsnake | *Threatened* (S3/G5) - Mazinaw-Lanark FMU. | Mosaic of fields and deciduous forest with high edge density. | Eggs typically laid in late June to early August in decaying wood (snags, stumps, logs), leaf piles, or compost piles. Communal nesting common; nests may be used by multiple females for multiple years. Eggs hatch from late August to early October. | Hibernates communally in traditionally used bedrock fissures from October through May. | Weatherhead and Charland 1985, Prior and Weatherhead 1996, Blouin-Demers et al. 2004, COSEWIC 2007a |
| Eastern ribbonsnake | *Special concern* (S3/G5) - Bancroft-Minden, French-Severn, Mazinaw-Lanark, & Pembroke FMUs. | Semi-aquatic species typically found along the edge of ponds, streams, and wetlands. | Gives birth to live young in late summer. Gravid females do not appear to have special habitat requirements. | Hibernates in animal burrows or rock crevices from October through April. May hibernate communally; fidelity to hibernacula not reported. | COSEWIC 2002a |
| Massasauga | *Threatened* (S3/G3G4) – Sudbury & French-Severn FMUs. | Rock barrens, conifer swamps, beaver meadows, thicket swamps, fens, bogs, and shoreline habitats. | Gives birth to live young in late summer. Gravid females associated with open habitats known as gestation sites | Hibernates in bedrock fissures, cavities associated with tree and shrub roots, animal burrows, and within hummocks or tussocks in | COSEWIC 2002b, Rouse 2006, Rouse pers. comm. 2007 |

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| | | | from mid-July to mid-September. May be used by multiple females; site fidelity common. | wetlands from September through May. May hibernate communally; fidelity to hibernacula reported. | |
| Milksnake | *Special concern* (S3/G5) - FMUs from Algoma to Nipissing and south. | Habitat generalist; meadows, fields, rock outcrops, upland and lowland forests, and forest edges. | Eggs typically laid in late May to early July in decaying logs and stumps, animal burrows, and other organic debris. Communal nesting typical. Eggs hatch in August or September. | Hibernates in bedrock fissures, animal burrows, and anthropogenic features from October through April. Often hibernates communally; fidelity to hibernacula reported. | COSEWIC 2002c |

**Rationale for direction**

Species at risk. Coarse filter direction in the *Landscape Guide* and other sections of this guide maintains a supply of potentially suitable habitat across landscapes. Some types of forest management operations might adversely affect oviposition/gestation sites and/or hibernacula that are frequently used by numerous individuals over multiple years. Protection of traditional, communal hibernacula considered to be important for the conservation of threatened species of snakes at northern latitudes (Prior and Weatherhead 1996).

The eastern foxsnake, eastern ratsnake, and massasauga show the greatest fidelity to communal hibernacula and may also be found concentrated (staging) in the vicinity of hibernacula for several days to weeks when snakes are entering and/or emerging from hibernacula (see above). Thus, direction identifies hibernacula used by these species as AOCs and focuses on:

- prohibiting physical disturbance of known hibernacula and
- minimizing operations involving heavy equipment around known hibernacula during the fall entrance and spring emergence periods when snakes are staging.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable known hibernacula used by the eastern foxsnake, eastern ratsnake, or massasauga at least once within the past 20 years and habitat within a 100 m radius defines the AOC. The size of the AOC (100 m) is based on the distance staging radio-tagged eastern ratsnakes and massasaugas ranged from their hibernacula following spring emergence (Rouse[1], unpubl. data; Blouin-Demers[2], pers. comm. 2008). |

[1] Jeremy Rouse, OMNR, Parry Sound District, Parry Sound, ON
[2] Gabriel Blouin-Demers, Univ. Ottawa, Department of Biology, Ottawa, ON

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| *Standard* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions … | Habitat alteration is prohibited within the inner 50 m of the AOC, reflecting the maximum distance that microclimate/vegetation effects are reported to extend from forest edges (see Matlack 1993, Fraver 1994, Burke and Nol 1998). Residual forest is required within the remainder of the AOC; forest that does not meet the definition of residual assumed to be unsuitable as staging habitat. |
| *Guideline* - Harvest, renewal, and tending operations involving heavy equipment (e.g., skidders, mechanical harvesters) are not permitted within 51-100 m of the area delineated as the hibernaculum during the period when snakes are entering or emerging from hibernacula (and potentially staging), except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | To minimize the risk of killing or injuring snakes, harvest, renewal, and tending operations are prohibited within the AOC during the *entrance and emergence periods*. |
| *Guideline* - The *entrance and emergence periods* are defined as September 1 to October 15 and April 15 to June 1. Local knowledge may be used to adjust these dates. | Snakes typically enter hibernacula from early September to mid-October and emerge from mid-April to early June (Weatherhead and Hoysak 1989; Blouin-Demers et al. 2000; COSEWIC 2000; COSEWIC 2002b; MacKinnon 2005; Rouse[1], unpubl. data). Thus, the *entrance and emergence periods* are defined as September 1 to October 15 and April 15 to June 1. |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 50 m of the area delineated as the hibernaculum. | A 50 m buffer of unharvested forest is prescribed around hibernacula (see above). Thus, no roads, landings, or aggregate pits are permitted within 50 m since these features modify habitat and increase the risk of traffic-related mortality. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and | Roads (and associated landings and aggregate pits) create access that may increase the risk of traffic-related mortality. Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within the outer 50 m of the AOC. |

[1] Jeremy Rouse, OMNR, Parry Sound District, Parry Sound, ON

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| aggregate pits within 51-100 m of the area delineated as the hibernaculum. | |
| *Guideline* - When operational roads are constructed within the AOC, winter roads and/or temporary water crossings will be used whenever practical and feasible to limit future access and disturbance. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and risk of traffic-related mortality. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *entrance/emergence periods*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *entrance and emergence periods*. |
| *Guideline* - Hauling and road maintenance operations (except when required for safety reasons or environmental protection) are not permitted on existing roads within 50 m of the area delineated as the hibernaculum during the *entrance/emergence periods*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Hauling and road maintenance operations may cause traffic-related mortality of snakes staging before entering or emerging from hibernacula. The risk of traffic-related mortality is assumed to be greatest in the inner half of the AOC. Thus, hauling and road maintenance operations are not permitted within 50 m of hibernacula during the *entrance and emergence periods*. |
| *Guideline* - Hauling and road maintenance operations (except | The risk of traffic-related mortality is assumed to be greatest in the inner half of the AOC. Thus, hauling and road maintenance operations may be permitted within the outer 50 m of the AOC during the *entrance and* |

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| when required for safety reasons or environmental protection) are not permitted within 51-100 m of the area delineated as the hibernaculum during the *entrance/emergence periods* unless accompanied by mitigative measures (e.g., operator awareness training). | *emergence periods,* but only if accompanied by measures to mitigate the risk of traffic-related mortality (e.g., operator awareness training). |

The eastern hog-nosed snake, eastern ribbonsnake, and milksnake are typically less likely to use communal hibernacula, show less fidelity, or exhibit less staging behavior. Thus, a small AOC (30 m) is prescribed in which harvest, renewal, and tending operations, and new roads, landings, and aggregates are not permitted. A 30 m AOC ensures no trees could be accidentally felled onto hibernacula and is of sufficient width to at least partially ameliorate microclimate/vegetation effects associated with forest edges (see Matlack 1993, Fraver 1994, Burke and Nol 1998). To minimize the risk of injury to snakes, hauling and road maintenance on existing roads and aggregate extraction from existing pits is not permitted within the AOC during the *entrance and emergence periods*. The AOC applies only to hibernacula known to have been used within 5 years because use of these features tends to be relatively ephemeral.

In most cases, forest management operations are unlikely to have significant effects on gestation/oviposition sites. Thus, a small AOC (30 m) is prescribed in which harvest, renewal, and tending operations, and new roads, landings, and aggregates are not permitted. A 30 m AOC ensures no trees could be accidentally felled onto gestation/oviposition sites and is of sufficient width to at least partially ameliorate microclimate/vegetation effects associated with forest edges (see Matlack 1993, Fraver 1994, Burke and Nol 1998). To minimize the risk of injury to snakes, hauling and road maintenance on existing roads and aggregate extraction from existing pits is not permitted within the AOC during the *egg laying and incubation periods* (June 1 to October 15). The AOC applies only to oviposition sites known to have been used within 5 years because use of these features tends to be relatively ephemeral. However, because gestation sites are enduring features, the AOC applies to sites known to have been used within 20 years.

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#### 4.3.5.3 Turtles

**Background**

| **Species group** | **Turtles** |
|---|---|
| Description | Six species of turtles found in the AOU are designated as species at risk: Blanding's turtle (*threatened*), eastern musk turtle (*threatened*), northern map turtle (*special concern*), spiny softshell (*threatened*), spotted turtle (*endangered*), and wood turtle (*endangered*). All 6 species are restricted to the GLSL forest region. |
| Habits and habitat | The eastern musk turtle, northern map turtle, spiny softshell, and stinkpot are almost entirely aquatic, typically inhabiting lakes, ponds, rivers, and streams (see Table 4.3c). These species are rarely found far from water, even when nesting (COSEWIC 2002a, b, c).<br><br>The Blanding's turtle and spotted turtle are typically associated with ponds or wetlands. Both species are considered to be semi-terrestrial. In some areas, spotted turtles are rarely found more than a few meters from water (Haxton and Berrill 1999) but in other areas they may spend up to half the summer buried in terrestrial 'forms' on rock outcrops or in forests up to 80 m from water (Litzgus and Brooks 2000, Joyal et al. 2001). Blanding's turtles are frequently found in terrestrial habitats while moving between wetlands which may be as far as 900 m apart (Ross and Anderson 1990, Rowe and Moll 1991). Moreover, in Maine, they have been found basking up to 40 m from water and may spend extended periods of dormancy buried in leaf litter in upland forest up to 110 m from water (Joyal et al. 2001).<br><br>The wood turtle is the most terrestrial of the turtles found within the AOU. In spring, wood turtles are found almost exclusively near rivers and large streams. In summer, males tend to stay in or near water while females spend lengthy periods on land, often making extensive inland movements, particularly in mid to late summer.<br><br>Eggs of turtles are typically laid in sandy or gravelly substrates in open situations, but are sometimes laid in moss, leaf litter, rotting wood or even on muskrat houses (Table 4.3c). Nest sites are frequently located on sandy or gravelly bars, points, or beaches in lakes, rivers, or streams, but anthropogenic features such as sandy roadsides, railway embankments, and aggregate pits are also often used (Table 4.3c). In some species, numerous females nest in the same general location. Females may make long movements (>1 km) to nest sites (Pluto and Bellis 1988, Joyal et al. 2001, Galois et al. 2002). Nest sites of the semi-terrestrial turtles may be some distance from water. For example, nests of the spotted turtle, wood turtle, and Blanding's turtle averaged about 50 m from water in Maine (Joyal et al. 2001), about 60 m from water in Massachusetts (Siart 1999), and about 200 m from water in Maine and Wisconsin (Ross and Anderson 1990, Joyal et al. 2001), respectively.<br><br>Within the AOU, 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 of, and |

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| | site fidelity to, hibernacula (Table 4.3c). |
| Effects of forest management | Little quantitative information on the effects of forest management operations. For the aquatic species, main threats are generally considered to be development and recreational use of shorelines, water level control, wetland drainage, environmental contaminants, and illegal collection (COSEWIC 2002a, b, c). For the semi-terrestrial species, main threats are generally considered to be illegal collection, traffic-related mortality, and permanent loss of habitat to agriculture and urbanization (COSEWIC 2004, 2005).<br><br>Forest access roads may increase risk of loss due to illegal collection and traffic-related mortality, especially in the vicinity of nesting areas and hibernacula (Brooks et al. 1992). Road construction could potentially also alter habitat suitability at nesting sites or hibernacula. For example, roads across wetlands might result in deeper penetration of frost during winter and thus potential freezing of hibernating turtles (Haxton 1998).<br><br>Forest harvesting may ultimately be beneficial to some species. For example, foraging wood turtles appear to favour shrubby habitats or young forest with low canopy closure (Quinn and Tate 1991, Compton et al. 2002, Arvisais et al. 2004). Moreover, early successional habitats (including clearcuts) may represent important nesting habitat for spotted turtles (Litzgus and Mosseau 2004). |
| Past direction | A draft guide was developed for wood turtles by Trute et al. (2004) and has been used as interim direction in Southern Region. Habitat protection for the wood turtle is addressed by ONTARIO REGULATION 437/09. No formal direction for the other species. |

**Table 4.3c. Information on status, distribution, general habitat requirements, nesting sites, and hibernation sites for turtles that are species at risk and occur within the AOU.**

| Species | Status & Distribution | General Habitat | Nesting Sites | Hibernation Sites | References |
|---|---|---|---|---|---|
| Blanding's turtle | *Threatened* (S3/G4) – Northshore to Nipissing FMUs and south. | Permanent wetlands with open water and submerged vegetation provide habitat throughout the active season and the majority of hibernation sites; small seasonal wetlands are used as foraging habitat and thermal refugia during summer. | Nesting typically occurs in June. Eggs generally laid in upland areas with sparse vegetation, often along roadways or in other disturbed habitats. Individual females return to the same general area to nest each year. | Anoxia-tolerant. Hibernates fully or partially buried in mud or organic substrates in wetlands, pools, or streams. Up to 14 individuals may use the same overwintering site; site fidelity appears to be common. | Joyal et al. 2001, COSEWIC 2005, Congdon and Keinath 2006, Ultsch 2006 |
| Eastern musk turtle | *Threatened* (S3/G5) - French-Severn, | Aquatic turtle of shallow lakes, ponds, marshes, and slow-moving | Nesting occurs in June and July. Eggs laid in shallow | Anoxia-intolerant. Hibernates underwater in mud or in mink or | Ernst 1986, COSEWIC 2002c, |

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| | Bancroft-Minden, Mazinaw-Lanark, & Ottawa Valley FMUs. | rivers and streams. | depressions in leaf litter, rotting wood, loamy soil, or gravel or soil-filled rock crevices; typically within 10 m of water. Sites may be used by >1 female; annual nest site fidelity. | muskrat burrows. May hibernate communally. | Ultsch 2006 |
| Northern map turtle | *Special concern* (S3/G5) – Sudbury, French-Severn, Bancroft-Minden, Mazinaw-Lanark, & Ottawa Valley FMUs. | Aquatic turtle found in lakes and large rivers with slow current and muddy bottom. | Nesting typically occurs in June and July. Eggs generally laid along sandy shorelines with low slope, sparse low vegetation, few roots, and few rocks. Sites may be used by numerous females. | Anoxia-intolerant. Hibernates on top of sand/gravel substrates or among submerged rocks and logs in deep pools in rivers. Hibernates communally. | Flaherty and Bider 1984, Pluto and Bellis 1988, Graham et al. 2000, COSEWIC 2002a, Ultsch 2006 |
| Spiny softshell | *Threatened* (S3/G5) – along the Ottawa River in the Ottawa Valley FMU. | Aquatic turtle of lakes, reservoirs, rivers, and creeks. | Eggs laid in fine gravel or coarse sand associated with sandy bars or points in rivers or lakes. Sites may be used by >10 females. Site fidelity reported. | Anoxia-intolerant. Hibernates shallowly buried in mud in relatively deep, well-oxygenated water. May hibernate communally. | Williams and Christiansen 1981, COSEWIC 2002b, Galois et al. 2002, Ultsch 2006 |
| Spotted turtle | *Endangered* (S3/G5) - French-Severn, Bancroft-Minden, & Mazinaw-Lanark FMUs. | Semi-terrestrial turtle of ponds, bogs, fens, marshes, woodland pools, and sedge meadows. | Nesting occurs in June. Eggs are generally laid in shallow soil or moss overlying bedrock, occasionally on a muskrat house; most nests are close to water. Communal nesting not reported. | Anoxia-tolerant. Hibernates in bogs under moss or tree root hummocks or in rock caverns. May show strong fidelity to individual hibernacula, with up to 9 turtles occupying one hibernaculum. | Haxton and Berrill 1999, Litzgus et al. 1999, COSEWIC 2004, Ultsch 2006 |
| Wood turtle | *Endangered* (S2/G4) – Algoma, Northshore, Sudbury, Algonquin Park, | Associated with rivers and large streams in spring and fall. Females inhabit alder thickets, young open mixed forest, | Nesting occurs in June on sandy points, road shoulders, railway embankments, clearcuts, utility rights-of-way, | Anoxia-intolerant. Hibernates in deep pools under overhanging roots or logs along watercourses, in beaver lodges and | Quinn and Tate 1991, Brooks et al. 1992, Siart 1999, Compton et al. 2002, |

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| | Bancroft-Minden, & Ottawa Valley FMUs. | fens, bogs, and marshes during summer. | agricultural fields, pastures, old fields and aggregate pits, usually close to water. Communal nesting not reported. | muskrat burrows. Hibernacula known to support up to 70 individuals and may be utilized by the same individuals on a recurring basis. | Arivais et al. 2004, Trute et al. 2004 |

**Rationale for direction**

Species at risk. The Blanding's turtle, spotted turtle, and wood turtle are *threatened* or *endangered*, terrestrial or semi-terrestrial (and thus most likely to be directly affected by road traffic and forest management operations), and/or potentially threatened by illegal collection. Thus, direction identifies habitat occupied by the Blanding's turtle and spotted turtle (wood turtle habitat is addressed by ONTARIO REGULATION 437/09) as AOCs and focuses on:

- minimizing access to populations by collectors,
- minimizing risk of direct mortality from traffic and forest management equipment, and
- protecting known nesting sites and hibernacula from unacceptable habitat alteration.

See species-specific direction below.

Direction identifies hibernacula used by the other 3 species as AOCs and focuses on protecting sites from unacceptable habitat alteration. Rationale for this direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable hibernacula and associated aquatic features known or suspected to have been used by the eastern musk turtle, northern map turtle, or spiny softshell at least once within the past 10 years define the AOC.<br>*Associated aquatic features* includes those features or parts of features that contain hibernacula and, within which, forest management operations have the potential to adversely affect the suitability of hibernacula. This includes river and stream segments 200 m above and below hibernacula (based on Trute et al. 2004) and normally, entire wetland polygons containing hibernacula. However, in the case of large wetland complexes, portions of the wetland contributing to the suitability of hibernacula may be delineated as the AOC. |
| *Standard* - Harvest, renewal, and tending operations are not permitted within the AOC. | Aquatic features containing hibernacula will rarely be forested habitats and thus directly affected by harvest, renewal, or tending operations. However, this restriction includes machine movement across features that contain hibernacula. |
| *Standard* - New all-weather roads, seasonal roads, or water crossings are not permitted within the AOC unless there is no practical or feasible alternative, and the road or water | Roads and water crossings may alter hydrological flow or frost penetration, potentially affecting suitability of hibernacula (see above). Thus, new all-weather roads, seasonal roads, or water crossings are not permitted within the AOC unless there is no practical or feasible alternative. |

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| crossing, including specific location, is identified and justified through the FMP AOC planning process. | |
| *Standard* - No operations permitted that would significantly alter hydrological flow (e.g., water drawdown). | No operations are permitted within the AOC that might otherwise significantly alter hydrological flow, potentially affecting suitability of hibernacula (e.g., water drawdown in beaver ponds). |
| *Guideline* - Reconstruction of water crossings within the AOC will be considered by MNR on a case-by-case basis. | Reconstruction of water crossings within the AOC may be acceptable if reconstructed crossings do not alter hydrological flow; considered by MNR on a case-by-case basis. |

Known nesting sites used by the eastern musk turtle, northern map turtle, or spiny softshell are protected by a small 30 m AOC in which harvest, renewal, and tending operations, and new roads, landings, and aggregates are not permitted. This AOC is consistent with that required for snakes that are species at risk (see Section 4.3.5.2). To minimize the risk of injury to nesting turtles or their nests, hauling and road maintenance on existing roads and aggregate extraction from existing pits is not permitted within the AOC during the *egg laying and incubation periods* (June 1 to September 30).

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**4.3.5.3 Continued**

**Background**

| **Species** | **Blanding's turtle** |
|---|---|
| S-rank | S3/G4 |
| Designation | *Threatened* |
| Trend – CDN | Declining (COSEWIC 2005). |
| Trend - ON | Declining (COSEWIC 2005). |
| Distribution | Found primarily in Ontario and US states bordering the Great Lakes, with disjunct populations in Nova Scotia and the New England states (COSEWIC 2005). Within the AOU, found predominantly along the coast of Georgian Bay, along the southern edge of the Canadian shield, and through the Ottawa Valley (COSEWIC 2005). |
| Habits and habitat | In the US, Blanding's turtles are generally active from March through November (Congdon and Keinath 2006). Only one detailed study of this species in Ontario; Edge (2008) considered the active season to run from May through September.<br><br>Primarily a species of ponds and wetlands (Ross and Anderson 1990, Rowe and Moll 1991, Hartwig and Kiviat 2005, Edge 2008). Ponds and permanent wetlands provide core habitat throughout the active season and the majority of hibernation sites; small seasonal wetlands (e.g., vernal pools) are used as foraging habitat and thermal refugia during summer in some areas (Congdon and Keinath 2006). In Ontario, swamps, ponds, marshes, bogs, lakes, and fens are preferred habitats (Edge 2008). Turtles may use >5 different ponds or wetlands within their home ranges, that may be >1 km apart (Ross and Anderson 1990, Piepgras et al. 1998, Joyal et al. 2001, Edge et al. 2007).<br><br>Species hibernates in organic substrates in wetlands (Congdon and Keinath 2006); bogs and fens are preferred to ponds and marshes in Ontario (Edge 2008). In Wisconsin, wetlands used by hibernating turtles were >0.5 m deep (Ross and Anderson 1990) but in Ontario, hibernating turtles appeared to prefer microsites that are shallower and colder than generally available (Edge 2008). Up to 14 individuals may use the same overwintering sites; site fidelity appears to be common (COSEWIC 2005).<br><br>Terrestrial habitats surrounding wetlands are also important components of habitat; individual turtles may spend days to weeks in upland habitat, either basking or aestivating (Rowe and Moll 1991, Joyal et al. 2001). In Maine, basking sites were within 40 m of wetlands and aestivation sites were within 110 m (Joyal et al. 2001). Turtles also use terrestrial habitats while moving between wetlands (Joyal et al. 2001, Edge 2008).<br><br>Nesting typically occurs in late May-early July (Congdon and Keinath 2006). Females may travel >1 km from wetlands occupied in spring to nest sites (Ross and Anderson 1990, Piepgras et al. 1998, Joyal et al. 2001). Individual females return to the same general area to nest each year (Congdon et al. 1983, Standing et al. 1999). Eggs are generally laid in upland areas with sparse vegetation, often along roadways or in other disturbed habitats (Congdon and Keinath 2006); nests were within a few meters of water in Nova Scotia (Standing et al. 1999) but a mean of 117 m from water in Ontario (Edge et al. |

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| | 2007), 135 m in Michigan (Congdon et al. 1983), 168 m in Wisconsin (Ross and Anderson 1990), and 242 m in Maine (Joyal et al. 2001). |
| Effects of forest management | Little quantitative information on the effects of forest management operations. Primary threats to populations are generally considered to be illegal collection (in Ontario, the species is protected from collection by the *Endangered Species Act 2007*), permanent loss of wetlands, and traffic-related mortality (COSEWIC 2005).<br><br>Forest access roads could potentially increase risk of loss due to illegal collection and traffic-related mortality. Female turtles appear to be especially vulnerable to traffic-related mortality (Steen et al. 2006). Population persistence appears to be very sensitive to even small increases in adult mortality (Congdon et al. 1993); annual loss of 2-3% of adults to traffic-related mortality is likely not sustainable (Gibbs and Shriver 2002). However, the magnitude and significance of traffic-related mortality on forest access roads is unknown. While there is anecdotal evidence of traffic-related mortality, Edge et al. (2007) did not record any traffic-related mortality in a study of 32 radio-tagged Blanding's turtles during 2 years in Algonquin Park. Only 1 of 51 radio-tagged Blanding's turtles was killed by traffic in a 2 year study in suburban Massachusetts (Grgurovic and Sievert 2005). Generally, traffic-related mortality is thought to be significant when the density of roads is >1 km/km$^2$ and traffic volume is >100 vehicles/lane/day (Gibbs and Shriver 2002).<br><br>Roads could also potentially affect the hydrology of wetlands used as hibernacula, especially if associated with water drawdown (see Spotted Turtle).<br><br>Harvest, renewal, and tending operations conducted in terrestrial habitats adjacent to ponds and wetlands could potentially affect turtles that are nesting, basking, aestivating, or moving between wetlands. However, the magnitude and significance to populations is unknown. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Threatened* species. General direction for ponds, wetlands, and woodland pools addresses suitability of aquatic habitats used by this species (Section 4.1). Forest management operations in occupied habitat may potentially cause mortality or facilitate illegal collection. Thus, direction identifies occupied habitat as AOCs and focuses on:

- reducing access to populations by collectors,
- minimizing risk of direct mortality from forestry-related traffic and forest management operations, and
- mitigating potential effects of forest management operations on special habitat features, especially known or suspected nesting sites and hibernacula.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable aquatic and associated habitats occupied by the Blanding's turtle within the past 20 years define the AOC.<br><br>*Suitable aquatic habitat* is defined as aquatic features that have a high potential to be used either during the active season (summer habitat) or |

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| | during hibernation (winter habitat) and include aquatic features that are both suitable as habitat (as identified by MNR based on field surveys or other reliable methods) and are either known to have been occupied based on field surveys or have a high likelihood of being occupied based on proximity (≤1 km) to individual *Element of Occurrence* observation points or other reliable sightings (a 1 km radius reflects the habitat delineation standards from *NatureServe* and captures average home range length; see Table 3 in Grgurovic and Sievert 2005).<br><br>*Associated habitats* include terrestrial habitats within 300 m of suitable aquatic habitat. A 300 m buffer around suitable aquatic habitat captures about 85% of the inter-wetland movements (Edge 2008), all basking and aestivation sites, and most nest sites (see above). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to the following restrictions: | Mortality or injury associated with encounters with heavy equipment is a potential risk (although there are no documented cases of this in a forestry context). Thus, restrictions are placed on harvest, renewal, and tending operations within the AOC. |
| *…* Harvest, renewal, and tending operations are not permitted within 30 m of known or suspected nesting sites or within 30 m of suitable summer habitat. | No harvest, renewal, or tending operations are permitted within 30 m of known or suspected nest sites (as per other SAR turtles) or within 30 m of aquatic summer habitat (to minimize disturbance of habitat with the highest likelihood of being used by basking or aestivating turtles). |
| *…* Operations involving heavy equipment (e.g., mechanical harvesters, skidders, bulldozers) or otherwise representing a potential injury risk to turtles are not permitted within suitable winter habitat (any season), within 150 m of suitable summer habitat during the *active season*, or within 151-300 m of suitable summer habitat during the *nesting period*. | Most terrestrial activity occurs within 150 m of aquatic habitats. For example, basking sites may be up to 40 m from water and aestivation sites may be up to 110 m from water (Rowe and Moll 1991, Joyal et al. 2001). Moreover, between 33 and 80% of inter-wetland movements occur within 100-200 m of wetlands (Edge 2008). However, during June, nesting females may be found within the entire 300 m buffer around aquatic habitats. Thus, direction is more restrictive within 150 m than 151-300 m of aquatic habitats, except during the nesting period. No operations involving heavy equipment are permitted within winter habitat during any season since these could potentially adversely affect suitability as hibernation sites. |
| *Guideline* - A local strategy will be developed to address how turtles will be protected if encountered during | Because turtles may be found >150 m from aquatic habitats during inter-wetland movements throughout the active season, a local strategy will be developed to address how turtles will be protected if encountered during operations. This strategy may involve options such as temporary cessation of operations or relocation of turtles by appropriate staff. |

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| operations. | |
| *Guideline* - The *active season* is defined as May 1 to September 30. The *nesting period* is defined as June 1 to 30. Local knowledge may be used to adjust these dates. | In Ontario, the active season runs from May through September; most nesting occurs in June (see above). |
| *Standard* - Landings and aggregate pits are not permitted within 150 m of suitable summer habitat. | To minimize access and future disturbance within terrestrial habitat most likely to be used during the active season (see above), landings and aggregate pits are not permitted within 150 m of suitable summer habitat. |
| *Standard* - New roads (including winter roads) are not permitted within suitable winter habitat or within 30 m of known or suspected nesting sites. | Roads are not permitted within winter habitat since they may affect the suitability of hibernacula by altering hydrological flow or frost penetration.<br>Roads are not permitted within 30 m of known or suspected nesting sites to reduce risk of illegal collection and traffic-related mortality. |
| *Standard* - Road construction and aggregate extraction are not permitted within 150 m of suitable summer habitat during the *active season* or within 151-300 m of suitable summer habitat during the *nesting period.* | See rationale for restrictions on harvest, renewal, and tending operations during the *active season* and the *nesting period*. |
| *Standard* - Water drawdowns are not permitted in suitable aquatic habitat. | Water drawdowns (e.g., removal of beaver dams) may adversely affect habitat suitability and are thus not permitted in suitable aquatic habitat. |
| *Standard* - During the *active season*, use of roads within the AOC will be accompanied by driver awareness training. | During the *active season*, use of roads within the AOC will be accompanied by driver awareness training designed to minimize risk of traffic-related mortality. |
| *Standard* - Within 150 m of suitable summer habitat, dust control may be accomplished with the use of water | Chemical dust suppressants, such as calcium chloride, are generally not considered to be highly toxic to terrestrial or aquatic organisms if applied at recommended rates (Bolander and Yamada 1999, Jones 1999). However, concern was expressed by members of the *Ontario Multi-species Turtles At Risk Recovery Team* that chemical dust suppressants |

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| only. | might potentially cause desiccation of turtle eggs in nests along roads. Thus, dust control may be accomplished with the use of water only along roads with a high likelihood of being used by nesting turtles (i.e., within 150 m of suitable summer habitat; see below). |
| *Guideline* - New all weather roads are not permitted within 150 m of suitable summer habitat unless there is no practical or feasible alternative, and the road, including specific location, is identified and justified through the FMP AOC planning process. | The primary threats to Blanding's turtles appear to be traffic-related mortality and, potentially, illegal collection (see above). Thus, new all weather roads are not permitted within terrestrial habitat most likely to be used during the active season (i.e., within 150 m of suitable summer habitat) unless there is no practical or feasible alternative. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new all weather roads, landings, and aggregate pits within 151-300 m of suitable summer habitat. | See rationale for restricting roads, landings, and aggregate pits within 150 m of suitable summer habitat. |
| *Guideline* - Reasonable efforts will be made to ensure roads constructed within the AOC will be located to avoid key habitat features (e.g., nesting sites, hibernacula) and concentrations of turtle sightings and to minimize access within the AOC. Roads will be located in consultation with MNR. | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Avoiding key habitat features (e.g., nesting sites, hibernacula) and concentrations of turtle sightings and minimizing the amount of the AOC accessed reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - Reasonable efforts will be made to promptly decommission new roads or implement access control measures within the AOC. | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Promptly decommissioning new roads or implementing access control measures reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - When roads are constructed | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Use of winter |

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| within the AOC, reasonable efforts will be made to use winter roads and temporary water crossings. | roads and temporary water crossings reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - Hauling is not permitted within 150 m of suitable summer habitat during the *active season* or within 151-300 m of suitable summer habitat during the *nesting period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *active season* and the *nesting period*. |
| *Guideline* - Use of roads within the AOC will be accompanied by a strategy to mitigate potential for traffic-related mortality of turtles if the road is used during the *active season*. Tactics may include … | Use of roads within the AOC will be accompanied by a strategy to mitigate potential for traffic-related mortality of turtles if the road is used during the *active season*. Tactics may range from warning signs, to speed limits, to gates based on the characteristics of expected traffic flow and local experience. |
| *Guideline* - During the *nesting and incubation periods* (June 1 to September 30) road maintenance operations that disturb the roadbed (except that required for safety reasons or environmental protection) are not permitted within 150 m of suitable summer habitat or along other road segments known or suspected to be used for nesting, except in extraordinary circumstances, as specifically identified and justified through the FMP AOC planning process. The | Destruction of nests during road maintenance operations is another potential forestry-related threat. Nests may be >300 m from water but the majority of nests in Ontario occur <150 m from water (Edge et al. 2007). Thus, road maintenance operations that disturb the roadbed are restricted on roads within 150 m of aquatic summer habitat or on roads known or suspected to be used for nesting during the *nesting and incubation periods*. |

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| timing of this restriction may be adjusted to reflect annual variation in weather or other local factors. | |

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**4.3.5.3 Continued**

**Background**

| **Species** | **Spotted turtle** |
|---|---|
| S-rank | S3/G5 |
| Designation | *Endangered* |
| Trend – CDN | Declining in Ontario (see below); may be extirpated in Quebec (COSEWIC 2004). |
| Trend - ON | Declining; of 104 local populations in Ontario, 35% may be extirpated and 50% may not have sufficient animals to be viable (COSEWIC 2004). |
| Distribution | Spotted turtles are found in disjunct populations across northeastern North America, including southern and central Ontario and southern Quebec (COSEWIC 2004). Within the AOU, spotted turtles are found only south of the French and Mattawa Rivers, primarily adjacent to Georgian Bay (COSEWIC 2004). |
| Habits and habitat | In central Ontario, spotted turtles are active from April through October (Litzgus et al. 1999, Haxton and Berrill 2001). In spring (April-May), spotted turtles migrate to marshes and ponds where they court and mate (Haxton and Berrill 1999, Litzgus and Brooks 2000). Nesting occurs in June. Eggs are generally laid in shallow soil or moss overlying bedrock (Litzgus and Brooks 1998); most nests are close to water (within 50 m in Pennsylvania [Ernst 1976], 100 m in Ontario [Litzgus[1], unpubl. data; Haxton[2], unpubl. data], 120 m in Maine [Joyal et al. 2001] but up to 312 m in Massachusetts [Milam and Melvin 2001]). During June through August, spotted turtles are generally associated with marshes (Haxton 1998, Haxton and Berrill 1999) but may also be found using seasonal wetlands in some areas (Joyal et al. 2001, Milam and Melvin 2001). In some parts of Ontario, they are rarely found more than a few meters from water throughout the summer (Haxton and Berrill 1999). In other parts of Ontario (and other parts of their range) they may spend up to half the summer months (July and August) buried in terrestrial 'forms' on rock outcrops or in upland or lowland forests (Litzgus and Brooks 2000, Joyal et al. 2001, Kaye et al. 2001, Milam and Melvin 2001). Upland aestivation sites were up to 80 m from water in Maine (Joyal et al. 2001), 166 m in Connecticut (Perillo 1997 cited in Bol 2007), and 412 m in Massachusetts (Milam and Melvin 2001).<br><br>In September and October, spotted turtles migrate to bogs where they may aestivate and eventually hibernate (Haxton and Berrill 1999); maximum distance moved from hibernacula was 70-869 m and 75-1025 m in 2 studies in Massachusetts (Kaye et al. 2001, Milam and Melvin 2001). Hibernacula may be under moss or tree root hummocks or in rock caverns (Litzgus et al. 1999). Spotted turtles may show strong fidelity to individual hibernacula, with up to 9 turtles occupying one hibernaculum (Litzgus et al. 1999, Haxton and Berrill 1999). |
| Effects of | Little quantitative information on the effects of forest management operations. |

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| forest management | Primary threats to populations across the species range are generally considered to be illegal collection (in Ontario, the species is protected from collection by the *Endangered Species Act 2007*), permanent loss of wetlands, traffic-related mortality, and pollution (COSEWIC 2004).<br><br>Forest access roads could potentially increase risk of loss due to illegal collection and traffic-related mortality. Female turtles appear to be especially vulnerable to traffic-related mortality (Steen et al. 2006). Population persistence of spotted turtles appears to be very sensitive to even small increases in adult mortality (Enneson and Litzgus 2008); annual loss of 2-3% of adults to traffic-related mortality is likely not sustainable (Gibbs and Shriver 2002). However, the magnitude and significance of traffic-related mortality on forest access roads is unknown. Generally, traffic-related mortality is thought to be significant when the density of roads is >1 km/km$^2$ and traffic volume is >100 vehicles/lane/day (Gibbs and Shriver 2002).<br><br>Construction of roads across occupied bogs might potentially affect the suitability of hibernacula if the roads modify hydrology or result in greater penetration of frost during winter (Haxton 1998).<br><br>Habitat alteration caused by forest harvesting not likely to affect spotted turtles; early successional habitats (including clearcuts) may actually represent important nesting (e.g., Litzgus and Mosseau 2004) or aestivation habitat (Ward et al. 1976). However, may potentially encounter heavy equipment when migrating to or from hibernacula or during nesting or summer aestivation. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Endangered* species. General direction for ponds and wetlands addresses suitability of aquatic habitats used by this species (Section 4.1). Forest management operations in occupied habitat may potentially cause mortality or facilitate illegal collection. Thus, direction identifies occupied habitat as AOCs and focuses on:

- reducing access to populations by collectors,
- minimizing risk of direct mortality from forestry-related traffic and forest management operations, and
- mitigating potential effects of forest management operations on special habitat features, especially known or suspected nesting sites and hibernacula.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable aquatic and associated habitats occupied by the spotted turtle within the past 20 years define the AOC.<br><br>*Suitable aquatic habitat* is defined as aquatic features that have a high potential to be used either during the active season (summer habitat) or during hibernation (winter habitat) and include aquatic features that are both suitable as habitat (as identified by MNR based on field surveys or other reliable methods) and are either known to have been occupied based on field surveys or have a high likelihood of being occupied based on proximity (≤500 m) to individual *Element of Occurrence* observation points or other reliable sightings (a 500 m radius reflects the habitat |

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| | delineation standards from *NatureServe* and captures average home range length; see Ernst 1970, Kaye et al. 2001, Milam and Melvin 2001).<br>*Associated habitats* include terrestrial habitats within 300 m of suitable aquatic habitat. A 300 m buffer around wetlands used during summer captures most nest and aestivation sites (see above). |
| *Standard* - Regular harvest, renewal, and tending operations are permitted within the AOC subject to the following restrictions: | Mortality or injury associated with encounters with heavy equipment is a potential risk (although there are no documented cases of this in a forestry context). Thus, restrictions are placed on harvest, renewal, and tending operations within the AOC. |
| … Harvest, renewal, and tending operations are not permitted within 30 m of known or suspected nesting sites, within 30 m of suitable summer habitat, or within 30 m of known or suspected aestivation sites. | No harvest, renewal, or tending operations are permitted within 30 m of known or suspected nest sites (as per other SAR turtles) or within 30 m of aquatic summer habitat (to minimize disturbance of habitat with the highest likelihood of being used by basking or aestivating turtles). Since aestivation sites may occasionally be >150 m from water (see below), a 30 m reserve is also prescribed for known or suspected aestivation sites. |
| … Operations involving heavy equipment (e.g., mechanical harvesters, skidders, bulldozers) or otherwise representing a potential injury risk to turtles are not permitted within suitable winter habitat (any season), within 150 m of suitable summer habitat during the *active season* (see below), or within 151-300 m of suitable summer habitat during the *nesting period*. | Most terrestrial activity occurs within 150 m of aquatic habitats. For example, all nest sites in Pennsylvania (Ernst 1976), Maine (Joyal et al. 2001), and Ontario (Litzgus[1], pers. comm. 2008; Haxton[2], pers. comm. 2008) were found within 150 m of water (some nests in Connecticut and Massachusetts were found >150 m from water; Perillo 1997 cited in Bol 2007, Milam & Melvin 2001). Moreover, most aestivation sites are within 150 m of water in Connecticut (Perillo 1997 cited in Bool 2007) and Maine (Joyal et al. 2001) (but >50% of sites were >150 m from water in Massachusetts; Milam & Melvin 2001). Thus, direction is more restrictive within 150 m than 151-300 m of aquatic habitats, except during the nesting period. No operations involving heavy equipment are permitted within winter habitat during any season since these could potentially adversely affect suitability as hibernation sites. |
| *Guideline* - A local strategy will be developed to address how turtles will be protected if encountered during operations. | Because turtles may be found >150 m from aquatic habitats throughout the active season, a local strategy will be developed to address how turtles will be protected if encountered during operations. This strategy may involve options such as temporary cessation of operations or relocation of turtles by appropriate staff. |

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| *Guideline* - The *active season* is defined as April 1 to October 31. The *nesting period* is defined as June 1 to 30. Local knowledge may be used to adjust these dates. | In Ontario, the active season runs from April through October; nesting occurs in June (see above). |
| *Standard* - Landings and aggregate pits are not permitted within 150 m of suitable summer habitat. | To minimize access and future disturbance within terrestrial habitat most likely to be used during the active season (see above), landings and aggregate pits are not permitted within 150 m of suitable summer habitat. |
| *Standard* - New roads (including winter roads) are not permitted within suitable winter habitat, within 30 m of known or suspected nesting sites, or within 30 m of known or suspected aestivation sites. | Roads are not permitted within winter habitat since they may affect the suitability of hibernacula by altering hydrological regime or frost penetration.<br>Roads are not permitted within 30 m of known or suspected nesting or aestivation sites to reduce risk of illegal collection and traffic-related mortality. |
| *Standard* - Road construction and aggregate extraction are not permitted within 150 m of suitable summer habitat during the *active season* or within 151-300 m of suitable summer habitat during the *nesting period.* | See rationale for restrictions on harvest, renewal, and tending operations during the *active season* and the *nesting period*. |
| *Standard* - Water drawdowns are not permitted in suitable aquatic habitat. | Water drawdowns (e.g., removal of beaver dams) may adversely affect habitat suitability and are thus not permitted in suitable aquatic habitat. |
| *Standard* - During the *active season*, use of roads within the AOC will be accompanied by driver awareness training. | During the *active season*, use of roads within the AOC will be accompanied by driver awareness training designed to minimize risk of traffic-related mortality. |
| *Standard* - Within 150 m of suitable summer habitat, dust control may be accomplished with the use of water | Chemical dust suppressants, such as calcium chloride, are generally not considered to be highly toxic to terrestrial or aquatic organisms if applied at recommended rates (Bolander and Yamada 1999, Jones 1999). However, concern was expressed by members of the *Ontario Multi-species Turtles At Risk Recovery Team* that chemical dust suppressants |

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| only. | might potentially cause desiccation of turtle eggs in nests along roads. Thus, dust control may be accomplished with the use of water only along roads with a high likelihood of being used by nesting turtles (i.e., within 150 m of suitable summer habitat; see below). |
| *Guideline* - New all weather roads are not permitted within 150 m of suitable summer habitat unless there is no practical or feasible alternative, and the road, including specific location, is identified and justified through the FMP AOC planning process. | The primary threats to spotted turtles appear to be traffic-related mortality and, potentially, illegal collection (see above). Thus, new all weather roads are not permitted within terrestrial habitat most likely to be used during the active season (i.e., within 150 m of suitable summer habitat) unless there is no practical or feasible alternative. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new all weather roads, landings, and aggregate pits within 151-300 m of suitable summer habitat. | See rationale for restricting roads, landings, and aggregate pits within 150 m of suitable summer habitat. |
| *Guideline* - Reasonable efforts will be made to ensure roads constructed within the AOC will be located to avoid key habitat features (e.g., nesting sites, hibernacula) and concentrations of turtle sightings and to minimize access within the AOC. Roads will be located in consultation with MNR. | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Avoiding key habitat features (e.g., nesting sites, hibernacula) and concentrations of turtle sightings and minimizing amount of the AOC accessed reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - Reasonable efforts will be made to promptly decommission new roads or implement access control measures within the AOC. | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Promptly decommissioning new roads or implementing access control measures reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - When roads are constructed | When roads must be constructed within the AOC, reasonable efforts will be made to mitigate potential effects of increased access. Use of winter |

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| within the AOC, reasonable efforts will be made to use winter roads and temporary water crossings. | roads and temporary water crossings reduces the risk of traffic-related mortality and illegal collection. |
| *Guideline* - Hauling is not permitted within 150 m of suitable summer habitat during the *active season* or within 151-300 m of suitable summer habitat during the *nesting period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for restrictions on harvest, renewal, and tending operations during the *active season* and the *nesting period*. |
| *Guideline* - Use of roads within the AOC will be accompanied by a strategy to mitigate potential for traffic-related mortality of turtles if the road is used during the *active season*. Tactics may include … | Use of roads within the AOC will be accompanied by a strategy to mitigate potential for traffic-related mortality of turtles if the road is used during the *active season*. Tactics may range from warning signs, to speed limits, to gates based on the characteristics of expected traffic flow and local experience. |
| *Guideline* - During the *nesting and incubation periods* (June 1 to October 31) road maintenance operations that disturb the roadbed (except that required for safety reasons or environmental protection) are not permitted within 150 m of suitable summer habitat or along other road segments known or suspected to be used for nesting, except in extraordinary circumstances, as specifically identified and justified through the FMP AOC planning process. The | Destruction of nests during road maintenance operations is another potential forestry-related threat. Nests may be >300 m from water but the majority of nests in Ontario occur <150 m from water (see above). Thus, road maintenance operations that disturb the roadbed are restricted on roads within 150 m of aquatic summer habitat or on roads known or suspected to be used for nesting during the *nesting and incubation periods*. |

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| timing of this restriction may be adjusted to reflect annual variation in weather or other local factors. | |

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### 4.3.6 Birds

No *Standards*, *Guidelines*, or *Best Management Practices* are presented for the loggerhead shrike, piping plover, or American white pelican (see Table 4.3a). The bald eagle, peregrine falcon, and short-eared owl are addressed in Section 4.2.2.

**Background**

| **Species** | **Cerulean warbler** |
|---|---|
| S-rank | S3B/G4 |
| Designation | *Special concern*; PIF Continental Watch List and Stewardship Species; BCR 12 Priority Species |
| Trend – CDN | Has shown the greatest decline of any warbler across North America from 1966-2000 (COSEWIC 2003). Within Canada, found primarily in Ontario where population has apparently been increasing over the last 50 years (see below). |
| Trend - ON | Apparently increasing in abundance over last 50 years (COSEWIC 2003). However, no significant change in the probability of observation between BBAs conducted in the 1980s and 2000s (Francis 2007). |
| Distribution | Found in northeastern North American, primarily from Minnesota and Missouri across to New York and North Carolina. Occurs at the northern edge of its range in Ontario (Hamel 2000). Found primarily south of the AOU; largest concentrations in the Carolinian forest and the Rideau Lakes area of eastern Ontario. Small number of sightings within the AOU (1% of OBBA squares within the Southern Shield Region); primarily along the southern edge of the Canadian shield (Francis 2007). |
| Habits and habitat | Builds small shallow cup nest on horizontal branches of hardwood trees of various species (Peck and James 1987). Nest height ranges from about 5 to 20 m (Hamel 2000); in Ontario, most nests were 9 to 12 m above ground (Peck and James 1987). Summer resident; typically breeds May through July (James 1991).<br><br>Typically nests in patches of mature tolerant hardwood forest (Peck and James 1987, Hamel 2000). Suitable nesting habitat has large, well-spaced trees used for foraging and a dense mid-story used for nesting. In West Virginia, occupied habitat had about 50 trees/ha >38 cm dbh (Weakland and Wood 2005).Territories in eastern Ontario established in forest with high basal area (average 29 $m^2$/ha)(Jones and Robertson 2001) but nests generally close to small canopy gaps (60% within 30 m; Oliarnyk and Robertson 1996). In a primarily forested region of Pennsylvania, habitat occupancy was positively related to proximity to canopy openings created by small clearcut blocks and associated roads (Rodewald 2005).<br><br>Although small canopy gaps may be an important component of nesting habitat, species is apparently sensitive to extensive forest fragmentation with ‘edge effects’ extending >300 m into forest (Weakland and Wood 2005, Wood et al. 2006). Minimum patch size occupied reported as ranging from as little as 10 ha to >1000 ha and may reflect landscape context and risk of nest-parasitism by brown-headed cowbirds (Hamel 2000). |
| Effects of | Principle threats considered to be loss and fragmentation of mature hardwood |

| | |
|---|---|
| forest management | forest (COSEWIC 2003).<br><br>Since this is a species of mature forest, negative effects of clearcutting on habitat use (e.g., Wood et al. 2005) are not surprising. Although dense forest is apparently preferred (see above), effects of selection-like harvesting may have limited effects on habitat use (Robinson and Robinson 1999, Twedt et al. 1999). Even shelterwood-like harvests appear to support moderate densities of this species (Rodewald and Yahner 2000, Wood et al. 2005).<br><br>Moreover, Jones and Robinson (2001) considered the species to be resilient to small scale disturbances including forest management operations associated with maple syrup production. A number of authors suggest that silviculture may be used to create or improve habitat for this species (Hunter et al. 2001, Hamel 2005, Hamel et al. 2005).<br><br>Roads and other small canopy gaps appear to have limited negative (but potentially positive) effects on this species. Weakland and Wood (2005) found territories were associated with roads more frequently than expected by chance. Oliarnyk and Robertson (1996) suggested nests were closer to dirt roads, rock outcrops, fields, and open water than expected by chance. Rodewald (2005) found habitat occupancy positively affected by proximity to small clearcuts and associated roads. |
| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. General habitat needs likely provided through coarse filter direction that creates a landscape mosaic including patches of mature tolerant hardwood forest varying in size (see *Landscape Guide*). Forest management operations may alter suitability of occupied habitat or disturb nesting birds. Thus, direction identifies occupied habitat as AOCs and focuses on:

- maintaining suitability of occupied habitat and
- avoiding disturbance of nesting birds during the *critical breeding period*.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding cerulean warblers within the past 10 years defines the AOC.<br><br>Occupied breeding habitat may be delineated through field survey or by identifying a 10 ha patch of suitable habitat associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 10 ha value represents the smallest patch of suitable habitat likely to be occupied (see above). |
| *Standard* - Selection harvest is permitted within the AOC following residual stand structure targets for old growth hardwood forest (see | Selection harvest appears to have minimal effect on habitat suitability (see above). However, a relatively high density of large well-spaced trees appears to be an important habitat component (see above). Thus, selection harvest is permitted outside the *critical breeding period*; following the old growth residual structural targets described in OMNR (2004:100) should maintain the density of large trees noted by Weakland and Wood (2005). |

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| the *Ontario Tree Marking Guide,* page 100) and subject to timing restrictions; other types of harvest are not permitted. | |
| *Standard* - Renewal and tending operations are permitted within the AOC subject to timing restrictions. | Renewal and tending operations associated with selection harvest are unlikely to have a significant effect on habitat suitability and are thus permitted within the AOC if conducted outside the *critical breeding period*. |
| *Standard* - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. | No modification to standard wildlife tree or downed woody material direction is considered necessary for this species. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Individual nest sites unlikely to be identified. Restricting operations to outside the *critical breeding period* ensures occupied nests will not be disturbed or destroyed. |
| *Guideline* - The *critical breeding period* is defined as May 1 to July 31 for all areas within the AOU. Local knowledge of breeding chronology may be used to adjust these dates. | Nesting begins in early-May and egg dates for Ontario range from May 24 to June 27 (James 1991). Thus, timing restriction from May 1 to July 31 should likely provide protection from initiation of nesting to fledging. |
| *Standard* - New aggregate pits are not permitted within the AOC. | Species appears to be sensitive to edge effects (see above). Aggregate pits represent large canopy openings and, potentially, a significant source of disturbance. Thus, new aggregate pits are not permitted within the AOC. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads and landings | Species appears to be sensitive to edge effects, but small canopy gaps actually appear to improve habitat suitability (see above). Thus, some new roads and small landings may be permitted within the AOC, but preferably only in large patches (>10 ha; see above). |

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| within the AOC, especially if the AOC is small (<10 ha). | |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for seasonal restrictions on harvest, renewal, and tending operations during the *critical breeding period*. |

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**4.3.6 Continued**

**Background**

| **Species** | **Kirtland's warbler** |
|---|---|
| S-rank | SHB/G1 |
| Designation | *Endangered*; PIF Continental Watch List; BCR 12 Priority Species |
| Trend – CDN | N/A, see below. |
| Trend - ON | Unknown. Recent record for 1 location in central Ontario the only documented breeding record for Ontario since 1945. About 70 records of spring and fall migrants or lone singing males across Ontario (Environ. Canada 2006). |
| Distribution | Primary breeding range restricted to Michigan, USA. However, recent record in central Ontario, historic breeding record near Midhurst, and frequent records of spring and fall migrants and lone singing males from Kenora to Petawawa. Proximity of expanding US population to Canadian border (within 25 km of Sault Ste. Marie) suggests potential for more sightings in Ontario (Environ. Canada 2006). However, microclimatic tolerances may limit potential distribution to southern portions of jack pine range (i.e., the GLSL forest) (Mayfield 1992). |
| Habits and habitat | Builds small shallow cup nest on the ground concealed by grass and other low vegetation such as blueberry, dwarf cherry, and sweetfern (Mayfield 1992). Nests not reused (Mayfield 1992).<br>Nests in large patches of young jack pine forest on well-drained sandy soils. Suitable patches are at least 30 ha in size, but preferably >80 ha, comprised of dense (>2500-3500 stems/ha, 35-65% canopy cover) stands 7 to 20 years old with some small openings (Anderson and Storer 1976, Probst and Hayes 1987, Probst 1988, Mayfield 1993). Spatial and temporal distribution influenced by landscape structure (Zou et al. 1992, Kashian and Barnes 2000). |
| Effects of forest management | Principle threats considered to be supply of young dense jack pine forest (in GLSL forest) and nest-parasitism by brown-headed cowbirds (Environ. Canada 2006).<br>Since this species inhabits young forest (≤20 years old), harvesting is generally beneficial as long as patches created are of sufficient size (see above) and renewal and tending operations do not promote a shift in tree species composition or produce stands that are too open (see above)(Probst 1988, Environ. Canada 2006). Prescribed burning may be an effective tool in producing suitable ground cover conditions (Probst and Donnerwright 2003). |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Endangered* species. General habitat needs likely provided through coarse filter direction that creates a landscape mosaic including patches of jack pine forest varying in age and size (see *Landscape Guide*). Forest management operations may alter suitability of occupied habitat or disturb nesting birds. Thus, direction identifies occupied habitat as AOCs and focuses on:

- maintaining suitability of occupied habitat and
- avoiding disturbance of nesting birds during the *critical breeding period*.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding Kirtland's warblers within the past 20 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying a 30 ha patch of suitable habitat associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 30 ha value represents the smallest patch of suitable habitat likely to be occupied (see above). |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC unless compatible with enhancing or maintaining habitat (e.g., prescribed burning) as specifically identified and justified through the FMP AOC planning process and conducted outside the *critical breeding period.* | Suitable habitat is unlikely to be harvested since stand age is typically ≤ 20 years (see above). However, some types of renewal or tending operations could potentially alter habitat suitability (e.g., by reducing tree density below the desired level of 2500-3500 stems/ha) . Only those operations that do not reduce habitat suitability are permitted (if conducted outside the *critical breeding period*).<br>Individual nest sites unlikely to be identified. Restricting operations to outside the *critical breeding period* ensures occupied nests will not be disturbed or destroyed. |
| *Guideline* - The *critical breeding period* is defined as May 1 to July 31 for all areas within the AOU. Local knowledge of breeding chronology may be used to adjust these dates. | Nesting begins in mid-May and fledging occurs from late June to mid-July (Mayfield 1992). Thus, timing restriction from May 1 to July 31 should likely provide protection from initiation of nesting to fledging. |
| *Standard* - New landings and aggregate pits are not permitted within the AOC. | Landings and aggregate pits reduce habitat suitability by removing nesting and foraging habitat. Thus, new landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - New roads are not permitted within the AOC unless there is no practical or feasible alternative, the patch of occupied | Roads may fragment patches of suitable habitat. However, if patches of occupied habitat are large (>80 ha), new roads may be permitted within the AOC if the location is approved by OMNR and roads are planned to minimize impact on occupied territories and optimal habitat. |

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| habitat is large (>80 ha), reasonable efforts will be made to mitigate potential impact on occupied habitat, and the road, including specific location, is identified and justified in the FMP through the FMP AOC planning process. | |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for seasonal restrictions on harvest, renewal, and tending operations during the *critical breeding period*. |

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**4.3.6 Continued**

**Background**

| **Species** | **Louisiana waterthrush** |
|---|---|
| S-rank | S3B/G5 |
| Designation | *Special concern*; PIF Continental Stewardship Species; BCR 12 Priority Species |
| Trend – CDN | Unknown. Insufficient BBS data to evaluate trend. |
| Trend - ON | Unknown. Insufficient BBS data to evaluate trend. Estimated to be 150 to 300 pairs in Ontario (COSEWIC 2006). No significant change in the probability of observation between BBAs conducted in the 1980s and 2000s (McCracken 2007). |
| Distribution | Widespread across the eastern US; occurs at the northern edge of its range in Ontario (Robinson 1995). Largest concentrations in the Carolinian forest. Small number of sightings within the AOU (<1% of OBBA squares within the Southern Shield Region); primarily along the southern edge of the Canadian shield (McCracken 2007). |
| Habits and habitat | Nests in small hollows or natural cavities in stream banks or associated with root mass of overturned trees (Peck and James 1987, Robinson 1995). Nests not reused (Robinson 1995). Summer resident; typically breeds May through July (James 1991).<br><br>Typically nests in riparian hardwood or mixedwood forest adjacent to permanent headwater streams with well developed riffle and pool sections (Craig 1985, Murray and Stauffer 1995, Prosser and Brooks 1998, Stucker 2000). May occasionally nest in hardwood swamps or along intermittent streams (Peck and James 1987, Robinson 1995, Prosser and Brooks 1998).<br><br>Home range is long and narrow, typically about ⅔ ha in size (Craig 1984) and stretching for about 400 m along streams (Eaton 1958). Most activity is centred on the stream; nests are generally <5 m from streams (Stucker 2000) and most invertebrate prey are captured in the water or attached to rocks, logs, or streamside vegetation (Craig 1984). However, Prosser and Brooks (1998) considered habitat within 50 m of streams to have potential for nesting and Brown et al. (1999) suggested that management should focus on habitat within 50 m of streams. Streams are preferred when associated with large patches of mature forest (Prosser and Brooks 1998). In highly fragmented landscapes, most frequently found in forest patches ≥3000 ha in size but patches as small as 25 ha may be used (Robbins et al. 1989). However, in less fragmented forest, has been found using 15 m wide buffer strips adjacent to clearcuts (Triquet et al. 1990). |
| Effects of forest management | Forest harvesting and forest fragmentation are considered primary threats (COSEWIC 2006), although there is little quantitative information on the effects of forest harvesting. Selection-like harvesting appears to have limited effect (Robinson and Robinson 1999). Used 15 m wide buffer strips adjacent to clearcuts in Kentucky (Triquet et al. 1990). No information on effect of roads. |

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| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. General habitat needs largely provided through coarse filter direction that protects water quality and habitat immediately adjacent to streams (Section 4.1.2). Forest management operations may alter suitability of occupied habitat or disturb nesting birds. Thus, direction identifies occupied habitat as AOCs and focuses on:

- maintaining suitability of occupied habitat and
- avoiding disturbance of nesting birds during the *critical breeding period*.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding Louisiana waterthrushes within the past 10 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying suitable habitat within 50 m on both sides of a stream for a distance of 400 m above and below individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 50 and 400 m values reflect the typical extent of habitat use (see above). |
| *Standard* - Selection harvest is permitted within the AOC subject to timing restrictions; no other types of harvest are permitted within the AOC. | Selection harvest appears to have minimal effect on habitat suitability (see above). Effects of other types of harvest on habitat suitability are unknown. Thus, selection harvest is permitted within the AOC subject to timing restrictions; no other types of harvest are permitted within the AOC. |
| *Standard* - Renewal and tending operations are permitted within the AOC subject to timing restrictions. | Renewal and tending operations associated with selection harvest are unlikely to have a significant effect on habitat suitability and are thus permitted within the AOC if conducted outside the *critical breeding period*. |
| *Standard* - Wildlife trees and downed woody material will be retained within harvested portions of the AOC as per general direction in Section 3.2.3. | No modification to standard wildlife tree or downed woody material direction is considered necessary for this species. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *critical* | Individual nest sites unlikely to be identified. Restricting operations to outside the *critical breeding period* ensures occupied nests will not be disturbed or destroyed. |

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| *breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | |
| *Guideline* - The *critical breeding period* is defined as May 1 to July 31 for all areas within the AOU. Local knowledge of breeding chronology may be used to adjust these dates. | Returns to Ontario in late April; egg dates are June 1 to July 8 (James 1991). Thus, timing restriction from May 1 to July 31 should likely provide protection from initiation of nesting to fledging. |
| *Standard* - New landings and aggregate pits are not permitted within the AOC. | Landings and aggregate pits reduce habitat suitability by removing nesting and foraging habitat. Thus, new landings and aggregate pits are not permitted within the AOC. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads within the AOC. | Effects of roads are unknown but roads could potentially fragment occupied habitat, reducing suitability. Thus, reasonable efforts will be made to avoid constructing new roads within the AOC. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | See rationale for seasonal restrictions on harvest, renewal, and tending operations during the *critical breeding period*. |

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**4.3.6 Continued**

**Background**

| Species | Red-headed woodpecker |
|---|---|
| S-rank | S3B/G5 |
| Designation | *Special concern*; PIF Continental Watch List; BCR 12 Priority Species |
| Trend – CDN | Declining. Canada BBS data from 1981-2005 suggest a significant declining trend (-6%/yr). |
| Trend - ON | Declining. Ontario BBS data from 1981-2005 suggest a declining (but not significant) trend (-4%/yr). Probability of observation declined by about 67% between BBAs conducted in the 1980s and 2000s (Woodliffe 2007). |
| Distribution | Occurs from the mid-western US and Manitoba across to New York and south to Florida. Found at the northern edge of its range in Ontario (Smith et al. 2000). Found primarily south of the AOU; largest concentrations in the Carolinian forest. Small number of sightings within the AOU (1% of OBBA squares within each of the Southern Shield and Northern Shield regions); primarily along the southern edge of the Canadian shield and around Fort Frances (Woodliffe 2007). |
| Habits and habitat | Typically nests in dead trees or in dead limbs on living trees; a variety of hardwood species is used (Peck and James 1983, Smith et al. 2000). Optimal dbh of nest trees about 50 cm (DeGraaf and Shigo 1985). Shows strong fidelity to nest sites; may excavate multiple nest cavities in same tree and/or reuse cavities for several years. May also use nest holes excavated by other woodpeckers (Smith et al. 2000). Summer resident; typically breeds May through July (James 1991).<br><br>Typically nests in or along the edge of open hardwood (occasionally mixedwood) forest (Peck and James 1983). Ideal nesting habitat may have only about 70 sawlog-sized trees/ha (Conner 1976, King et al. 2007). Does not require large blocks of forest. Will nest in patches of forest ranging from 0.5 to 20 ha in size (Conner 1976); woodlots >2 ha in size are apparently preferred (Gutzwiller and Anderson 1987) and woodlots as small as 3 ha may be large enough to support multiple pairs (Conner 1976). Generally nests close to openings (Conner and Adkisson 1977) at least 30 m across (Jackson 1976). Uses these open areas for foraging (Conner 1976). Will also nest in very open habitats such as burns, beaver ponds, fields, pastures, city parks, and golf courses (Peck and James 1983, Smith et al. 2000).<br><br>Typically uses large dead trees for nesting and roosting. Nesting habitat had about 30 snags/ha in Wisconsin (King et al. 2007). However, requirements for supply of snags and cavity trees less than that for many other woodpeckers such as pileated and hairy woodpeckers (Shackelford and Conner 1997), perhaps because it spends relatively little time drilling for insects in dead wood (e.g., <5%; Jackson 1976); during the breeding season >70% of its insect prey obtained by 'fly-catching' or by 'stooping' (Smith et al. 2000). |
| Effects of forest | No information on the direct effects of forest management operations but generally appears to be tolerant of human activities (Smith et al. 2000). |

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| management | Clearcutting may have a negative effect; but may use clearcuts in which snags or residual patches are retained (Dickson et al. 1983, Harrison and Kilgo 2004). Partial harvesting (especially creation of group selection openings) in hardwood forest appears to result in increased abundance (Twedt et al. 1999, Moorman and Guynn 2001). However, supply of large snags for nesting and roosting may potentially limit abundance (Smith et al. 2000). |
| Past direction | No species-specific direction. Direction for retention of snags and cavity trees likely beneficial (Naylor et al. 1996). |

**Rationale for direction**

Species of *special concern*. Coarse filter direction at landscape and stand scales likely provides long term supply of habitat. Forest management operations may alter suitability of occupied habitat or disturb nesting birds. Thus, direction identifies occupied habitat as AOCs and focuses on:

- maintaining suitability of occupied habitat and
- avoiding disturbance of nesting birds during the *critical breeding period*.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding red-headed woodpeckers within the past 10 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying a 3 ha patch of suitable habitat associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 3 ha value represents the smallest patch of suitable habitat likely to likely to support >1 pair (see above). |
| *Standard* - Harvest is permitted within the AOC that retains ≥70 dominant or codominant trees/ha subject to timing restrictions; known nest trees will be retained in uncut patches ≥20 m in radius. | Conventional clearcutting may reduce suitability of nesting habitat (Dickson et al. 1983). However, regularly uses open hardwood stands; ideal nesting habitat in Wisconsin averaged about 70 sawlog-sized trees/ha (King et al. 2007). Thus, harvest is permitted within the AOC that retains ≥70 dominant or codominant trees/ha.<br>Typically nests in large snags and shows strong nest site fidelity. Thus, when nests are known, nest trees will be retained in small uncut patches (≥20 m radius) to protect the tree from felling damage and avoid health and safety concerns for forest workers. |
| *Standard* - Renewal and tending operations are permitted within the AOC subject to timing restrictions. | Renewal and tending operations are unlikely to have a significant effect on habitat suitability and are thus permitted within the AOC if conducted outside the *critical breeding period*. |
| *Guideline* - Wildlife trees and downed woody material will be | Cavity-using species. Density of decadent trees generally a better predictor of habitat use than density of snags (King et al. 2007). Thus, wildlife tree retention should focus on retention of living cavity trees. |

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| retained within harvested portions of the AOC as per general direction in Section 3.2.3; living wildlife trees with cavities or the potential to develop cavities will be emphasized. | |
| *Guideline* - Creation of group openings will be encouraged in single tree selection cuts. | Creation of group selection openings in mature hardwood forest appears to increase habitat suitability (Moorman and Guynn 2001) and are thus encouraged. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | Few individual nest sites are likely to be identified. Restricting operations to outside the *critical breeding period* ensures occupied nests will not be disturbed or destroyed. |
| *Guideline* - The *critical breeding period* is defined as May 1 to July 31 for all areas within the AOU. Local knowledge of breeding chronology may be used to adjust these dates. | Returns to Ontario in early May; median egg dates are May 31 to June 17 (Peck and James 1983, James 1991). Based on a 13 day incubation period and a 26 day period to nest departure (Smith et al. 2000), most fledging likely occurs by mid-July. Thus, timing restriction from May 1 to July 31 should provide protection from initiation of nesting to fledging. |
| *Standard* - New aggregate pits are not permitted within the AOC. | Aggregate pits reduce habitat suitability by removing nesting and foraging habitat. Thus, new aggregate pits are not permitted within the AOC. However, species is not sensitive to edge effects; thus, new roads and landings are permitted within the AOC. |
| *Guideline* - Road construction and aggregate extraction are not permitted within the AOC during the *critical breeding period*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC | See rationale for seasonal restrictions on harvest, renewal, and tending operations during the *critical breeding period*. |

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| planning process. | |

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**4.3.6 Continued**

**Background**

| **Species** | **Black tern** |
|---|---|
| S-rank | S3B/G4 |
| Designation | *Special concern*; moderate conservation concern (NAWCP 2002). |
| Trend – CDN | Stable? Canadian BBS data suggest little annual change (-0.8%) from 1981-2005. |
| Trend - ON | Declining? Overall, similar probability of observation during OBBAs in the 1980s and 2000s, but about a 50% decline in the GLSL (Weseloh 2007). Ontario BBS data suggest declining (but non-significant) annual trend (-11.2%) from 1981-2005. Moreover, Marsh Monitoring Program data suggest significant annual decline (-17.1%) from 1995-2003 (Crewe et all. 2005). |
| Distribution | Occurs from the Great Lakes region west through the central prairie provinces and states (Dunn and Agro 1995). In Ontario, found primarily south of the AOU; scattered records across the AOU (Weseloh 2007). |
| Habits and habitat | Small nest generally built on floating mats of dead vegetation or wood (Peck and James 1983, Dunn and Agro 1995). May nest singly but usually nests in small loose colonies (average of about 9 nests in Ontario; Peck and James 1983). Weak site fidelity (30-70% of birds return to same wetland to breed) compared to other terns and gulls (Novak et al. 1992).<br><br>Typically nests in marshes dominated by cattails or bulrushes, or the marshy borders of lakes, rivers, and ponds (Peck and James 1983, Dunn and Agro 1995). Preferred habitat has water depth about 0.5 m with 40-60% cover of emergent vegetation (Hickey and Malecki 1997). Wetlands >20 ha are apparently preferred, although small wetlands may be occupied when part of larger wetland complexes (Zimmerman et al. 2002). |
| Effects of forest management | Terns are generally considered to be sensitive to human activities (e.g., Rodgers and Smith 1995, Carney and Sydeman 1999) but there is little quantitative information for this species. Anecdotal evidence of disturbance by recreational activities such as fishing and boating (Kudell-Ekstrum and Rinaldi 2004). However, generally considered to be tolerant of human activity unless colony is entered (Dunn and Agro 1995); intense disturbance by investigators did not influence hatching or fledging success (Shealer and Haverland 2000).<br><br>Nests in marshes, thus harvest, renewal, and tending operations likely have little direct effect on habitat. Most likely to be affected by construction of roads through occupied wetlands. |
| Past direction | No species-specific direction. |

**Rationale for direction**

Colonial-nesting species at risk (*special concern*). Weak nest-site fidelity. General direction for wetlands (Section 4.1.3) likely provides long term supply of habitat. Most forest management operations likely have limited effect on habitat suitability or potential to disturb nesting birds. However, road construction across occupied wetlands could potentially directly or indirectly alter habitat structure through physical disturbance or modification of hydrological regime. Thus, direction identifies occupied habitat as AOCs and focuses on restricting construction of roads, landings, and aggregate pits.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding black terns within the past 10 years defines the AOC.<br><br>Occupied breeding habitat may be delineated through field survey or by identifying a 20 ha patch of suitable non-forested wetland habitat (or the entire wetland polygon if <20 ha) associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 20 ha value represents the smallest patch of suitable habitat likely to occupied (see above). |
| *Standard* - New all weather roads, landings, and aggregate pits are not permitted within the AOC. | All weather roads, landings, and aggregate pits may reduce habitat suitability either directly (by removing wetland vegetation) or indirectly (by altering hydrological regime) (see 4.2.3) and thus are not permitted within the AOC. |
| *Standard* - Water drawdowns or other activities that significantly alter hydrological regime are not permitted. | Water drawdowns or other activities that significantly alter hydrological regime may reduce habitat suitability and thus are not permitted within the AOC. |
| *Guideline* - New winter roads are not permitted within the AOC unless there is no practical or feasible alternative, reasonable efforts will be made to mitigate potential impact on occupied habitat, and the road, including specific location, is identified and justified through the FMP AOC planning process. | Winter roads may reduce habitat suitability by removing wetland vegetation used for nesting but are considered to have limited effect on hydrological regime. Thus, new winter roads should normally not be permitted within the AOC, but may be considered if there is no practical or feasible alternative and reasonable efforts will be made to mitigate potential impact on occupied habitat (e.g., avoiding those portions of wetlands containing nests). |

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**4.3.6 Continued**

**Background**

| **Species** | **Golden-winged warbler** |
|---|---|
| S-rank | S4B/G4 |
| Designation | *Special concern*; PIF Continental Watch List; BCR 12 Priority Species |
| Trend – CDN | Declining. 79% decrease across Canada from 1993-2002 (COSEWIC 2006). |
| Trend - ON | Declining? No significant provincial change in the probability of observation between BBAs conducted in the 1980s and 2000s but significant decline noted in the Southern Shield and Carolinian regions (Vallender 2007). |
| Distribution | Ranges from Saskatchewan through the Lake States to Ontario and Quebec, south along the Appalachians to Georgia (COSEWIC 2006). In Ontario, found in the GLSL forest and south. Greatest abundance along the southern edge of the Canadian Shield (Vallender 2007). |
| Habits and habitat | Builds a bulky cup nest, on the ground or low in vegetation, usually in clump of tall grasses or other vegetation (Peck and James 1987, Confer 1992).<br>Nests in a wide range of shrubby and early successional habitats including old fields, recent cutovers, rights-of-ways, and shrubby wetlands (Peck and James 1987, Confer 1992, Hamel et al. 2005, Kubel and Yahner 2008); frequently considered a habitat specialist dependent on early successional 'scrub' (10-30 years old)(COSEWIC 2006). Tends to occur in loose 'colonies' and may need ≥10 ha of suitable habitat (Confer and Knapp 1981, Hunter et al. 2001, Hamel et al. 2005). |
| Effects of forest management | Primary threats considered to be loss of early successional nesting habitat, hybridization with the blue-winged warbler, and nest parasitism by the brown-headed cowbird (COSEWIC 2006).<br>Forest management operations are likely largely positive since harvesting can create suitable breeding habitat (e.g., Conner and Adkisson 1975, Klaus and Buehler 2001, Roth and Lutz 2004). However, road construction in shrubby wetlands could potentially directly or indirectly alter habitat structure through physical disturbance or modification of hydrological regime. |
| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. Forest management operations likely beneficial since they create a shifting mosaic of early successional habitat suitable for breeding. Forest management operations in upland habitat likely have limited effect on habitat suitability or potential to disturb nesting birds (thus, no direction for occupied upland habitat). However, road construction across occupied wetlands could potentially directly or indirectly alter habitat structure through physical disturbance or modification of hydrological regime. Thus, direction identifies occupied wetland habitat as AOCs and focuses on restricting construction of roads, landings, and aggregate pits.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding golden-winged warblers within the past 10 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying a 10 ha patch of suitable non-forested wetland habitat (or the entire wetland polygon if <10 ha) associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 10 ha value represents the smallest patch of suitable habitat likely to occupied (see above). |
| *Standard* - New all weather roads, landings, and aggregate pits are not permitted within the AOC. | All weather roads, landings, and aggregate pits may reduce habitat suitability either directly (by removing wetland vegetation) or indirectly (by altering hydrologic regime) and thus are not permitted within the AOC. |
| *Standard* - Water drawdowns or other activities that significantly alter hydrological regime are not permitted. | Water drawdowns or other activities that significantly alter hydrological regime may reduce habitat suitability and thus are not permitted within the AOC. |
| *Guideline* - New winter roads are not permitted within the AOC unless there is no practical or feasible alternative, reasonable efforts will be made to mitigate potential impact on occupied habitat, and the road, including specific location, is identified and justified through the FMP AOC planning process. | Winter roads may reduce habitat suitability by removing wetland vegetation used for nesting but are considered to have limited effect on hydrological regime. Thus, new winter roads should normally not be permitted within the AOC, but may be considered if there is no practical or feasible alternative and reasonable efforts will be made to mitigate potential impact on occupied habitat (e.g., avoiding those portions of wetlands containing nests). |

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**4.3.6 Continued**

**Background**

| **Species** | **Least bittern** |
|---|---|
| S-rank | S3B/G5 |
| Designation | *Threatened* |
| Trend – CDN | Uncertain (COSEWIC 2001) |
| Trend - ON | Declining? Provincially, similar probability of observation in BBAs conducted in the 1980s and 2000s, but significant decline noted in the Carolinian region (Woodliffe 2007). Moreover, the Marsh Monitoring Program data suggest a significant (-8.5%) annual decline from 1995-2003 (Crewe et al. 2005). |
| Distribution | Occurs from Minnesota, Ontario, and the New England states, south to Texas and Florida. Found at the northern edge of its range in Ontario (Gibbs et al. 1992). Found primarily south of the AOU; scattered records across the AOU from Algoma to Nipissing south and around Lake of the Woods and Eagle Lake in northwestern Ontario (Woodliffe 2007). |
| Habits and habitat | Builds small shallow nests of twigs, sticks, and dead plant material supported by rushes, grasses, shrubs, or small trees (Peck and James 1983). May nest in loose colonies (Gibbs et al. 1992). Nests not reused (Gibbs et al. 1992) but nests in successive years may be as close as 5 m apart (Meyer and Friis 2008).<br>Typically nests in large cattail marshes but will use marshes >5 ha in size (Brown and Dinsmore 1986, Lor and Malecki 2006, Tozer et al. 2007). Nests are generally in dense pockets of emergent vegetation usually <10 m from open water (Gibbs et al. 1992) and as far as 200 m from shore (Peck and James 1983). |
| Effects of forest management | Primary threat considered to be loss of wetland habitat, mainly as a result of drainage for agriculture or urbanization (COSEWIC 2001).<br>No information on the direct effects of forest management operations but generally appears to be tolerant of human activities (Gibbs et al. 1992).<br>Road construction in wetlands could potentially modify habitat suitability by altering hydrological regime. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Threatened* species. General direction for wetlands (Section 4.1.3) likely provides long term supply of habitat. Most forest management operations likely have limited effect on habitat suitability or potential to disturb nesting birds. However, road construction across occupied wetlands could potentially directly or indirectly alter habitat structure through physical disturbance or modification of hydrological regime. Thus, direction identifies occupied habitat as AOCs and focuses on restricting construction of roads, landings, and aggregate pits.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding least bitterns within the past 20 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying a 5 ha patch of suitable non-forested wetland habitat (or the entire wetland polygon if <5 ha) associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 5 ha value represents the smallest patch of suitable habitat likely to occupied (see above). |
| *Standard* - New all weather roads, landings, and aggregate pits are not permitted within the AOC. | All weather roads, landings, and aggregate pits may reduce habitat suitability either directly (by removing wetland vegetation) or indirectly (by altering hydrological regime) and thus are not permitted within the AOC. |
| *Standard* - Water drawdowns or other activities that significantly alter hydrological regime are not permitted. | Water drawdowns or other activities that significantly alter hydrological regime may reduce habitat suitability and thus are not permitted within the AOC. |
| *Guideline* - New winter roads are not permitted within the AOC unless there is no practical or feasible alternative, reasonable efforts will be made to mitigate potential impact on occupied habitat, and the road, including specific location, is identified and justified through the FMP AOC planning process. | Winter roads may reduce habitat suitability by removing wetland vegetation used for nesting but are considered to have limited effect on hydrological regime. Thus, new winter roads should normally not be permitted within the AOC, but may be considered if there is no practical or feasible alternative and reasonable efforts will be made to mitigate potential impact on occupied habitat (e.g., avoiding those portions of wetlands containing nests). |

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**4.3.6 Continued.**

**Background**

| **Species** | **Yellow rail** |
|---|---|
| S-rank | S4B/G4 |
| Designation | *Special concern* |
| Trend – CDN | Unknown. Canada BBS data from 1981-2005 suggest a non-significant increasing trend (9.9%/yr). However, habitat supply in the southern (and northern?) part of its range is considered to be declining (COSEWIC 2001). |
| Trend - ON | Declining? Insufficient BBS data to evaluate trend. Provincially, no significant difference in the probability of observation in BBAs in the 1980s and 2000s, but significant (50%) reduction in the Hudson Bay Lowlands region (Tozer 2007). |
| Distribution | Breeds from Alberta to New Brunswick and Maine; found at the central portion of its range in Ontario (Bookhout 1995). Found primarily north of the AOU within the Hudson Bay Lowlands; within the AOU, scattered records from Kenora to Geraldton; Algoma and New Liskeard south (Tozer 2007). |
| Habits and habitat | Builds a small cup nest made of sedges and grasses on or just above the ground in graminoid cover (Peck and James 1983, Bookhout 1995).<br>Typically nests in shallow marshes dominated by dense cover of sedges, grasses, and rushes, especially wire sedge (Bookhout 1995, COSEWIC 2001, Goldade et al. 2002). May occupy wetlands as small as 0.5 ha, but is typically found in wetlands ≥14 in Maine and ≥24 ha in Minnesota (see review in Goldade et al. 2002). Little information on nest site fidelity (Goldade et al. 2002). |
| Effects of forest management | Major threats to species considered to be loss of wetlands to draining (in the south) and over-grazing by snow geese in the north, and replacement of graminoid wetland communities by wetland shrub communities through natural succession (Bookhout 1995, COSEWIC 2001). Anecdotal information on effects of human activities such as mowing or bird watching on this species (Bookhout 1995, Goldade et al. 2002).<br>No information on the effects of forest management operations. Road construction in wetlands could potentially modify habitat suitability by altering hydrological regime. |
| Past direction | No species-specific direction. |

**Rationale for direction**

Species of *special concern*. General direction for wetlands (Section 4.1.3) likely provides long term supply of habitat. Most forest management operations likely have limited effect on habitat suitability or potential to disturb nesting birds. However, road construction across occupied wetlands could potentially directly or indirectly alter habitat structure through physical disturbance or modification of hydrological regime. Thus, direction identifies occupied habitat as AOCs and focuses on restricting construction of roads, landings, and aggregate pits.

Rationale for direction is described below:

| Direction | Rationale |
|---|---|
| *Standard* - Delineated habitat comprises the AOC. | Suitable habitat occupied by breeding yellow rails within the past 10 years defines the AOC.<br>Occupied breeding habitat may be delineated through field survey or by identifying a 15 ha patch of suitable non-forested wetland habitat (or the entire wetland polygon if <15 ha) associated with individual *Element of Occurrence* observation points or other reliable sightings associated with breeding activity. The 15 ha value represents the smallest patch of suitable habitat likely to occupied (see above). |
| *Standard* - New all weather roads, landings, and aggregate pits are not permitted within the AOC. | All weather roads, landings, and aggregate pits may reduce habitat suitability either directly (by removing wetland vegetation) or indirectly (by altering hydrological regime) and thus are not permitted within the AOC. |
| *Standard* - Water drawdowns or other activities that significantly alter hydrological regime are not permitted. | Water drawdowns or other activities that significantly alter hydrological regime may reduce habitat suitability and thus are not permitted within the AOC. |
| *Guideline* - New winter roads are not permitted within the AOC unless there is no practical or feasible alternative, reasonable efforts will be made to mitigate potential impact on occupied habitat, and the road, including specific location, is identified and justified through the FMP AOC planning process. | Winter roads may reduce habitat suitability by removing wetland vegetation used for nesting but are considered to have limited effect on hydrological regime. Thus, new winter roads should normally not be permitted within the AOC, but may be considered if there is no practical or feasible alternative and reasonable efforts will be made to mitigate potential impact on occupied habitat (e.g., avoiding those portions of wetlands containing nests). |

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### 4.3.7 Mammals

No *Standards*, *Guidelines*, or *Best Management Practices* are presented for the American badger or woodland caribou (see Table 4.3a). The cougar and grey fox are addressed in Section 4.2.5.

#### 4.3.7.1 Wolverine den sites

Background

| **Species** | **Wolverine** |
|---|---|
| S-rank | S2/G4 |
| Designation | *Threatened* |
| Trend – CDN | Reduced from presettlement era; may have occurred throughout Canada, except in the Maritime provinces. Populations generally stable and healthy with some exceptions (see Trend – ON) (COSEWIC 2003). |
| Trend - ON | Few population data but evidence of range retraction. In the presettlement era, may have occurred throughout the province. By the 1950s, wolverines were largely restricted to that part of northeastern and northwestern Ontario above an east-west line drawn across the top of Lake Nipigon. By 2000, range restricted to that part of northwestern Ontario from Red Lake-Sioux Lookout north to Fort Severn-Peawanuck (Dawson 2000). |
| Distribution | Circumpolar species. In North America, occurs from Alaska to NWT; throughout British Columbia, across northern Alberta, Saskatchewan, Manitoba, to northwestern Ontario (COSEWIC 2003). In Ontario, found largely in the northwestern part of the province from Red Lake-Sioux Lookout north to Fort Severn-Peawanuck (Dawson 2000). |
| Habits and habitat | Wolverines occupy a wide variety of habitats within tundra, montane, and boreal forest ecosystems; common characteristics of habitat are a supply of ungulate carrion and isolation from human activity (Hash 1987, Banci 1994, Copeland and Krucera 1997).<br>Within their large home ranges (approximately 100 km$^2$ for females with young; Hornocker and Hash 1981, Whitman et al. 1986, Banci and Harestad 1990, Wedholm 2006), the supply of suitable denning sites may be limiting and may influence kit survival (Banci 1994). Female wolverines use two types of dens. Natal dens are used during parturition; 1 to 3 maternal dens are then used until kits are weaned (Magoun and Copeland 1998). Dens are comprised of snow tunnels up to 60 m long and are typically associated with large boulders, large woody debris, or fallen trees (Banci 1994, Magoun and Copeland 1998, Krebs and Lewis 2000). Dens are frequently located in ravines where deep snow accumulates or along rocky talus slopes (Magoun and Copeland 1998). Dens may be reused in subsequent years (Lee and Niptanatiak 1996, Magoun and Copeland 1998), but not always (Krebs and Lewis 2000). About 60% of dens were occupied each year in Norway (May 2007). |
| Effects of forest management | Forest management operations are generally surmised to have a negative effect on wolverines (Banci 1994, Ruggiero et al. 2007). However, evidence is somewhat equivocal. |

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| | For example, in Montana, radio-tagged wolverines were never observed in recent clearcuts (<15 years old) (Hornocker and Hash 1981). In northwestern Ontario, only 1 of 99 locations of radio-tagged wolverines was in a clearcut and that location was within an uncut patch in a cutover (Neil Dawson et al., in prep.). Lofroth (2001) also noted a generally low use of clearcuts in British Columbia, but did observe considerable activity in regenerating clearcuts during a winter of high hare abundance. While observation of tracks suggested that wolverines did occasionally cross clearcuts in Montana, when they did, they moved in straight lines at a running gait (compared to more meandering paths followed in forested habitat) (Hornocker and Hash 1981).<br><br>In British Columbia, landscape-scale habitat use was negatively related to the amount of recently harvested area (Krebs et al. 2007). In northwestern Ontario, analysis of aerial surveys from a 58,800 km$^2$ area suggested that landscape-scale habitat use was similarly negatively related to the amount of harvested area, possibly in response to elevated wolf abundance (Bowman et al. 2007). However, use-availability analysis indicated that wolverines did not appear to avoid recent clearcuts (<15 years old) when locating home ranges or when using habitat within home ranges, although these results may be somewhat biased by capture methodology (Neil Dawson et al., in prep.).<br><br>The primary effect of forest management operations on wolverines may be associated with the construction of roads and the potential for subsequent increased human contact. Numerous studies suggest a negative relationship between the density or proximity of roads and habitat use (Austin 1998, Carroll et al. 2001, Rowland et al. 2003, May et al. 2006, Copeland et al. 2007, Krebs et al. 2007). Estimated thresholds of effect range from about 0.4 to 1.7 km of road per km$^2$ of habitat (Carroll et al. 2001, Rowland et al. 2003).<br><br>In northwestern Ontario road densities averaged about 0.4 km/km$^2$ within portions of home ranges that received 95% of wolverine use and 0.3 km/km$^2$ within portions that received 50% of use (core areas). There were no roads within the core area of the single denning female studied. The two wolverines with the highest road densities within the core area of their home ranges (0.5 and 1.2 km/km$^2$) were both incidentally killed by trappers suggesting that 0.4 km of road per km$^2$ of habitat may be a realistic threshold in Ontario. |
| Past direction | No species-specific direction. |

**Rationale for direction**

*Threatened* species. Uses a wide variety of habitat types but appears to require large areas (100s km$^2$) that support an adequate abundance of ungulate prey and have little human infrastructure. The landscape-scale approach to the management of caribou habitat is expected to maintain large blocks of unharvested and roadless habitat suitable for wolverines (see the *Forest Management Guide for Boreal Landscapes*). However, specific protection of den sites from human disturbance may also be warranted (Copeland and Krucera 1997). Thus, direction identifies den sites as AOCs and focuses on:

- minimizing disturbance of wolverines using dens sites and
- maintaining suitability of habitat surrounding den sites.

Rationale for direction is described below:

| Direction | Rationale |
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| *Standard* - Delineated habitat comprises the AOC. | Natal or maternal dens known to have been occupied by wolverines within the past 10 years (unless documented as unoccupied for ≥3 consecutive years) and habitat within a 4 km radius defines the AOC.<br><br>Human contact may cause females to abandon den sites (Myrberget 1968, Copeland 1996; both cited in Copeland and Krucera 1997). Unfortunately, there is relatively little known about the relationship between proximity of forest management operations and use of dens or reproductive success. Most studies infer effects of human activities from the proximity of dens to human infrastructure, especially roads.<br><br>Available information suggests that dens are generally located considerable distances from roads. For example, the sole den site located in Ontario was 7 km from the closest active logging road and 5 km from the nearest access, a mining trail (Dawson[1], pers. comm. 2007). In 2 study areas in British Columbia, 21 dens were located ≥4 km from the nearest road, despite the fact that most of the wolverines studied were live-trapped adjacent to roads (Krebs[2], pers. comm. to N. Dawson, 2006). In Norway, 50 dens averaged 7.5 km from well-traveled public roads (all were ≥2 km away) and about 3 km from lightly-traveled private roads (May[3], pers. comm. 2007).<br><br>This type of information generally supports large recommended buffers between dens and human activities such as snowmobiling and skiing that range from 2 to 8 km (e.g., Univ. Wyoming 2000, BCMWLAP 2002, Blouin 2006). An AOC with a radius between these extremes (4 km) is prescribed. |
| *Standard* - In consultation with MNR's Species at Risk staff, a den site management plan will be developed that outlines the extent and timing of harvest, renewal, and tending operations acceptable within the AOC, as well as conditions on roads, landings, and aggregate pits. | In consultation with MNR species at risk staff, a den site management plan will be developed that outlines the extent and timing of harvest, renewal, and tending operations acceptable within the AOC, as well as conditions on roads, landings, and aggregate pits.<br><br>This approach was adopted to provide flexibility, facilitate the incorporation of emerging knowledge of wolverine habitat requirements and the effects of human activities, and ensure consistency with the requirements of the *Endangered Species Act 2007*. |
| *Guideline* - Reasonable efforts will be made to incorporate the AOC into a large block of unharvested and unroaded forest (e.g., a leave block in the caribou mosaic). | To the extent practical and feasible, AOCs should be incorporated into large blocks of unharvested and unroaded forest (e.g., a leave block in the caribou mosaic) to maximize benefits to wolverines and minimize effects on wood supply. |

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[2] John Krebs, Columbia Fish and Wildlife Compensation Program, Nelson, BC
[3] Roel May, Norwegian Institute for Nature Research, Trondheim

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| *Guideline* - The den site management plan will: i) Normally prohibit harvest, renewal, and tending operations, road construction, and aggregate extraction within the AOC. However, some operations may be permitted to meet ecological, social, or economic objectives; and ii) Include a Use Management Strategy for existing roads that will provide locally-appropriate measures to minimize road-associated impacts on wolverines. This may include access controls while roads are in use and a decommissioning plan for roads following use. | The primary function of the AOC is to minimize the potential for human contact. Thus, no further harvest, renewal, or tending operations, road construction, or aggregate extraction will normally be permitted within the AOC. However, in some specific situations, some activities may be permitted to meet specific ecological, social, or economic objectives. The den site management plan will also include a Use Management Strategy for existing roads that will provide locally-appropriate measures to minimize road-associated impacts on wolverines. This may include access controls while roads are in use and a decommissioning plan for roads following use. |

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### 4.3.7.2 Eastern wolf traditional rendezvous sites

**Background**

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| **Species** | **Eastern wolf** – see 4.2.5 (gray wolf) for background information |

**Rationale for direction**

General habitat needs of wolves provided by direction in the *Landscape Guides* and Section 3.0 of this guide that promotes a diversity of habitat conditions to support a range of large and medium-sized prey.

Rendezvous sites are important site-specific habitat features and wolves may be relatively intolerant of human activities within the vicinity of occupied sites. However, a wide variety of conditions are used as rendezvous sites and use may be relatively transitory. As well, rendezvous sites are not addressed by the *Fish & Wildlife Conservation Act 1997*. Thus, direction is provided only for traditional rendezvous sites of the eastern wolf (planning teams should use the most recent information available to determine whether wolves in their FMU are likely the eastern or northern grey subspecies, e.g., see OMNR 2005). Traditional rendezvous sites are defined as those used ≥2 weeks/year (*sensu* Theberge and Theberge 2004) and used during ≥2 years within the past 10 years. When detailed information on the periodicity of use is lacking, presence of matted vegetation, well-worn trails, and abundant wolf scat can be used as evidence of traditional use (e.g., Pimlott et al. 1969).

Direction identifies traditional rendezvous sites as AOCs and focuses on:

- minimizing disturbance of wolves using traditional rendezvous sites and
- maintaining suitability of habitat immediately surrounding traditional rendezvous sites.

Rationale for direction is described below:

| Direction | Rationale |
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| *Standard* - Delineated habitat comprises the AOC. | Rendezvous sites known to have received traditional use by the eastern wolf and habitat within a 200 m radius defines the AOC.<br>Wisconsin and Michigan both recommend similar protection for dens and rendezvous sites (MDNR 1997, WDNR 1999). Thus, given uncertainty about the potential effects of forest management operations, a 200 m AOC is prescribed based on the direction for dens (Section 4.2.5). |
| *Standard* - Harvest, renewal, and tending operations are permitted within the AOC subject to timing restrictions and the following conditions … | In the absence of information on the effects of harvest, renewal, and tending operations on use of rendezvous sites, direction follows that prescribed for dens (Section 4.2.5). However, because wolves exhibit less fidelity to rendezvous sites than to dens, direction for harvest operations is slightly less restrictive. |
| *Guideline* - Harvest, renewal, and tending operations are not permitted within the AOC during the *normal* | There is no information on how wolves react to different types of forest management operations. Thus, as a precautionary approach, no harvest, renewal, and tending operations are not permitted within the AOC during the *normal period of use.* |

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| *period of use*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | |
| *Guideline* - The *normal period of use* by wolves is May 15 to September 15 in the Great Lakes–St. Lawrence forest and June 1 to October 1 in the boreal forest. Local knowledge of the chronology of use may be used to adjust these dates. | Denning activities begin in early April to early May in Ontario depending on latitude and wolves are associated with dens for 2 to 3 months (see 4.2.5). Rendezvous sites are then used until early fall. Thus, timing restrictions of May 15 to September 15 in the GLSL forest and June 1 to October 1 in the boreal forest are likely appropriate (Allison[1], pers. comm. 2008; Patterson[2], pers. comm. 2008). |
| *Standard* - New roads, landings, and aggregate pits are not permitted within 100 m of rendezvous sites. | A 100 m buffer of residual forest is prescribed around rendezvous sites (see above). Thus, no roads, landings, or aggregate pits are permitted within 100 m since these features modify habitat and facilitate future disturbance. |
| *Guideline* - Reasonable efforts will be made to avoid constructing new roads, landings, and aggregate pits within 101-200 m of rendezvous sites. | Roads (and associated landings and aggregate pits) create access that may facilitate future disturbance by other forest users. Thus, reasonable efforts are required to avoid constructing new roads, landings, and aggregate pits within the outer 100 m of the AOC. |
| *Guideline* - When roads are constructed within the AOC, temporary roads and/or water crossings will be used whenever practical and feasible to limit future access and disturbance. | When roads must be constructed within the AOC, use of temporary roads and/or water crossings is preferred to limit future access and disturbance. |
| *Guideline* - Road construction and aggregate extraction are not permitted within 200 m of a rendezvous site during | See rationale for restrictions on harvest, renewal, and tending operations during the *normal period of use*. |

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| the *normal period of use*, except in extraordinary circumstances as specifically identified and justified through the FMP AOC planning process. | |
| *Guideline* - Hauling and road maintenance operations (except when required for safety reasons or environmental protection) are not permitted within 100 m of a rendezvous site during the *normal period of use* unless the road predates the rendezvous site or except in extraordinary circumstances, as specifically identified and justified through the FMP AOC planning process. | Hauling and road maintenance operations are considered to have a relatively low potential impact on rendezvous site use. Thus, hauling and road maintenance operations are only restricted within 100 m of occupied sites.<br><br>Hauling and road maintenance operations are not restricted if the road predates the rendezvous site. This direction assumes that wolves that use sites adjacent to existing roads are tolerant of these types of operations. |

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# 5.0 OPERATIONAL CONSIDERATIONS

## 5.1 Roads and Water Crossings

### 5.1.1 Roads

#### Background

While roads have numerous, beneficial effects from and economic perspective, from a social perspective their effects can be mixed. They provide access to resources and recreational opportunities, but the higher the density of roads in an area, the less “remote” it is. This can be a concern for those who are seeking, or selling, remoteness (i.e., resource-based tourism). Roads have no natural, biological equivalent, and can have a substantial impact on the environment (see below). Roads and road-use planning are often the most controversial aspect of writing a FMP. The impacts from roads are also often closely associated with water crossings (see Section 5.1.2).

Reviews by Spellerberg (1998) and Trombulak and Frissell (2000) revealed many of the effects of roads on both terrestrial and aquatic ecosystems, such as habitat fragmentation, effects on the behaviour of animals, alteration of the chemical and physical environment, and as a way exotics can spread into the environment. Spellerberg (1998) also suggested that concerns and uncertainties extended beyond roads and right of ways, but also into the adjacent buffer zones. In addition, depending on the road location, the use management strategy, and the type or category of road (e.g., highway vs. forest management ‘branch’ road), the degree of the impact(s) can differ substantially. Potential impacts can often be minimized through mitigation, and the restoration of impacted ecosystems is also possible. For example, use of good planning and engineering practices can avoid potentially negative impacts such as erosion or ponding (which can flood forest stands) along and adjacent to the right-of-way; decommissioning and abandonment of roads and road networks can restore a level of “remoteness”.

#### Ecological effects of roads

Roads can have adverse effects on fish and wildlife resources. Forman and Alexander (1998) said roadkill of wildlife in settled landscapes can be considerable; roads can affect animal use patterns in a variety of ways (e.g., in winter, roads can become a travel corridor ‘trap’ during periods of deep snow (Woods and Munro 1996) and can lead to increased hunter access and higher than desirable harvest of some species, such as moose (Rempel et al*.* 1997). Roads can also attract animals (e.g., to consume gravel or salt). Black bears use roads as travel corridors and to escape from insects, and feed in roadside clearings where important food plants like clover, dandelion, peavine and vetchling occur (Brown et al. 1999). However, when bear behaviour includes use of roads, they are more susceptible to hunting and overharvest (Kellyhouse 1980, Young and Beecham 1986, Brody and Stone 1987).

Zimmerling (*in prep.*) reported that in the boreal forest of Ontario, the abundance of almost two-thirds of landbirds, many of them habitat generalists, did not vary based on proximity to roads. Among the remaining species, some were more abundant at roadsides (e.g., chipping sparrow), while some were more abundant at roadless points (e.g., red-breasted nuthatch).

Roads have been implicated as a factor in the decline of woodland caribou. Possible causes are increased predation by wolves using roads, which lets them hunt the landscape in an effective and efficient fashion (e.g., Bergerud et al*.* 1984, James and Stuart-Smith 2000), as well as increasing the mortality rates due to increased hunting and poaching by humans (Racey and Armstrong 2000).

Roads can have mixed impacts on furbearers including Marten. Webb and Boyce (2009) note that in Alberta roads, seismic lines and ATV trails all provide better access for hunters and trappers. They also increase fragmentation over the landscape that generally lessens the population. However, these disturbances also leave brush piles that can aid the Marten in hunting smaller mammals.

There are concerns with roads regarding over-harvest and access to sensitive and vulnerable fisheries. In Ontario, lake trout and brook trout are valuable species both vulnerable to exploitation (Oliver et al. 1991, OMNR 2007a, Kaufman et al. 2009). Access to lake trout lakes has been identified as a major concern (OMNR 2007b), and in some instances, use of Crown land to help manage lake trout fisheries has been addressed or is recommended through use of the *Crown Land Use Policy Atlas.*

Resource-based tourism may identify remoteness as a value to be protected and that roads and access are the issue which needs to be addressed. In these situations, direction on implementation of mitigative measures and appropriate road use is provided by the forest management guide *Management Guidelines for Forestry and Resource-Based Tourism.*

Proper road planning will help to mitigate many of the potential negative impacts associated with roads. In addition to planning location, the impacts from roads are often closely associated with design and construction details. For example, roads can impact on hydrological function and result in erosion of sensitive landscapes. To minimize impacts on fish and wildlife, roads are not usually not permitted in critical fish and wildlife habitats, such as in the vicinity of colonial bird nests (Section 4.2.2), or if they are, mitigative measures are used to minimize adverse effects.

The crossing of wetlands such as bogs, fens, marshes and swamps with a road can also have an impact beyond the roadway. In addition to construction and engineering concerns, crossing wetlands can result in changes to the water table and changes to vegetation (e.g., standing trees can die from flooding) (see 4.1.3).

Decommissioning is a part of the use management strategy for roads and road networks and needs to be carried out in an environmentally sound manner. Decommissioning can result in lessened access to an area by humans and wildlife (e.g., wolves, which use roads to aid in hunting; Section 3.3) Decommissioning can also result in 'de-fragmentation' of the forest, particularly if roadbeds are regenerated to forest cover. Decommissioning, done properly, can minimize the potential for longer-term concerns, particularly with respect to compliance (e.g., erosion, vehicular access controls).

**Past direction**

Much of the past direction for forest roads has come from the *Environmental Guidelines for Access Roads and Water Crossings* (OMNR 1990). That document, now under review, remains the basis for much of the current direction (Standards, Guidelines, and Best Management Practices) and rationale for Section 5 of the Stand and Site Guide. Other synthesis of environmentally sensitive approaches to forest road and water crossing considerations include those written by Gillies (2007), Gucinski et al. (2001), and Pulkki (2003).

### 5.1.1.1 Roads outside areas of concern

**Rationale for direction**

Roads may also have an effect on other values, features, or resources that may require the implementation of specific mitigation techniques not provided by this section of the guide. Mitigative measures for site-specific values will generally be provided in Section 4.0 of this guide, while appropriate direction for other features or values may be provided by other forest management guides (e.g., *Forest Management Guide for Cultural Heritage Values*), or in other pieces of direction (e.g., legislation; policies). In some situations, appropriate mitigative measures may have to be developed by the planning team.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* – Materials moved during construction, such as grubbed or earth fill material; will not be piled where they block drainage courses. | Placing materials moved during construction into drainage courses makes them susceptible to erosion and could result in deposition of sediment in associated water features.<br>Depending on the type and size of drainage course the material may also block movement of fish.<br>In each case this practice needs to be avoided. |
| *Standard* – Fill material for roads built below the high water level, within the floodplain of a water feature, will be erosion resistant and/or protected from erosion. | Roads should be designed to be erosion resistant, especially in or around water features. This can be challenging in areas that are subject to flooding or changing water tables.<br>Special care needs to be taken in these areas to ensure road integrity is maintained while water features and fish habitats are protected. Use of rip rap and other erosion reducing materials are recommended. |
| *Standard* – Any exposed mineral soil between the height of land and a water crossing, or within 100 m of a water crossing, whichever is less, will be trimmed to a stable angle and be protected from erosion so sediment will not enter the water after construction. | Trimming exposed mineral soil to a stable angle greatly reduces the chance of sediment movement and subsequent deposition within water features.<br>OMNR (1990) recommends that a stable slope should have a horizontal to vertical ratio of between 1.5 and 2.0 (horizontal) to 1.0 (vertical). |
| *Standard* – MNR will ensure that the signs used to identify the use management strategies for roads (e.g., travel restrictions) are maintained. | The *FMPM* has planning and documentation requirements for all new primary road corridors and branch roads. The requirements include an environmental analysis of each new primary road corridor and a rationale for each new branch road, as well as the development of use management strategies for such roads (including maintenance of the use management strategy through signage; Hunt and Hosegood (2008) found the use of signs to restrict vehicular traffic (mainly moose hunters) resulted in a high compliance rate, but did not eliminate all traffic). |
| *Guideline* – The planning, construction, and maintenance of primary and branch road corridors and road network locations, and their applicable use management strategies, will consider:<br>i) the strategic direction | This *Guideline* ensures consistency with planning requirements and addresses specific concerns regarding roads and access on values, features, and resources (e.g., wildlife habitat, fisheries and remote tourism). See *Management Guidelines for Forestry and Resource-Based Tourism* (OMNR 2001) for further direction and information regarding the development of use management strategies for roads and road networks. |

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| associated with other resource plans, policies and directives (e.g., *Crown Land Use Policy Atlas*);<br>ii) the strategic direction being addressed through the use of LLPs resulting from the application of the Landscape Guide;<br>iii) the management objectives, and emphasis for specific areas (e.g., direction provided by the *Crown Land Use Policy Atlas*; LLPs as described in Section 3.3 of this guide); and<br>iv) the potential impact (including benefits) to other natural resource features, land uses, and values (e.g., lakes and streams, cottage sites, boat caches. | |
| *Guideline* – Ensure engineering safety considerations are incorporated into road planning. | Safety of forest workers and the public is of paramount importance. Thus, engineering safety standards will be incorporated into road planning (see OMNR 1990 for details). |
| *Guideline* – Have a monitoring program for roads or road networks and use appropriate mitigation to prevent or stop erosion in ditches, on steep slopes, etc. | Ensuring maintenance of a safe road system is critical to users of the roads and to the protection of terrestrial and aquatic habitats from erosion, sediment, etc. Thus, monitoring roads and mitigation to ensure safe, stable conditions will be incorporated into road planning (see OMNR 1990 for details). |
| *Guideline* – When all-weather roads must cross wetlands, provide frequent cross drainage culverts to ensure that surface water is equalized on both sides of the road and impacts to hydrologic flow and wetland function are minimized (see also Sections 4.1.3, 4.3.1, 4.3.5.3 and 4.3.6). | Planning and maintaining roads must minimize the impacts on hydrological conditions and aquatic habitats (see OMNR 1990 for details). |
| *Guideline* – When the road location and landings | Placing roads or landing in these sensitive aquatic features can negatively impact the hydrological features, water quality, and fish |

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| within the approved corridor are being finalized, avoid recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge that are connected to lakes, ponds, rivers, or streams and small unmapped wetlands (e.g., woodland pools) (see also Sections 4.1.3, 4.3.1, 4.3.5.3 and 4.3.6). | habitat.<br>Efforts must be made in road planning, design, and locations to avoid sensitive aquatic features to reduce negative impacts in these areas (see OMNR 1990 for details). |
| *Guideline* – If recognizable ephemeral streams, springs, seeps, and other areas of groundwater discharge that are connected to lakes, ponds, rivers, or streams, or small unmapped wetlands must be crossed, use construction and maintenance techniques and practices to minimize impacts to hydrologic flow and wetland function. Natural water movements will not be impeded, accelerated, or diverted (see also Sections 4.1.3, 4.3.1, 4.3.5.3 and 4.3.6). | If sensitive aquatic features must be crossed, efforts must be used to minimize the impacts on natural water movements (see OMNR 1990 for details).<br>Section 5.1.2 (water crossings) provides further direction for crossings in these sensitive areas. |
| *Guideline* – Identify areas of concentrated surface water flow and prevent blockage through appropriate use of cross drainage culverts. Some of these locations may best be determined the following spring when ponding is evident at unpredicted locations along a new road. | Efforts need to be made to ensure water flow is not blocked during road construction. Use of strategically placed, appropriately sized drainage culverts helps to overcome this concern.<br>Regular monitoring of roads to ensure the desired function of drainage culvers, and to identify areas of concern where further culverts are needed is important. (see OMNR 1990) |
| *Guideline* – Where ditches leading downhill from rock cuts pass over earth material, use techniques to protect the earth/rock interface from erosion. | Efforts must be made to limit potential erosion leading to deposition of sediment in streams in road construction.<br>Use of techniques including diversion ditches, straw bales to filter water in the ditch, etc can be used.<br>Consult *Environmental Guidelines For Access Roads and Water Crossings* (OMNR 1990) for further information. |

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| *Guideline* – Grubbing of low vegetative cover between the height of land (e.g., the high point on a ditch line) and a water crossing, or within 100 m of a water crossing, whichever is less, will be limited to that required to address engineering issues and safety concerns, such as the removal of hazards. | Grubbing is the removal of stumps, roots, embedded logs, organics, and unsuitable soils before, or concurrently with, subgrade road construction. The organic material helps to provide stability to microsite – lessening the chances of erosion or movement of sediment.<br>To protect water features from deposition of sediment the area, grubbing is limited only to meet engineering goals or where safety concerns warrant it. |
| *Guideline* – Have a plan to ensure rock or earth remains within the right-of-way when explosives and blasting are required. | Protection for fish and fish habitat is contained in the federal *Fisheries Act*. Blasting in or near water produces shock waves that can kill fish and will normally be avoided. Blasting with a potential impact on fish or fish habitat will only be done following approval from DFO. (*Guidelines for the Use of Explosives in or near Canadian Fisheries Waters* (Wright and Hopky 1998) provides further details.)<br>When blasting is required, in or near water features, care needs to be used to contain blasted materials so they don't harm wildlife or impact on aquatic or terrestrial habitats. |
| *Guideline* – When constructing roads during the bird nesting season, and occupied nests are encountered, follow direction in Section 4.2.2. | See Section 4.2.2 for rationale. |
| *Guideline* – When planning primary and branch road corridors, avoid high value wildlife habitats such as ungulate wintering areas (see Sections 3.3.3 and 3.3.4 and the Landscape Guide for further information). | See Sections 3.3.3 and 3.3.4 for rationale. |
| *Guideline* – Do not place windrows or grubbing materials across known migration paths of wildlife in a manner that could impede their travel. | Care must be taken to ensure that during the course of road construction that terrestrial and aquatic habitats are protected.<br>Identifying and protecting game trails, and escape routes are critical when materials are being moved in road construction. Cervids are known to run down the right-of-way ahead of a vehicle and are often reticent to plunge into areas with unsure footing, such as windrows of rock or slash, as well as deep snow or a snowbank.<br>Protection of aquatic habitats is covered in other Standards and Guidelines (see Section 4). |

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| | See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Guideline* – Reasonable efforts (e.g., clearing of logging debris, avoid steep ditching) will be made to ensure that recreational portage routes and trails used for accessing and working traplines are passable following forest management operations. | Direction is provided to ensure that recreational portage routes and trails used for accessing and working traplines are passable following forest management operations. This replaces direction that was previously in the *Code of Practice for Timber Management Operations in Riparian Areas*, which was included in that appended to that document to address *Term and Condition 76 in the Decision of the Environmental Assessment Board for the Class Environmental Assessment by the Ontario Ministry of Natural Resources on Timber Management on Crown Lands in Ontario (1994)*. This direction is included in the roads section of this guide but will also apply to any harvest areas that may affect the passability of recreational portage routes and trails used for accessing and working traplines. Reasonable efforts are intentionally not defined in the direction and are intended to be tailored to individual circumstances. The two examples provided (clearing of logging debris and avoidance of steep ditching) are not an exhaustive list of what may be reasonable. |
| *Best management practices* | A number of BMPs are provided which address specific concerns in the general harvest area with respect to managing roads, the physical environment, and associated fish and wildlife habitats. For example, specific direction is provided for roads associated with wetlands and peatlands. Roads in these kinds of features can be problematic from a road construction and maintenance perspective, and can also affect hydrologic flow, wetland function, and some habitats of fish and wildlife (see 4.1.3).<br><br>Other BMPs are provided in recognition of the need to take special care to protect these highly sensitive values and to provide extra precautionary measures that may be required in some situations.<br><br>This includes techniques to allow travel and escape routes for wildlife.<br><br>The suggestion to avoid loop roads in high quality wildlife habitats is largely to facilitate decommissioning and abandonment strategies (Frederick 1991). Loop roads generally receive high use by forest users, hunters, and other recreationists, and once a pattern of high use has been established, it is difficult to change. Additional direction associated with roads and wildlife habitat in the Section includes linkages to further direction for areas where habitat management for cervids is emphasized (Section 3.3). |

#### 5.1.1.2 Roads within areas of concern

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – Before construction of any road in | Direction to mitigate adverse effects of roads and traffic on specific |

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| an AOC, ensure all considerations with respect to road planning, location, use management strategy and other mitigation techniques are consistent with the specific direction for the associated value as described in Section 4.0. | values is contained in Section 4. See 4.1-4.3 for rationale. |
| *Standard* – Unless approved by MNR, construction and maintenance operations that may enter a water feature (i.e., in-water work) or that may potentially cause sediment to enter a water feature, are not to occur in shoreline AOCs during periods of fish spawning, incubation, and fry emergence.<br>These periods are outlined in generic timing restrictions for each region, by species or fish group, in Table 5.1b in Section 5.1.2. | Protection of fish habitat is especially critical during the periods of spawning, incubation and fry emergence. These dates are outlined in Table 5.1b.<br>In-water work must be avoided during these periods because it may introduce sediment, or may physically disturb spawning fish or eggs.<br>See *Environmental Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Standard* – Fill material placed to build the road below high water level within the floodplain of a water feature will be erosion resistant and/or protected from erosion. | One underlying principle in road building to use materials that limit the potential of erosion or deposition of sediment into water features.<br>This is especially important in operations where material needs to be added to roadbeds that are below the high water level and are susceptible to water movements during parts of the year.<br>See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Guideline* – Narrow the clearing width of the road right-of-way to the minimum required for construction and safety purposes. Some AOC prescriptions specify maximum right-of-way widths (see Section 4 for details). | This *Guideline* helps to maintain the amount of productive land (section 5.2.4) and protect that amount of natural terrestrial habitat (see Section 4).<br>Right-of-ways in AOCs are normally kept as narrow as possible. However, road and driving safety must be considered and may take precedence in determining right-of-way widths. See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Guideline* – To maintain drainage patterns and minimize the potential for | Care needs to be taken to ensure natural watercourses are maintained during road construction. This is especially true in AOCs that by definition are sensitive. Appropriate sized cross road |

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| sediment laden roadbed or ditch run-off to reach a water feature, use cross drainage culverts whenever a road crosses a gully or other natural drainage feature. | culverts helps to maintain natural drainage patterns. See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Guideline* – To minimize the potential impacts on fish habitat and water quality in shoreline AOCs:<br>i) fill in or around a water feature will be erosion resistant;<br>ii) in erodable soils, it will be necessary to use erosion control techniques;<br>iii) trees will be felled so they do not fall into water;<br>iv) design ditches so they do not discharge directly into a water feature; ditches will divert flow into the bush so the water filters through natural vegetation before entering a water feature unless impractical to do so, and<br>v) where it is not practical to disperse ditch water before the ditch reaches a water feature, mitigative measures will be required. | This *Guideline* emphasizes one of the underlying principles in this section; that in road building it is important to use materials that limit erosion or deposition of sediment into water features. Working in an AOC only emphasizes this principle. See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details. |
| *Guideline* – Roads built within 15 m of a water feature and not associated with a water crossing will: use techniques and practices to reduce the possibility of roadbed erosion; avoid grubbing; and, design ditches to minimize the possibility of sediment entering the water feature. | Another *Guideline* that helps meet the underlying principle in this section; to limit the potential of erosion or deposition of sediment into water features. See Environmental *Guidelines For Access Roads and Water Crossings* (1990) for further details.<br>. |
| *Guideline* – Reasonable efforts (e.g., clearing of logging debris, avoid steep ditching) will be made to ensure that recreational | Direction is provided to ensure that recreational portage routes and trails used for accessing and working traplines are passable following forest management operations. This replaces direction that was previously in the *Code of Practice for Timber Management Operations in Riparian Areas*, which was included in that appended |

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| portage routes, and trails used for accessing and working traplines, are passable following forest management operations. | to that document to address *Term and Condition 76 in the Decision of the Environmental Assessment Board for the Class Environmental Assessment by the Ontario Ministry of Natural Resources on Timber Management on Crown Lands in Ontario (1994)*. This direction is included in the roads section of this guide but will also apply to any harvest areas that may affect the passability of recreational portage routes and trails used for accessing and working traplines. Reasonable efforts are intentionally not defined in the direction and are intended to be tailored to individual circumstances. The two examples provided (clearing of logging debris and avoidance of steep ditching) are not an exhaustive list of what may be reasonable. |
| *Best management practices* | The BMPs in this section follow the principles that the Standards and Guidelines have emphasized – to work in such a way to lessen the potential deposition of sediment into water features, to select appropriate sized culverts, to monitor and maintain them as needed, and to have a plan in place to identify beaver activity in the area, and deal with dams in a timely manner. |

### 5.1.1.3 Decommissioning of roads

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – Where decommissioning is planned, it will be incorporated into the approved use management strategy for roads and road networks as per FMPM requirements. | Follow the process outlined in the FMPM. |
| *Guideline* – For each road or road network scheduled to be decommissioned, ensure decommissioning is consistent with the approved use management strategy and techniques are carried out in accordance with the requirements in the annual work schedule. | Follow the process outlined in the FMPM. |
| *Guideline – For* each | Stabilize slopes (following procedures outlined in OMNR 1990) will |

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| road or road network scheduled to be decommissioned, stabilize slopes and areas of the road with known or identifiable hazards (e.g., slopes susceptible to washouts) to prevent erosion and protect public safety. | help to reduce risk of washouts that may result in deposition of sediment in water features, creation of obstructions to fish movement, or creation of safety hazards.<br><br>OMNR (1990) recommends that a stable slope should have a horizontal to vertical ratio of between 1.5 and 2.0 (horizontal) to 1.0 (vertical). |
| *Guideline* – Specific road and road network decommissioning direction is provided in Section 3.3, as well as in the Landscape Guide. Where applicable, this direction will contribute to the use management strategy for the road or road network. | Road networks after decommissioning still have impact on wildlife (travel corridors, food sources, access to hunters or fishermen, etc), and their long-term impacts on wildlife and their habitat should be considered when planning and implementing decommissioning practices. |
| *Guideline* – Decommissioning of roads is usually related to decommissioning of water crossings. Ensure the schedules for road or road network and water crossing decommissioning (Section 5.1.2.3) are coordinated.<br><br>When decommissioning a road or road system, assess all water crossings on that road or road system (Section 5.1.2.3). | In order to ensure a thorough and efficient decommissioning, the planning of, and decommission both roads and water crossings needs to be coordinated and should take place at the same time. |
| *Guideline* – For decommissioned roads or road networks, MNR will have an appropriate monitoring program to address environmental and/or safety concerns. | Planning and management for roads for forest management activities is outlined in the *Forest Management Planning Manual.*<br><br>Based on the plan outlined in local FMPs, monitoring and compliance is necessary to ensure environmental and safety concerns of road decommissioning is achieved. |

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| *Best management practices* | Decommissioning requires considerable planning that focus on use management strategies and long-term impacts on the social and physical environment.<br><br>A number of BMPs are provided that reduce the environmental footprint of the decommissioned road (OMNR 1990), and approached to limit access on unmaintained roads.<br><br>They also focus on approaches to ensure the potential erosion and deposition of sediment into water features is limited. |

### 5.1.2 Water Crossings

**Background**

The term “water crossing” refers to any crossing of a water feature by a road. At a minimum, permanent and intermittent streams or lakes appearing on the Ontario Base Maps (OBM) at 1:20,000 scale for Northern Ontario or 1:10,000 scale for southern Ontario, or on the 1:50,000 federal maps if the smaller scale OBM maps are not available, will be identified. During the construction of a road, when unmapped streams are encountered or the actual location of a stream is different from the mapped location in the forest management plan and annual work schedule, a revision to the annual work schedule will be required. Refer to the *Forest Management Planning Manual* (2004) and *Forest Information Manual* (2009) for direction.

Water crossing structures have great potential to impact fish habitat and fish populations (Evans and Johnston 1980, OMNR 1990, Poulin and Argent 1997, Bates 1999). Improperly constructed water crossing structures that block normal fish movement and migration can result in reduced spawning success because fish may abandon their spawning run or spawn in less suitable habitat. If blockage is complete and permanent, some fish species could be eliminated from portions of the drainage basin. Blockage of fish migration could also result in the fish being more vulnerable to predators or harvest.

In the planning of water crossings, *The Forest Management Planning Manual* (2004) provides for acceptable variations to the location of the crossing (which may be acceptable as a result of the considerations in the determination of the crossing location) and acceptable variations to conditions on construction (which may include acceptable optional water crossing structures, alternative construction methods and alternative mitigative measures). Acceptable variations to the design of the water crossing are based on information on the characteristics of the crossing location and the natural resource feature, land use or values associated with the crossing.

**Ecological effects of water crossings**

The *Environmental Guidelines for Access Roads and Water Crossings* (OMNR 1990) indicates the potential negative impacts to water quality and fisheries resources were the most common concerns associated with water crossings. The particular design of a water crossing may affect the type and level of impact on aquatic resources. The seriousness of the impact depends on many factors, including:

- the sensitivity of the natural environment to disturbance,
- the nature of the aquatic environment and it’s associated natural communities (e.g., fish, wildlife, vegetation),
- ground topography,
- soil types along the route,
- construction materials used,
- geometric road standard,
- the use management strategy for the road or road network,
- construction and maintenance practices,
- mitigation techniques implemented,
- the timing of activities, and
- how the crossing is decommissioned.

Fish habitat occurs in lakes, rivers, streams, and even areas that experience flood water levels for only a few weeks in the spring.). Improperly designed, constructed, and maintained water crossings can affect fish and fish habitat either directly or indirectly by blocking migration, causing sedimentation, removing shade and food sources through loss of vegetation, and adding deleterious substances to the water. Some activities associated with water crossings, particularly use of explosives, can kill fish directly.

Of all forest management activities, studies have shown that road construction, especially when associated with water crossings, results in the greatest input of sediment to the aquatic environment (Forman and Alexander 1998).

Blockage can result from the accumulation of sediment, gravel, logs, vegetation, or ice jams inside or at the entrance of the crossing. Beaver damming activity is often the cause of blockage. Culverts wider than the stream channel, however, can discourage beavers from plugging the culvert (Jensen et al. 2001).

Numerous studies have shown that culverts can also block fish movement if they constrict the stream channel, resulting in an increase in water velocity that exceeds the swimming ability of fish species affected (e.g., Moore et al. 1999; Fig. 5.1a).

Perched culverts, those installed above the streambed or on a steep slope causing a waterfall, can also block fish passage. If the culvert outlet is higher than the jumping ability of the fish (and in Ontario, only a few species are 'jumpers'), then upstream migration is effectively blocked. Over time, erosion of the downstream channel can result in a perched culvert and/or a lowering of water levels (from filling in of the stream bed or a widening of the stream channel). Fish require a certain depth of water in order to swim. Fall spawners, such as whitefish and brook trout, are particularly at risk since fall water levels may already be low.

Sedimentation can be a problem for fish not only during the construction of crossings, but after the crossing has been put in place. High water conditions, freezing and thawing, or simple wear and tear on crossing materials can create situations where sediment begins to be generated.

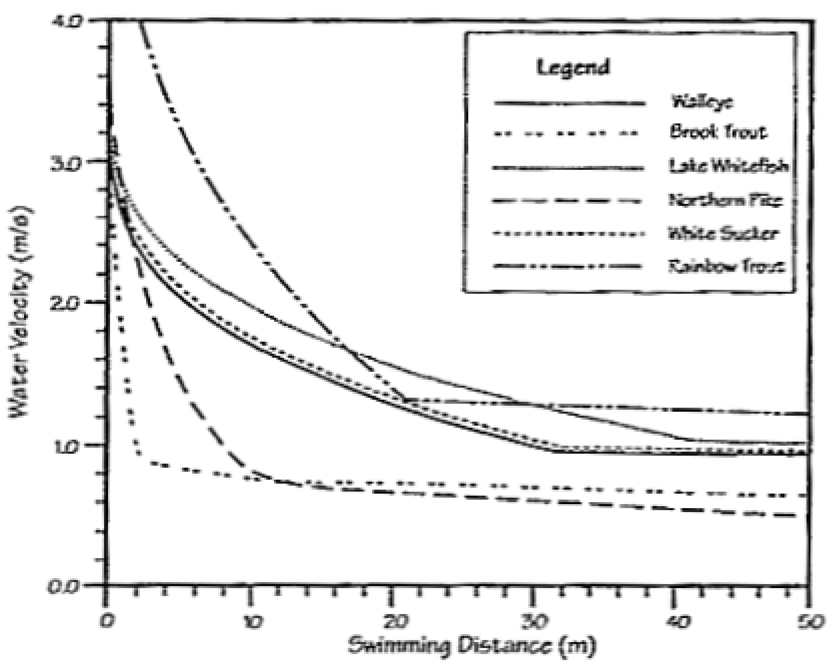


**Fig. 5.1a. Water velocity and fish swimming ability (from Moore et al. 1999).**

Sediment is generally referred to either as suspended or bedload. Suspended sediments can:

- clog and abrade fish gills, possibly causing suffocation,
- reduce water clarity, making it difficult for some fish to find food or detect predators,
- alter aquatic food chains by screening out available sunlight for microscopic plants and reducing primary production, and

- alter oxygen levels and water temperature.

Bedload sediment can:

- alter stream flow'
- clog the interstitial spaces of a gravel or cobble spawning area so the free flow of oxygenated water and removal of wastes is impaired, resulting in fish egg and fry mortality (Fig. 5.1b),
- cause eggs to be deposited on top of spawning beds making them vulnerable to predators, and
- alter the food chain by smothering or displacing benthic invertebrates, which are a food source for some fish species (Ward 1992).

Construction activities, which remove vegetation and topsoil without proper erosion control measures, can cause an increased sediment load into water features; while improperly designed stream crossings can alter water velocities and direction of flow, leading to scouring of the stream bed and banks. Sediment from a water crossing is carried downstream by the water flow, therefore the cumulative effects of several crossings within a watershed can add up. See *The Problem of Sediment in Water For Fish* (Ward 1992).

Installation of a single culvert in a stream with a wide and well-developed floodplain can alter flow characteristics. Instead of the flood water moving down the floodplain, it will be redirected by the road fill and concentrate as channel flow through the pipe. This can de-stabilize the stream channel and cause downstream bank erosion, channel erosion, and upstream flooding.

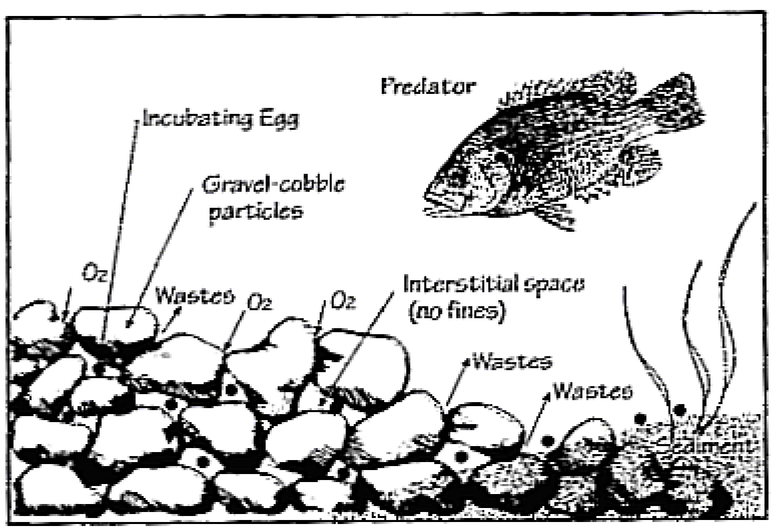


**Fig. 5.1b. Features of a gravel-cobble fish spawning habitat (Illustration by Kestevan Design).**

Such impacts can be mitigated by passing channel flow through the culvert and some floodplain flow over the floodplain using side culverts and/or a low, stable road grade designed for water to spill over it.

Water crossings can alter the natural channel, but with proper design in-stream flow can be accommodated to meet biological and engineering requirements. For example, creation of a pool-riffle sequence or placement of boulders for fish passage might be the mitigation needed given the conditions at the site, the range of water flows likely to occur, the fish species present and the requirements for a safe and stable structure. Good reference books are available for technical details (Seehorn 1992, Newbury and Gaboury 1993, Rosgen 1996, Slaney and Zaldokas 1997).

Water crossings which require blasting as part of the construction need to have DFO approval prior to proceeding. Use of explosives can contribute to sedimentation as well as killing fish directly. Proponents should also be familiar with the *Guidelines for the Use of Explosives in or near Canadian Fisheries Waters* (Wright and Hopky 1998).

When decommissioning of water crossings results in abandonment of the structure and non-maintenance, the water crossing can be an on-going risk to fish and the aquatic environment. The cessation of maintenance at a particular water crossing will likely lead to failure of the structure at some time in the future, potentially resulting in deposition of sediment in the aquatic environment and blockage of fish migration. In addition, non-maintenance and removal of water crossings may also pose a risk to human health and safety. Water crossings are particularly dangerous when crossing structures have been removed, but roads can still be traveled (by a vehicle, including ATV's), or when crossing structures have not been removed, but are no longer safe (e.g., the crossing structure has deteriorated).

How the water crossing will be decommissioned may be a function of the nature of the crossing structure (Table 5.1a, Fig. 5.1c). Generally, small crossings structures, such as culverts, are more likely to fail over a given period of time than larger, more permanent structures such as bridges. All crossing structures, however, require periodic maintenance. Other specialized types of crossings are winter-only crossings and low water crossings such as fords.

Temporary winter-only water crossings provide cost-effective access for a few months between freeze-up and spring break-up. Since the ground (and in the case of an ice-bridge, the water) is frozen, the road can be built with minimal disturbance to the aquatic or terrestrial environment. In most cases summer access will not be available so it is important to plan the crossing and follow-up silvicultural treatments with the access restrictions in mind. However, ice bridges can still have an impact on fish and fish habitat, and need to be carefully planned and installed.

**Table 5.1a. Common types of water crossings on forest roads in Ontario (OMNR in prep[1]).**

| Site Conditions | Structure Type | Design Considerations |
|---|---|---|
| Larger crossings:<br>• Drainage area > 50 km$^2$<br>• Flow > 25 m$^3$/sec<br>• Water width > 10 m<br>• Water depth > 1.5 m | Bridge:<br>• OMNR permanent bridge (10-24 m)<br>• Modular truss bridge (18-40m)<br>• Temporary steel bridge (5-12m) | • Single or multiple spans<br>• Possible in-stream abutment or pier<br>• Channel morphology & stability<br>• Permanent or temporary need<br>• Crib or pile bridge foundation |
| Smaller crossing:<br>• Riffle with gravel, cobble, or larger substrate<br>• Streambed slope < 3.5%<br>• Bedrock or unmovable boulders<br>• Shallow fast water | • OMNR permanent bridge (10-24m)<br>• Temporary bridge (< 10 year need)<br>  o Steel portable (5-12m span)<br>  o Local log bridge (< 6 m span)<br>• Arch culvert (< 20' span)<br>• Embedded round culvert<br>  o Set 20-40% D below streambed<br>  o Natural substrate fills into pipe<br>  o Channel width in pipe = natural | • Clear span normal water width<br>• Permanent or temporary need<br>• Crib or pile bridge foundation<br>• MNR design, FERIC design or custom design by a P.Eng.<br>• Pre-construction testing to confirm embedment is possible. If embedment not possible, change to bridge or arch. |
| Smaller crossing:<br>• Substrate is gravel, sand or finer<br>• Stream slope < 0.5%<br>• Quiet flow velocity (no surface ripples) | • Normal round culvert:<br>  o Set 10% D below streambed | • Size for design flood flows<br>• Channel morphology & stability<br>• Pipe alignment in stream<br>• Quality installation & backfill |

[1] OMNR. In prep. Environmental guidelines for access roads and water crossings, 2nd Edition. Queen's Printer for Ontario. Toronto. ON

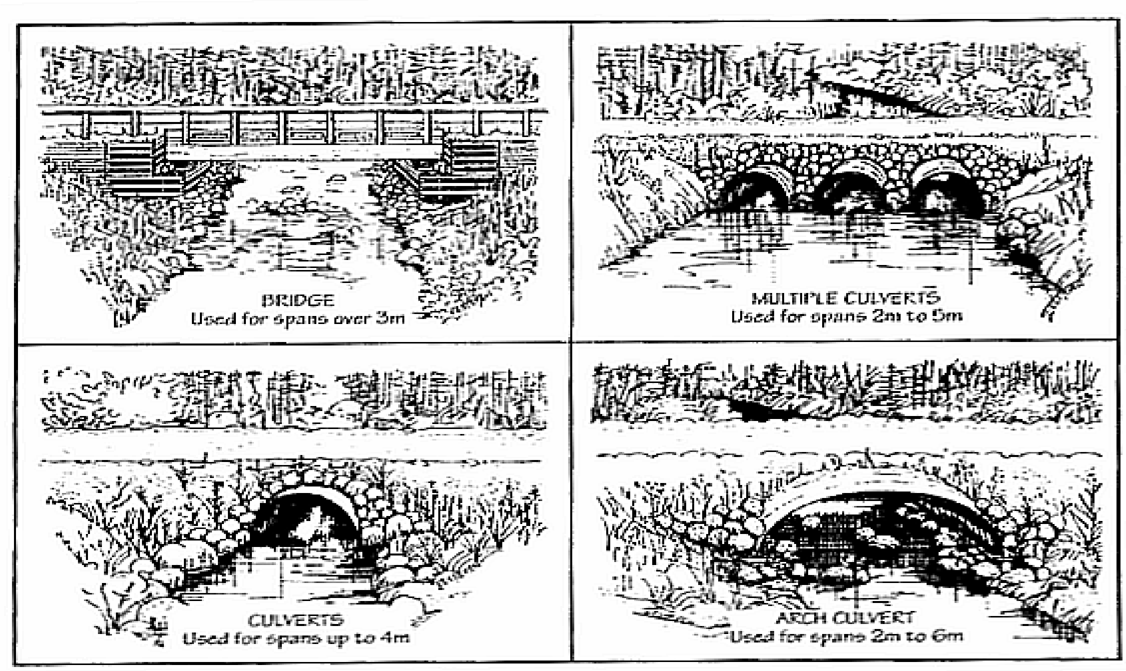


**Fig.5.1c. Types of water crossing structures (Illustration by Kestevan Design).**

### Past direction

As with section 5.1.1 (Roads), much of the past direction in section 5.1.2 (Water crossings) came from the *Environmental Guidelines for Access Roads and Water Crossings* (OMNR 1990). That document, now under review, remains the basis for much of the current direction (Standards, Guidelines, and Best Management Practices) and rationale for Section 5 of the Stand and Site Guide. Other synthesis of environmentally sensitive approaches to forest road and water crossing considerations include those written by Gillies (2007), Gucinski et al. (2001), and Pulkki (2003).

### 5.1.2.1 Design and location of water crossings

### Rationale for direction

A policy and standards for bridges are contained in the *Final Report on Crown Land Bridge Management* (OMNR 1989). Corrugated steel culverts are “solid-steel” structures and their installation should follow recommended practices to avoid problems. Refer to the MNR publication *CSP Culvert Installations at Water Crossings on Forest Access Roads* (Wilson 1996). Culvert pipes made of other materials (e.g., concrete, cast iron) should be installed following the manufacturer’s recommendations.

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – The submission, review and approval of water crossings built under authority of the CFSA | To ensure all regulatory requirements are met, direction and requirements in the FMPM and other appropriate legislation will be followed in the submission, review and approval of water. |

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| will comply with the requirements of the FMPM and all other applicable legislation. Further information about the approval process for water crossings (e.g., MNR engineering approvals) can be obtained from the local MNR and/or Conservation Authority. | |
| *Standard* – The culvert or bridge opening size shall be determined by hydrologic and hydraulic analyses, in accordance with design procedures developed for Ontario use. A water crossing structure with a single span greater than 3 m is considered to be a bridge; design of all bridges will comply with the requirements in the *Crown Land Bridge Management Guidelines*. | Common types of water crossings are outlined in Table 5.1a. Selection of appropriate type and size of crossing is critical in protecting water feature values.<br><br>Culverts often result in a constricted flow channel and an increase in water velocity. A constriction can also occur during flood flows if the floodplain area is dammed by fill forcing all the water through the main channel. Fish have adapted to moving through fast water in short bursts between resting areas; in circular culverts, the absence of bottom substrates creates a long distance without resting places. If the water velocity exceeds the swimming ability of the fish, migration will be effectively blocked. This is particularly true for spring spawners such as walleye, pike, and suckers, whose migration runs often coincide with peak water flows in April and May. If the energy needed to swim through a crossing structure is excessive, spawning may not occur or spawning success may be impaired. Procedures for estimating flow velocity in culverts are available in the references (Katapodis 1993 and OMTO 1997).<br><br>Other good reference books are available for technical details (Slaney and Zaldokas 1997, Rosgen 1996, Newbury and Gaboury 1993, Seehorn, 1992). |
| *Standard* – Selection of the type of water crossing structure, its location and its capacity to pass water and allow for the movement of fish, will consider:<br><br>i) possible negative effects on the form and function of the undisturbed natural channel and its floodplain;<br><br>ii) the fish species present and the impact of the crossing structure on them, as required by the *Fisheries Act*; and<br><br>iii) whether the water | Similar to the *Standard* above, it is critical to select the proper size water crossing to reduce the impacts on water flow, fish and fish habitat.<br><br>Considerations are based on size of crossing, water velocity, fish species present, navigability, etc. |

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| crossing is over navigable waters. | |
| *Guideline* – Avoid crossing in areas which affect known critical fish habitat, such as fish spawning, feeding, over-wintering, or nursery areas. | Crossings may alter the suitability of critical habitats such as spawning sites by altering water flow, disrupting, stream bed, adding sediment etc (see above). Selection of water crossing location should avoid these sites. |
| *Guideline* – Avoid steep high banks or sites where actively slumping banks are evident. | A key goal in any water crossing is to reduce the impacts of erosion and deposition of sediment into water features. Steep or slumping banks are conditions vulnerable for these impacts to occur and should be avoided.<br>Mitigating approaches are found in OMNR 2000. |
| *Best management practices* | The BMPs encourages water crossings to be located in areas that are less susceptible to impacts to the water features (i.e.; potential erosion or deposition of sediment).<br>They also remind the user to be aware of beaver activity in the area and make decisions on location based on the activity. |

#### 5.1.2.2 Installation and maintenance of water crossings

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – Those responsible for installation and maintenance will monitor operations and select operating practices, materials, and mitigation techniques at each water crossing to prevent the harmful alteration, disruption or destruction of fish habitat or the impairment of water quality. Harmful alteration, disruption, or destruction of fish habitat is not permitted without DFO approval. | This *Standard* is a reminder for those responsible for installation, maintenance, and monitoring of water crossings to ensure that there is no harmful alteration, disruption or destruction (HADD) of fish habitat or water quality.<br>Such actions are not allowed under the *Fisheries Act.* |
| *Standard* – The | Water crossings should be designed to allow free and unobstructed |

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|---|---|
| installation of a water crossing will not result in the impediment of fish passage; mitigative techniques will be applied if the structure has the potential to impede or block fish migration or passage. | fish passage through water crossings so that fish can migrate, or travel at any time, to spawning, rearing, feeding, over-wintering, or other essential areas without harmful delay.<br><br>If there is potential for the unobstructed passage not to happen, actions need to take place to help fish get the unobstructed passage. |
| *Standard* – At any time of year, the free movement of water and fish will not be blocked or otherwise impeded, except for brief periods during construction and as approved by MNR. | Similar to the *Standard* above, actions need to be taken to maintain the free and unobstructed fish passage throughout the year. |
| *Standard* – The removal of stream boulders is generally not acceptable, except where necessary for installation of a crossing structure which retains a natural streambed (e.g., a bridge). | This *Standard* recognized the importance of the natural streambed materials (gravel and boulders) to fish habitat, and specifically identifies the need to keep the streambed intact. |
| *Standard* – Construction operations that may enter a water feature (i.e., in-water work) or that may potentially cause sediment to enter a water feature, are not to occur during periods of fish spawning, incubation, or fry emergence, unless approved by MNR. Timing restrictions vary cross the province; generic timing restrictions, by species for each MNR region, are provided in Table 5.1b (below). If warranted, local MNR offices can vary timing dates and mitigative measures based on local knowledge. | In-water operations have the potential to disrupt normal water flow and also can be a source of deposition of sediment into the water.<br><br>These changes to normal conditions can smother fish eggs and reduce reproductive success.<br><br>Timing restrictions (found in the Guide and below in Table 5.1b) are designed to keep construction away from critical spawning times to help protect fish stock. |
| *Standard* – Fill material | Roads should be designed to be erosion resistant, especially in or |

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| required to build the road at the site of the crossing, below the high water level and within the floodplain of the water feature, will be erosion resistant and/or protected from erosion. | around water features. This can be challenging in areas that are subject to flooding or changing water tables.<br>Special care needs to be taken in these areas to ensure road integrity is maintained while water features and fish habitats are protected. Use of rip rap and other erosion reducing materials are recommended. |
| *Standard* – Any exposed mineral soil between the height of land and the water crossing, or within 100 m of the water crossing, whichever is less, will be trimmed to a stable angle and be protected from erosion so sediment will not enter water. | Trimming exposed mineral soil to a stable angle greatly reduces the chance of sediment movement and subsequent deposition within water features. |
| *Standard* – During construction and maintenance of a water crossing, contamination of a water feature by foreign materials such as lumber, nails, fuel, oil, or herbicides is not permitted (the crossing structure itself, including temporary crossings, can be in the water, if the approved design allows for this). | Introduction of foreign materials into a water feature may alter habitat suitability (e.g., by blocking fish passage) or have detrimental effects on fish or their food (e.g., contamination by liquid fuels) and should not take place. |
| *Standard* – Prevent sediment from entering the water features by using erosion and sediment control techniques. | All operations associated with water crossing installation will follow appropriate mitigative techniques to minimize the risk of depositing sediment in a water feature (see above for a discussion of the ecological effects of sediment).<br>Refer to Ward (1992) for details on sediment and the impact is has on fish, and to OMNR (1990) for sediment control techniques. |
| *Standard* – Blasting in or near water produces shock waves that can kill fish and will normally be avoided. Blasting with a potential impact on fish or fish habitat will only be done following approval from DFO. | Protection for fish and fish habitat is contained in the federal *Fisheries Act*. Blasting in or near water produces shock waves that can kill fish and will normally be avoided. Blasting with a potential impact on fish or fish habitat will only be done following approval from DFO.<br>*Guidelines for the Use of Explosives in or near Canadian Fisheries Waters* (Wright and Hopky 1998) provides further details. |
| *Standard* – Upon completion of a water | This *Standard* focuses on the need to leave the worksite clean (through removal of no longer used crossing materials and garbage), |

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| crossing, any temporary fill, culverts, refuse, etc. will be removed from the construction area and properly disposed of in a satisfactory manner. | and to use practices that can reduce possible deposition of sediment in water. Sediment can impact fish by clogging gulls, reducing water quality altering food chains, and altering oxygen and temperature levels in the water (Ward 1992).<br>Removing garbage and other unwanted materials helps to restore the sense of “remoteness” sooner. |
| *Standard* – After construction, on-site inspections will be made by the proponent to confirm these standards are being met. | This *Standard* is part of the inspection and monitoring process that should be involved in all road and water crossing activities. |
| *Standard* – If using temporary winter-only crossings, materials other than ice and snow will be removed from the stream prior to spring break-up. | If using temporary winter-only crossings, materials other than ice and snow will be removed from the stream prior to spring break-up to ensure neither sediment nor other foreign materials is deposited in the stream (see Ward 1992 for a discussion on sediment and fish). |
| *Standard* – Upon installation, each new water crossing will be incorporated into the approved program for monitoring roads and water crossings. | This *Standard* is part of the inspection and monitoring process that should be involved in all road and water crossing activities. |
| *Standard* – These standards are applicable to previously installed water crossings when they are replaced or upgraded due to sub-standard safety, environmental, or operational reasons. | Any replaced or updated water crossing will meet the current standards for water crossings. |
| *Guideline* – Use techniques and materials appropriate for the conditions encountered at each water crossing, to minimize disturbance of a water feature and significantly reduce the potential for erosion and sedimentation. | All operations associated with water crossing installation will follow appropriate mitigative techniques to minimize the risk of depositing sediment in a water feature (see above for a discussion of the ecological effects of sediment).<br>Refer to Ward (1992) for details on sediment and the impact is has on fish. |
| *Guideline* – Ensure logs and brush which may need to be removed or trimmed at the crossing | While water side trees may naturally fall into water features, placing additional woody material into water features is not allowed.<br>Ensure logs and brush which may need to be removed or trimmed at |

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| site do not enter the water feature. | the crossing site do not enter the water feature to minimize risk of blocking fish passage or disturbing critical fish habitats. |
| *Guideline* – Grubbing of low vegetative cover between the height of land and a water crossing, or within 100 m of a water crossing, whichever is less, will be limited to that required to address engineering issues and safety concerns, such as the removal of hazards. | Grubbing is the removal of stumps, roots, embedded logs, organics, and unsuitable soils before, or concurrently with, subgrade road construction. The organic material helps to provide stability to microsite – lessening the chances of erosion or movement of sediment.<br>To protect water features from an increased potential of deposition of sediment should be limited to locations where the removal is required to meet construction goals or where safety concerns warrant it. |
| *Guideline* – When diverting and/or removing water for dry installations, chase away or trap and relocate live fish before completely dewatering the area (note: permits may be required; consult the local MNR district office for further information). | When diverting and/or removing water for dry installations, ensure all fish are moved before completely dewatering the area to ensure compliance with the *Fisheries Act* and the related DFO *Operational Statements.*<br>This *Guideline* is also a reminder that the *Fisheries Act* does not allow harmful alternation, disruption or destruction of fish habitat without DFO approval. |
| *Guideline* – Apply mitigative techniques to provide for fish passage if there is potential to impede or block fish migration during installation of the crossing. | This *Guideline* is also a reminder that the *Fisheries Act* does not allow harmful alternation, disruption or destruction of fish habitat without DFO approval. |
| *Guideline* – Begin site stabilization and clean-up as soon as possible after the water crossing has been installed, including the removal of all diversions. | Begin site stabilization and clean-up as soon as possible after the water crossing has been installed, including the removal of all diversions, to minimize risk of erosion and sediment deposition and interruption of fish passage. |
| *Guideline* – Trim fill slopes to a stable angle, or use other mitigative stabilization techniques. A person should be able to walk up the slope without causing slumping and sliding of soil particles. When a temporary channel is no | Trim fill slopes to a stable angle, or use other mitigative stabilization techniques to minimize the risk of erosion and sediment deposition.<br>OMNR (1990) recommends that a stable slope should have a horizontal to vertical ratio of between 1.5 and 2.0 (horizontal) to 1.0 (vertical). |

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| longer required, it should be stabilized to avoid long-term erosion. | |
| *Guideline* – Construct and use fords during the driest time of the year but not during the restricted time of high risk to fish; ensure the ford does not restrict fish passage. | Fording shallow streams is a commonly used method of water crossings. Planning is important to construct these crossings at time that have the least impact on aquatic habitat and fish.<br>To protect fish, it's best to avoid constructing these crossings during the fish's sensitive times of spawning, incubation and fry emergence.<br>It's also critical to ensure that once completed, the ford doesn't restrict passage of fish. |
| *Guideline* – Material used within the stream and on the banks to improve the crossing will be clean, non-erodable, and non-toxic to aquatic life. | Roads should be designed to be erosion resistant, especially in or around water features. This can be challenging in areas that are subject to flooding or changing water tables.<br>Special care needs to be taken in these areas to ensure road integrity is maintained while water features and fish habitats are protected. Use of rip rap and other erosion reducing materials are recommended. |
| *Guideline* – Install culverts on a straight section of stream. When installation of a culvert on a straight section of stream is not possible, minimize the change in stream morphology and impacts on fish habitat. | Maintaining culverts in straight sections of streams helps to minimize changes in stream morphology.<br>These changes, including alterations in water speed, erodibility of streambed or banks, rate of sediment transport, etc. has an impact of water feature and the fish habitat. |
| *Guideline* – Replace or correct existing water crossings that pose a risk to public safety or<br>fish passage or fish migration (e.g., Fig.. 5.1c) using the guidance and advice provided in MNR and forest industry's *Forest Roads and Water*<br>*Crossing Initiative Task Team Report*. Specifically:<br>i. Through the existing approved program for monitoring roads and water crossings (Standard), significant changes and problems with water crossings will be identified and | Over time and use water crossing will show wear and tear, and degrade.  Monitoring of water crossings will identify crossings were problems are developing which put risk to the public, fish and fish habitat.<br>When identified, these crossings must be replaced or corrected as soon as possible. |

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| inventory data bases will be updated.<br><br>ii. Identified problem water crossings will be corrected to current prescribed standards as soon as practical on a priority basis.<br><br>iii. Problems that pose the greatest risk to public safety, fish passage, or<br><br>fish migration will be given a higher priority for remedial action, while lesser priority problems will be attended to as time and resources permit. | |
| *Best management practices* | Proper installation and maintenance of water crossings are critical for human safety and protection of fish habitat.<br><br>This includes using appropriate sediment control to isolating equipment when installing, regularly ensuing that culverts are clear, that a beaver management plan is in place to eliminate damming of the water feature and ensuring approaches are stabilized by reseeding in effected areas.<br><br>They also remind the operators that for temporary, winter only use that culverts are not recommended. – ice bridges offer a more cost effective approach. However, ice bridges can have impacts on fish and fish habitat and need to be planned carefully. |

**Table 5.1b. Timing restrictions for in-water work to protect fish and fish habitat during sensitive spawning and incubation periods.**

| **Fish Species** | **Region** | | |
|---|---|---|---|
| Spring Spawners | Northwest | Northeast | Southern[2] |
| Walleye | Apr 1 – Jun 15<br>Apr 1 – Jun 20[3] | Apr 1 – Jun 20 | Warmwater Fisheries<br>No in-water construction from Apr 1 – Jun 30, unless risk to the fish population(s) can be prevented or mitigated as approved by MNR. |
| Northern Pike | Apr 1 – Jun 15 | Apr 1 – Jun 15 | |
| Lake Sturgeon | May 1 – Jun 15 | May 1 – Jun 30<br>May 1 – Jul 15[3] | |
| Muskellunge | May 1 – Jun 30<br>May 15 – Jul 15[4] | May 15 – Jul 15 | Coldwater/Mixed Fisheries<br>No in-water construction from Oct 1 – Jun 30, unless risk to the fish population(s) can be prevented or mitigated as approved by MNR. |
| Largemouth Bass | May 15 – Jul 15 | May 15 – Jul 15 | |
| Smallmouth Bass | May 15 – Jul 15 | May 15 – Jul 15 | |
| Rainbow Trout | Apr 1 – Jun 15 | Apr 1 – Jun 15 | |
| Unknown Species | Apr 1 – Jun 15 | Apr 1 – Jun 15 | Coldwater Fisheries<br>No in-water construction from Oct 1 – May 31, unless risk to the fish population(s) can be prevented or mitigated as approved by MNR. |
| Fall Spawners | | | |
| Lake Trout | Sept 15 – May 15<br>Sept 1 – May 30[4] | Sept 15 – May 30<br>Sept 1 – May 30[4] | |
| Brook Trout | Sept 1 – Jun 15 | Sept 1 – Jun 15 | |
| Pacific Salmon | Sept 1 – Jun 15 | Sept 1 – Jun 15 | Unknown Fisheries<br>No in-water construction from Oct 1 – Jun 30, unless risk to the fish population(s) can be prevented or mitigated as approved by MNR. |
| Lake Whitefish | Oct 1 – May 15<br>Sept 15 – May 30[4] | Oct 1 – May 15<br>Sept 15 – May 30[4] | |
| Lake Herring | Oct 15 – May 15<br>Oct 1 – May 30[4] | Oct 15 – May 15<br>Oct 1 – May 30[4] | |
| Unknown Species | Sept 1 – Jun 15 | Sept 1 – Jun 15 | Critical Fisheries Habitat<br>No in-water construction allowed. |

[1] All dates inclusive. Dates listed for all regions are to be used in the absence of better (i.e., local) information. In-water work can proceed with appropriate mitigation as approved by MNR or the appropriate authority.
[2] Dates are for areas of Southern Region within the AOU. Timing restrictions in this region are not based on fish species, but on fish community types, or critical fish habitat, as shown in the column.
[3] If there is a late spring.
[4] In northern areas. Northern areas are not precisely defined; consult with MNR district office for applicability.

### 5.1.2.3 Decommissioning and rehabilitation

**Rationale for direction**

Rationale for is described below:

| **Direction** | **Rationale** |
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| *Standard* – If decommissioning of a | In decommissioning, all roads and water crossings need to be considered and assessed. Decommissioning does not necessarily |

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| road or road system is being considered (Section 5.1.1.3), all water crossings on that road or road system will be assessed. Water crossings that will no longer be maintained will be formally decommissioned in an environmentally sound manner and approved by MNR.<br><br>Decommissioning may or may not require removal of a water crossing. | mean that water crossings are removed.<br><br>Unmaintained water crossings may deteriorate over time and they represent a potential risk to fish habitat (i.e., potential source of sediment, potential blockage of fish passage; etc.) and a potential hazard to public safety if they fail.<br><br>The criteria to be considered as to whether or how a water crossing is to be removed and the mitigative techniques applied, is intended to allow decisions to be made on the basis of site-specific information, aided by the knowledge and expertise of the planning team. |
| *Standard* – During decommissioning, workers will prevent contamination of a water feature by foreign materials such as lumber, nails, logs, brush, fuel and oil. | Introduction of foreign materials into a water feature may alter habitat suitability (e.g., by blocking fish passage) or have detrimental effects on fish or their food (e.g., contamination by liquid fuels) and will not take place. |
| *Standard* – Decommissioning and rehabilitation operations that may enter a water feature (i.e., in-water work) or that may potentially cause sediment to enter a water feature, are not to occur during periods of fish spawning, incubation, or fry emergence, unless approved by MNR. Timing restrictions vary across the province; generic timing restrictions, by species for each MNR region, are provided in Table 5.1b (above). If warranted, local MNR offices can vary timing dates and mitigative measures based on local knowledge. | In-water operations have the potential to introduce sediment into the water that can smother eggs and reduce reproductive success.<br><br>Timing restrictions (found in the Guide and above in Table 5.1b) are designed to keep construction away from critical spawning and incubation times to help protect fish stock. |
| *Standard* – The | Those responsible for installation and maintenance of water crossings |

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| proponent for decommissioning of water crossings will monitor operations and mitigation techniques to prevent the harmful alteration, disruption, or destruction of fish habitat, the impairment of water quality, and, problems related to fish passage. | need to ensure that there is no harmful alteration, disruption or destruction (HADD) of fish habitat or water quality during those operations.<br>The *Fisheries Act* does not allow harmful alternation, disruption or destruction of fish habitat without DFO approval. |
| *Standard* – Fill material placed below the high water level within the floodplain of a water feature will be erosion resistant and/or protected from erosion. | Roads should be designed to be erosion resistant, especially in or around water features. This can be challenging in areas that are subject to flooding or changing water tables.<br>Special care needs to be taken in these areas to ensure road integrity is maintained while water features and fish habitats are protected. Use of rip rap and other erosion reducing materials are recommended. |
| *Standard* – Any exposed mineral soil between the height of land and the water crossing, or within 100 m of the water crossing, whichever is less, will be trimmed to a stable angle and be protected from erosion so sediment will not enter the water. | Trimming exposed mineral soil to a stable angle greatly reduces the chance of sediment movement and subsequent deposition within water features.<br>OMNR (1990) recommends that a stable slope should have a horizontal to vertical ratio of between 1.5 and 2.0 (horizontal) to 1.0 (vertical). |
| *Standard* – Upon completion of decommissioning, any temporary fill, culverts, refuse, etc. will be removed from the construction area and disposed of in a satisfactory manner. | Decommissioned roads should be left in a tidy, safe manner where there is little chance of temporarily used materials (i.e.; fill) ending up being a source of erosion and deposition of sediment.<br>Removing culverts no longer being used and refuse also help to restore a sense of “remoteness” to the area more quickly. |
| *Standard* – Following decommissioning, on-site inspections will be made by the proponent to confirm the standards are being met. Problems are to be reported to MNR immediately. | Decommissioning must be done in a manner that ensures the crossing does not pose a threat to fish habitat or public safety.<br>On-site inspections will ensure the standard is met. |
| *Standard* – For decommissioned water crossings that have not | Any water crossing will need a level of maintenance over time to ensure it meets safety standards. Where a decommissioned water crossing has not been removed regular inspections or monitoring will |

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| been removed, have a monitoring program to identify and mitigate safety and environmental issues. | help to identify concerns to public safety or to fish habitat. |
| *Guideline* – Whether and how a water crossing structure is to be removed will be based on an analysis of biological, water quality, engineering, and safety criteria, which considers, at a minimum, the following items:<br>**Biological**<br>i) history of beaver activity;<br>ii) sensitivity of fish species;<br>iii) whether the structure is currently an impediment to fish migration or may be an impediment to fish migration in the future;<br>iv) the presence of critical fish habitat and the likelihood of the habitat being impacted should a washout occur; and<br>v) whether removal activities would cause damage to fish or fish habitat.<br>**Water Quality**<br>i) in the event of a washout or erosion problems, will additions to natural background levels of suspended sediments affect downstream fish habitat or other values.<br>**Engineering**<br>i) the type of the water crossing structure (e.g., culvert); | The steps required and recommended when decommissioning a water crossing are intended to minimize environmental (e.g., water quality and fish habitat) and safety hazards associated with the removal of the structure or cessation of regular monitoring and maintenance.<br>A broad range of potential impacts needs to be considered. This includes how decommissioning activities (including removal of water crossings) will effect habitat and activities of wildlife, the impacts of water quality, life expectancy of materials being left in place, and the safety to users (both wildlife and humans) of the decommissioned site after activities have ended.<br>The criteria to be considered as to whether or how a water crossing is to be removed and the mitigative techniques applied, is intended to allow decisions to be made on the basis of site-specific information, aided by the knowledge and expertise of the planning team. |

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| ii) the length of time the structure was designed to be functional (e.g., whether the crossing has been designed for a 10-year or 100-year storm event);<br>iii) the expected life of the materials used in the construction of the crossing structure;<br>iv) whether the fill material is similar to the streambed/streambank material;<br>v) whether the road will allow for floodwaters to pass without washing out;<br>vi) the amount and type of fill used in construction of the water crossing;<br>vii) impact of removal of the crossing on the use management strategy of the associated road or road network; and<br>viii) costs of removal.<br>**Safety**<br>i) if the water crossing structure failed or if a washout occurred, would a hazardous situation result. | |
| *Guideline* – Use techniques appropriate for the conditions encountered at each crossing to minimize disturbance of the water feature and the potential for erosion and sedimentation during and after decommissioning. | See comments about sediment control in 5.1.2.2.<br>For additional information on techniques see OMNR (1990), and on problems with sediment see Ward (1992). |
| *Guideline* – Decommissioning of water crossings is | See comments in 5.1.1.3 |

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| related to decommissioning of roads. Ensure the schedules for water crossing and road or road network decommissioning (Section 5.1.1.3) are coordinated. | |
| *Guideline* – Decommissioning of the water crossing will be consistent with the vehicular traffic expected by the use management strategy for the road or road network. | If the road network is still available for use after decommissioning (e.g.; allowing fording of shallow streams after a culvert has been removed), care needs to be taken to ensure water crossing locations offer safe passage for the user and protection to water features and fish habitat. |
| *Guideline* – If continued vehicle passage can be considered after removal of the crossing structure, ensure the crossing site is safe and erosion resistant. | When water crossings are removed stabilization of the area is critical to reduce the chance of erosion, and deposition of sediment into water features.<br>In cases where vehicles passage can be considered after the water crossing is removed (e.g.; via ford), extra care must be give to the site to stabilize the impacted area and leave it in a condition where erosion deposition of sediment in a water feature will not happen.<br>Some techniques for this are outlined in the Guide's Appendix 5.2c and in OMNR 2000. |
| *Best management practices* | Decommissioning of water crossings implies that they will be impassable for vehicle traffic.<br>Removal of water crossing may provide a safety risk to travelers on the road. It is suggested to put barriers on each side of the crossing area to provide a warning of the hazard.<br>Where culverts are not removed in the decommissioning, it is recommended to excavate a depression near the remaining culvert to allow water passage in cases where the culvert becomes blocked. This practice will help to reduce road sediment from moving downstream.<br>Other helpful practices can be found in OMNR (2000). |

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### 5.2 Soil and Water Conservation

**Background**

As a general introduction to section 5.2 it is useful to begin by differentiating between site disturbance and site damage. Site disturbance can be described as any physical, biological, or chemical change to the site. Site damage is merely a gradation of site disturbance that has crossed a threshold for a particular variable being observed. The variable may be soil porosity, water infiltration rate, or available nitrogen. Defining when that threshold is crossed, and therefore when site disturbance becomes site damage, is very difficult and varies depending on a number of factors. The specific values used in the *Standards* and *Guidelines* are an estimate of that threshold, based on best available information, to be verified during guideline effectiveness monitoring (see Section 7). The depth of available literature varies by the type of site disturbance and gets weaker as you begin to add in additional dimensions such as site conditions (e.g., soil texture), season of operations (summer vs. winter), type of harvesting (clearcut vs. partial harvest), and tree species. A summary of the available information is included in the specific rationale below.

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* – The standards and guidelines in Sections 5.2.1-5 apply equally to operations within the regular harvest area and areas of concern. | Site damage may adversely affect regeneration success, tree growth, and the suitability of both terrestrial and aquatic habitats (see following sections). Thus, direction to conserve both soils and water recourses needs to be considered through all areas where harvesting occurs – both within regular harvest areas and areas of concern. |
| *Standard* – The standards and guidelines in Sections 5.2.1-5 apply equally to all harvest, renewal, and tending operations. | Any forest operation that involves heavy equipment has the potential to create site disturbance that might affect silvicultural objectives and habitat suitability. Thus, potential impacts from operations need to be considered through all stages of harvest, renewal, and tending. |
| *Guideline* – Unless specifically referenced in the individual piece of direction, the direction in Section 5.2.1-5 does not apply to roads, aggregate pits, landings, or roadside work areas. | These areas are excluded because they are either addressed in other sections of this guide (e.g., Section 5.1) or because it is necessary to permit concentrated disturbance within these areas to allow for efficient access and extraction of forest products. |
| *Guideline* – When assessing site disturbance of a current operation, any site disturbance associated with previous entries will | Effects of site disturbance on silvicultural objectives or habitat suitability are cumulative. Thus, effects of operations that occur sequentially should be assessed together.<br>For example if a clearcut harvest created 8% rutting during harvest and 7% rutting in subsequent renewal the cumulative effect would be |

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| be taken into consideration. | 15% rutting for operation.<br><br>However, site disturbance associated with individual operations may be assessed independently when operations are separated by a long period of time (20 years).<br><br>For example if a selection harvest 20 years ago having significant rutting and subsequent erosion since the time of harvest, those impacts would normally be excluded from the assessment of the current entry. |

### 5.2.1 Rutting and compaction

**Background**

Soil rutting occurs when the downward pressure exerted on the soil exceeds its shear strength and causes failure. Similarly, compaction occurs when the downward pressure exceeds the strength of the soil to resist it and the soil is compressed (Sutherland 2005). Unlike rutting, compaction is often not visible. In the general case, rutting is accompanied by compaction (e.g., along the sides and at the bottom of the rut), but in very wet to saturated soils, rutting can occur without compaction (Greacen and Sands 1980, Williamson and Neilson 2000). Rutting of soils generally occurs during the frost free season, on sites with nearly saturated to saturated soils, and on sites lacking a strong root mat.

Susceptibility of forest soils to rutting and compaction is influenced by the following factors (Arnup 1999):

- applied force,
- native strength of the soil, which is influenced by soil structure, texture, coarse fragment content, and organic matter content,
- soil moisture level at the time of the operation,
- season of operation,
- thickness and density of the root mat layer, and
- thickness and type (fibric vs. humic) of the surface organic layer.

As the water content of a soil approaches saturation, air spaces become filled with water, and the potential for rutting and compaction increases. When the soil is saturated, or nearly saturated, it can reach a near liquid state when a force is applied (Hatchell et al. 1970). Generally, fine-textured soils, especially those with a silt or clay component, are more susceptible to rutting and compaction than are coarse textured soils (Arnup 1999). Organic soils which are composed of more than 40 cm of wet organic material, are also susceptible to rutting because of their very low load-bearing strength. Fibric organic soils, especially those with a well-developed root mat layer, are less susceptible to rutting than well-humified organic soils (OMNR 1997b). The maximum seasonal rutting hazard is normally associated with the spring snowmelt and ground thawing. When the ground is frozen, mineral and organic soils are not normally susceptible to rutting.

When considering all these factors in combination, a hazard rating table can be developed for various soil types. Appendix 5.2b provides a rutting and compaction hazard rating for forest soils in Ontario.

Rutting and compaction are associated with the deformation of the soil surface and internal structure. Rutting and compaction can affect the following soil characteristics (Arnup 1999):

- loss of stratification (soil mixing),
- increased bulk density,
- decrease in porosity (especially air-filled macropores),

- decrease in thickness of the root mat layer,
- decrease in water infiltration rate,
- decrease in hydraulic conductivity and diffusion,
- increased depth of freezing,
- change in nutrient ion diffusion rate (either increase or decrease), and
- inhibited rooting and root gas exchange.

Additionally, compaction and rutting may impact a site by:

- reducing the productive area of a site, by causing deformation of the forest floor and/or by creating an opportunity for water ponding (i.e., less area available for immediate renewal),
- either increasing or decreasing run-off depending on the orientation and pattern of the ruts,
- changing plant communities due to altered moisture regime, mixing of soil, and exposure of buried seeds,
- disruption of nutrient flow on telluric sites, and
- increased potential for erosion due to displacement of organic layers, especially when mineral soil is exposed.

As noted, soil disturbance has the potential to affect the composition, structure, and function of ecosystems. One measure of this affect that has been the focus of some study is forest growth and yield. Arnup (1999) reports on several studies and reviews that examined the potential effect of compaction on forest growth and yield and found the majority reported some negative effect (ranging from 5-50% growth reduction). More specifically, trees with 10 to 40% of their rooting zone compacted by a factor of 10% or more above undisturbed density produced 14% less basal area growth over 12 years. Trees with more than 40% of their rooting zone compacted by a factor of 10% or more averaged 30% less basal area growth. In a study of compaction by forestry equipment on four soils in the Alberta foothills, Corns (1988) found significant reductions in seedling growth and survival associated with increasing bulk densities, at levels approximating those observed immediately after, and 5 to 10 years after logging and site preparation.

The majority of effects related to rutting and compaction are generally negative. However, on some sites (e.g., some coarse soils, some peaty soils) light to moderate compaction can actually improve germination success, water and nutrient availability, and tree growth (Greacen and Sands 1980, Arnup 1999, Kozlowski 1999, Fleming et al. 2006). As well, soil disturbance at some locations can also indirectly enhance seedling growth by controlling competing vegetation (Miller et al. 2004; Duckert, Pers. comm. 2009[1]). Arnup (1999) observed that an increase in soil strength following compaction may result in trees with more compact root systems that occupy less volume of soil. However, if air, water, and nutrients are in plentiful supply, and root length is sufficient to meet the requirements of the shoot, then top growth need not be impaired as a result of the restricted root system. Under these circumstances compaction may even be beneficial. Plant water supply could be improved because of greater water retention and hydraulic conductivity. The uptake of mobile ions, which mainly move in the soil by mass flow, could be improved. The uptake of less mobile ions (e.g., phosphorus, copper, and potassium), which move in the soil mainly by diffusion, could also be improved because light to moderate compaction increases the apparent diffusion coefficient of ions as well as packing more ions into a given volume of soil (Greacen and Sands 1980).

It is important that any measurable effect of soil disturbance, particularly in the short term, not be considered in isolation. Short term effects may or may not indicate long term trends (Hatchell et al. 1970, Pennock and van Kessel 1997, Stone and Elioff 2000). Corns (1988) cautions that despite the results of some field experiments, more research is needed to understand the myriad of factors responsible for tree growth to credit observed growth reductions to any one factor such as compaction or rutting. This applies equally to positive and negative tree growth responses.

[1] Dan Duckert, OMNR, CNFER, Thunder Bay, ON.

For example, several studies found that changes in the level of competition on compacted or rutted sites explained much of the variation in tree growth response (e.g., Brais 2001, Farrish et al. 1995).

Sites that have been rutted or compacted due to forestry operations may naturally recover in part or completely, given enough time. The rate of recovery to pre-harvest conditions for soils compacted by harvesting operations is not well understood. Natural processes such as freeze-thaw cycles, root activity, and soil fauna have been estimated to facilitate recovery in 5-20 years (Wasterlund 1992, Arnup 1999). Other estimates (Hatchell and Ralston 1971, Wert and Thomas 1981, Froehlich and McNabb 1984) suggest that recovery time may be as long as a rotation. The rate of recovery is influenced by the initial degree of compaction, site characteristics (e.g., texture), seasonal variation in temperature, and the subsequent use of the site (e.g., type of regeneration). Recovery rate will influence the potential affect on subsequent forest growth and ecosystem productivity. As the length of time when adverse soil conditions are present starts to approach the rotation age or the re-entry cycle, the potential for decreased productivity greatly increases. Indeed, many partial harvest treatments in Ontario operate on a 20-30 year cycle. Some of our fast growing native trees (e.g., jack pine, poplar) can be operated on a rotation as short as 40-50 years. Other hybrids and exotics can be harvested on even shorter rotations.

Active rehabilitation is an option for compacted or rutted sites and generally involves mechanical tilling to loosen and/or grade the soil. Rehabilitation through tilling may be effective in restoring forest crop productivity (Lacey and Ryan 2000, Miller et al. 2004). However, if done under non-optimal conditions, it can actually make things worse (van den Akker 2002). Other rehabilitation techniques are, or may become, available (e.g., biorehabilitation - Lister et al. 2004) but by far the most economical approach is a focus on prevention.

In summary, Arnup (1999) reviewed a number of studies of the effects of machine traffic on forest soils and provided the following conclusions:

- Soil compaction effects are most evident in the uppermost 20 cm of mineral soils under forces applied by typical harvesting practices.
- Soil texture interacts with the moisture condition of the soil at the time of operation, affecting the degree of compaction.
- Moist, fine soils are more susceptible to compaction than are dry, coarse soils.
- On moist, medium to fine textured mineral soils, compaction effects increase with the number of vehicle trips.
- On dry mineral soils, little compaction will result from one or two vehicle passes.
- Surface root mats, woody debris, and surface vegetation are critical in enhancing the ground strength of mineral and organic soils.

Repeated traffic on the same trail will increase the severity of rutting and compaction while reducing the percentage of a site that is damaged. Conversely, dispersion of traffic may reduce the intensity of damage, but may result in a higher percentage of the site being damaged to some degree. There is greater opportunity to disperse skid trails in conventional clearcut systems than in partial cut systems where repeated use of a few main trails is normally required to protect residual trees. Maximum rutting often occurs where machinery is turned as on a corner of a main skid trail. Landings and trail convergence points are subjected to the most traffic and therefore are much more likely to be damaged by rutting (and compaction).

Skidding and forwarding equipment that do not have the ability to reach or winch pose a greater rutting and compaction hazard. Grapple skidders for example, which must drive up to every pile (bunch) of wood, potentially affect more area than do cable skidders. They are also less able to avoid wet areas than a cable skidder which may use its winch to pull wood across wet areas. Equipment with greater load capacities, such as forwarders or clambunk skidders, may cause less overall ground disturbance as fewer passes are required to move the same volume of wood. However, the increased weight of the load needs to be considered against the actual foot print and the susceptibility of the site. The use of low ground pressure equipment variations, such as high-flotation tires, can significantly reduce the occurrence or severity of rutting and erosion (Schurman and Mackintosh 1985). Equipment combinations that can process in the block and produce a slash mat to drive on can help distribute the machine weight and reduce the risk of compaction. Nadezhdina et al. (2005) found that a slash mat reduced soil pressure measured at 10 cm by approximately half. However, use of slash mats can cause delayed regeneration due to smothering and should be used carefully.

Forest operations that break or displace the litter and organic layer of the soil may in turn contribute to rutting by reducing the overall load bearing capacity of the ground. Damage may occur directly as a result of the ground pressure of the equipment used and also indirectly as a result of exposing the mineral soil to the impact of rainfall which can result in the loss of surface soil structure (i.e., puddling). The creation of furrows by site preparation equipment such as scarification drags, Young's teeth, or disk trenchers is normally beneficial from a silvicultural perspective. Inappropriate or excessive use of these types of equipment can result in a form of damage and may also lead to subsequent problems with erosion.

**Rationale for direction**

When considering the significance of any change in soil or water properties associated with forest management operations, it is necessary to consider what may be expected naturally. Of particular interest is how soil properties change when naturally disturbed. Our overall approach to forest management has emulation of natural disturbances at its core (CFSA). How a soil reacts to natural disturbance is very much dependent on the nature of the disturbance and the nature of the soil (Arocena and Opio 2003, Chanasyk et al. 2003). While there are many similarities between forest harvesting and natural disturbances (e.g., watering up, reduced organic surface layers) there are no natural analogs for rutting and compaction.

Rutting and compaction can reduce productivity of the forest ecosystem, alter hydrology, and compromise the integrity of extraction trails. Independent Forest Audits have identified a lack of specific provincial direction for rutting and compaction as a problem. Issue resolution in at least one FMP arose, in part, due to the lack of specific provincial direction. Field compliance staff have struggled to develop a common understanding of what constitutes rutting or compaction and when rutting or compaction is significant. Local Citizens Committees and members of the public have expressed concern over rutting in terms of both site disturbance and aesthetic impacts. For these reasons, specific direction related to rutting and compaction, rather than just a BMP approach as in the past (see OMNR 1997b), has been included in this guide.

In the development of standards and guidelines for rutting and compaction, a distinction was made between clearcut and partial harvest systems. When considering the affect of rutting and compaction on productivity, the potential for impact is higher in partial cut systems where the growth of residual trees is the main contributor to future growth. For this reason a lower threshold has been set for partial harvest systems.

A further distinction between clearcut and partial cut systems is the future use of extraction trails. Partial cut systems generally involve the establishment of a network of extraction trails to be used in subsequent entries. Clearcutting involves a longer time between subsequent entries, the extraction trails are not as well developed, and are normally regenerated. For this reason, a standard related to maintaining the integrity of extraction trails was included for partial harvest systems but not for clear cutting.

In the direction, a minimum depth of 30 cm is used to define a rut. This depth was selected to correspond to:

- The rooting depth of feeder roots for most tree species (Burns and Honkola 1990, Finér et al. 1997). For example Henderson et al. (1990) references a paper by Gale and

Gregal (1987) indicating 60% of the roots of early-successional species, 78% of the roots of mid-successional species, and 92% of the roots of tolerant species are located in the upper 30cm of soil.

- A depth in excess of that required for efficient site preparation activities (Sutherland and Foreman 1995).
- A depth that would have a high likelihood of intercepting or otherwise affecting surface and shallow sub-surface water flow.

The minimum length of 4 m that defines a rut was selected in part to ensure a minimum consistency with the trend in national and international standards. Maintaining some consistency in definition greatly expands the knowledge base available and potential application of effectiveness monitoring and research from other jurisdictions to Ontario and vice-versa.

Rationale for direction is described below:

| **Direction** | **Rationale** |
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| *Standard* – No more than 50% of any 0.1 ha circle is permitted in ruts. | The % coverage limits in subsequent standards ensure that the amount of rutting on the operating block as a whole is not excessive. This standard of no more than 50% of any 0.1 ha circle in ruts ensures that there is no significant concentration of rutting in one area. Without this *Standard* it would be possible to satisfy the block limit (e.g., 10% in clearcut areas) by creating nearly continuous rutting on a few ha and no rutting on the other 20 ha. The 0.1 ha size approximates a 30 x 30 meter area. This size is easy to visualize and is used in some *Standard Operating Procedures* (SOPs) designed for third party certification.<br><br>Unlike the % coverage standards discussed below, this *Standard* applies to all soil types. More than 50% rutting over a 0.1 ha area has a high likelihood of causing disruption of hydrological function and can lead to the creation of long-term non-productive areas. Areas of concentrated rutting, particularly on organic and fine-textured soils, may require artificial regeneration and/or vegetation management to maintain or regenerate a productive forest. With the exception of landings and roadside work areas, concentrated rutting on coarse soils (i.e., sand) is less likely to occur but has been included for simplicity of application.<br><br>It is important to note that this *Standard* is not intended to discourage the appropriate use of BMPs to reduce the overall area of rutting. For example, there may be circumstances in a clearcut harvest block where an area of susceptible soil must be skidded across to get wood from one part of the block to roadside. Depending on a number of factors, the operator may choose to intentionally concentrate rutting by crossing the susceptible area at a single location multiple times, rather than single crossings in multiple locations, to avoid rutting the rest of the susceptible area. This standard was designed to allow for this kind of intelligent operating. For example a trail that is 15 m wide (approximately 3 to 4 machine passes wide) could be 100% rutted before the amount of rutting in a 0.1 ha circle centered on that trail would exceed 50%. |
| *Standard* – No ruts permitted that channel water into, or within 15 m | This *Standard* is intended to minimize the risk of transporting sediment into water features and the creation of a HADD as defined by the federal *Fisheries Act*. Sediment can alter habitat and |

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| of lakes, ponds, rivers, streams, woodland pools, or those portions of mapped non-forested wetlands dominated by open water or non-woody vegetation (see Section 4.1). | adversely affect water quality and aquatic organisms (see discussion in 4.1). The 15 m value reflects the buffer prescribed for ruts and mineral soil exposure in Section 4.1. |
| *Standard* – **Partial Harvest:** No more than 2% of any 20 ha area (or the operating block if less than 20 ha) is permitted in ruts. | The intent of this measure is to recognize that numerous ruts across the operating block have a high likelihood of negatively affecting both hydrology and productivity by intercepting water, shearing roots, creating areas of compacted soil with limited or no root permeability, etc.<br><br>The value of 2% is on par with national trends and represents an estimate of the threshold beyond which negative impacts are expected and damage becomes more likely. Development workshops with practitioners in Ontario initially suggested that a value of 5% would reflect previous standards used in FMPs and an understanding of what is achievable in efficient operations where machinery, site conditions, and timing of harvest are properly matched. Upon further review of the interaction of the limit on trail coverage (20 and 30% guideline discussed below) and the 5% limit on rutting, it was determined that 5% was excessively high. When you consider that only the wheel track is measured as the rut, and most trails are single width trails where there is an area between the wheels that is not measured as a rut, to exceed 5% rutting on a 20 ha sample area would require more than 30% of the length of a trail to be double rutted (i.e., both wheels cause a rut greater than 30cm deep).<br><br>Twenty hectares was selected as a large enough area to allow for some intelligent testing of soil conditions by machine operators without fear of immediately exceeding the standard but a small enough area that compliance inspectors will be able to make a reasonable approximation of the % of the area in ruts. The value was calibrated through field testing of various assessment methods during the development of this guide. The selection of 20 ha also ensures simplicity of application of the entire guide as this value is also used as the assessment area for wildlife trees. |
| *Standard* – **Clearcut - Shallow soils** (i.e., <30cm): No more than 5 % of any 20 ha area (or the operating block if less than 20 ha) is permitted in ruts. | Shallow soils (<30 cm) have been separated from deeper soils as the ruts by definition are exposing bedrock. The threshold was reduced to 5% to reflect the reduction in growing area and the increased potential for erosion and disruption of hydrological flow. |
| *Standard* – **Clearcut – All other soils:** No more than 10 % of any 20 ha area (or the operating block if less than 20 ha) is permitted in ruts. | This measure is similar to that for partial harvest but has been increased to 10%. The higher threshold is due to the fact that there are fewer residual stems and their future growth is generally less of a concern. While the new regeneration is less affected by rutting effects such as root shear (excepting suckers), productivity impacts due to rutting are still likely from compaction, local hydrological alterations, |

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| | and increased competition. In a survey of other jurisdictions, and ad-hoc investigations in Ontario, less than 10% rutting is achievable in efficient operations when machinery, site conditions, and timing of harvest are properly matched.<br><br>Ruts in sandy soils are generally less of a concern since sands have a very simple internal structure, channeling of water is unlikely due to high infiltration rate, and growth responses due to rutting and compaction are inconclusive, with some sites showing a positive response (e.g., Arnup 1999).<br><br>Organic soils were considered for exclusion from this standard to recognize the ability of other measures (e.g., operating in frozen conditions, using high floatation equipment) to achieve the desired result, and the inconclusive evidence for productivity effects when organic soils are rutted. Organic soils have been included in this standard to account for those occasions where other measures do not adequately reduce the amount of rutting and to recognize that negative productivity and hydrological effects are likely on some sites, and that our ability to recognize those sites in advance is limited. |
| *Guideline* – The area of rutting and compaction will be minimized. | This *Guideline* is a statement of the desired result. While it may seem redundant to include when there are specific limits on the amount of rutting, it has been included to be explicitly clear that the goal is as little rutting and compaction as possible. While the specific standards are 2, 5, and 10%, that does not mean that 1.5, 4.5, or 9.5 percent is a good result. The BMPs, strategies, and techniques included in this section provide some options to achieve this guideline. |
| *Guideline* – In advance of any operations, MNR and industry compliance staff will agree to an approach to measuring the percent coverage, depth, and length of a rut, definition of roadside work area, and percent coverage of extraction trails. Appendix 5.2a is provided as a suggested starting point. | This *Guideline* is intended to provide clarity for field compliance staff and minimize the potential for conflicting interpretation in the field. Defining a common approach ahead of time should increase the likelihood of two inspectors getting the same result. Appendix 5.2a is provided as a starting point only. The appendix can be thought of as a partial list of categories that should be addressed with examples of how they could be filled in. |
| *Guideline* – Area in extraction trails will be minimized and will not exceed the following values unless a higher value is required to meet objectives and specified in the FMP (silviculture ground rule, *conditions on regular operations*, etc).<br><br>• 20% for selection | These values are believed to represent an upper limit of trail coverage required for efficient forest management operations. Minimizing extraction trail coverage reduces the area of potential compaction and maximizes the protection of advanced regeneration and residual crop trees. Significant compaction can occur in a single machine pass (Williamson and Nielson 2000, McNabb et al. 2001, Sutherland 2003). The 20 and 30% values have been used in various forms in current FMPs and originate in the GLSL silviculture guides (OMNR 1998a, OMNR 1998b). Recent field studies Partington and Lirette (2005) support these values as representative of efficient operations.<br><br>The 30% value for thinning was based on the limits for shelterwood harvest and the expected trail coverage in row thinning operations. |

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| • 30% for shelterwood and thinning | While 30% is expected to minimize the risk of rutting and compaction, there may be silvicultural reasons to have a much lower trail coverage than 30%. For example a knowledge synthesis and problem analysis on commercial thinning by Kayahara et al. (2007) suggests the limit should be 10-15%. Similarly, a lower value may also be desirable in shelterwood final removal cuts to minimize damage to regeneration.<br><br>There may also be cases where it is silviculturally appropriate to exceed the 20/30% values. An example may be the regeneration cut of a shelterwood harvest when yellow birch regeneration is to be promoted and exposed mineral soil associated with trails is desirable. Requiring a value other than 20/30% to be documented in an approved FMP (SGR, CRO, etc) ensures a critical review of the practice will occur prior to implementation; the action will be pre-planned, and will be linked to silvicultural objectives. Specific silvicultural limits on trail coverage are important considerations in developing a prescription but are outside the scope of this guide. |
| *Guideline* – Ruts on long slopes, or on short steep sections, can cause significant erosion that can degrade sites and prevent future use of extraction trails. Local criteria will be developed to identify when stabilization, repair, and/or work stoppage must occur to mitigate effects. | This *Guideline* is intended to recognize the importance of maintaining the integrity of extraction trails for future use, as well as the potential for erosion (see section 5.2.2). There is a wide variety of approaches that could be used to meet the intent of this guideline. No explicit values have been included for the maximum slope or minimum length of rut when mitigation or rehabilitation should occur. It is anticipated that planning teams will build on existing local criteria to meet the intent of this guideline.<br><br>While work stoppage is a possible outcome in some circumstances, it may be acceptable in other circumstances to stabilize a problem area and continue working with plans to mitigate or rehabilitate after the fact. The option to mitigate or rehabilitate is provided to allow operators to make a conscious decision to accept damage and then “fix” the damage. Mitigating or rehabilitating (e.g., water bars) will ensure the extraction trails can be used in the future. Applying mitigation or rehabilitation techniques may be part of satisfying this guideline, however, the area of any ruts that are rehabilitated will still contribute to other standards and guidelines such as the percent of the operating block in ruts. |
| *Guideline* – In clearcut operations, where advanced regeneration is a significant contributor to future forest development (e.g., CLAAG, HARP, white pine advanced regeneration, tolerant hardwood understory, etc.), the area in extraction trails will be minimized. On sites susceptible to rutting, achievement of this guideline will have to be balanced against the increased rutting that | Protection of advanced regeneration is critical when it is being relied on for all, or a significant portion of, the future stand. Extraction trails severely reduce advanced regeneration by direct physical damage and should therefore be minimized. The area in extraction trails can be minimized by using approaches such as consistently maximizing the reach distance of the machinery and utilizing ghost trails. This *Guideline* is intended to apply to both partial harvest and clearcutting (i.e., CLAAG, HARP, advanced white pine understorey). As noted, achievement of this guideline will have to be balanced against other guidelines to minimize soil disturbance. One way to minimize soil disturbance is to utilize dispersed skidding, which is counter to minimizing damage to residuals. The guide does not provide specific direction on how to balance these two objectives as the answer will vary based on local circumstances. |

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| may occur when extraction is concentrated on fewer trails. | |
| *Best management practices* | The BMPs listed in this section, and the suggested strategies found in Appendix 5.2c(i) in the Guide, provide direction and recommendations to achieve the standards and guidelines in this section.<br>BMPs are based on the material presented in the section background (see above) and supported by ongoing research and monitoring of practices in Ontario conditions.<br>This includes training options and suggestions on operational timing (when load bearing capacity is greatest), trail layout, equipment options, site considerations, etc. |

### 5.2.2 Erosion

#### Background

Erosion is the accelerated movement of soil materials by the actions of water, wind, or gravity. While gravitational erosion does occur in Ontario, surface erosion by water and wind are by far more common. The following factors influence the susceptibility of a site to erosion:

- topographic position,
- percentage slope,
- length of slope,
- micro-topography of the slope (e.g., concave vs. convex slope, presence of gullies, channels, or ruts),
- presence of surface organic matter (litter and humus layers),
- well-developed root mat and live vegetation,
- soil texture (especially silt and fine sand content),
- soil structure (well developed structure improves infiltration and reduces runoff),
- soil depth / depth to bedrock, and
- moisture content.

When considering all these factors in combination, a hazard rating table can be developed for various soil types. Appendix 5.2b provides an erosion susceptibility rating for soils in Ontario.

While erosion of soils is a natural phenomenon, certain forest operations have the potential to significantly accelerate these processes. The adverse effects of accelerating these processes include:

- reduced productivity through the removal of nutrient rich upper soil layers,
- creation of unproductive sites through severe gully formation, exposure of bedrock, and exposure of infertile sub-surface soils,
- direct destruction of vegetation through catastrophic erosion and smothering,
- degrading water quality and fish habitat by depositing soil particles and nutrients into water features,
- damaging or destroying soil structure in fine textured soils and depositing structureless eroded soil materials, and
- rendering access roads and extraction trails impassable.

Forest operations such as road construction and site preparation, which expose mineral soil, increase the potential for erosion. Road construction and water crossing activities are the most high-risk forest operations. Refer to section 5.1 and related rationale for a discussion of the impacts of improper road and water crossing installation and maintenance.

Forest harvesting (and many natural disturbance events) inherently increases the risk of erosion by removing forest cover. The choice of harvesting and logging system will affect the degree of risk of erosion. Generally speaking, clearcutting and full tree harvesting present a greater risk than does partial harvest and cut-to-length logging. Delayed reforestation will increase the time period to which the site is susceptible to erosion. The removal of competing vegetation can also prolong the time period during which the site is at an elevated risk.

Materials mobilized through erosion may become deposited on existing root systems. Changes in soil depth around trees can cause injury to root systems (Sillick and Jacobi 2006). Since many of the fine feeder roots are located close to the soil surface, adding soil over the existing soil surface places the major root mat that much deeper (McDaniel no date). Additional soil around a tree base acts as a blanket and prevents normal air and moisture circulation to the roots (Bernard et al. 2006). Changing the soil grade by as little as 15 cm can cause extensive damage to the root system of some species of trees (Dempster 1989, Gilman 2003).

Direction for roads and water crossings (Section 5.1), rutting and compaction (Section 5.2.1), and aquatic and wetland ecosystems (Section 4.1) will normally minimize risk of erosion.

Inadequate soil aeration occurs commonly as a result of soil compaction, filling-in with soil over roots, and flooding of soils (Kozlowski 1985). Inadequate soil aeration affects tree roots through the development of oxygen deficiency and the accumulation of an excess of carbon dioxide. Both an excess of carbon dioxide and a deficiency of water reduce the permeability of roots to water, causing a reduction in water absorption (Kramer 1950).

Smothering or compaction damage is difficult to diagnose because it may take 5 to 7 years after injury for symptoms to appear (Dempster 1989). Trees may live 2 or 3 years, or even longer after filling/flooding, then die suddenly. A drought after a period of flooding is particularly likely to cause injury because the root system cannot absorb sufficient water from dry soil. Aeration is rarely a problem in sandy- or coarse-textured soils (Kramer 1950).

Bottomland species such as red and silver maple have at least some degree of tolerance to poor soil aeration (Kozlowski 1985). Yelenosky (1964) rated *Acer* spp. and *Quercus* spp. as intermediate in fill tolerance. *Betula* spp. and *Cornus* spp. were considered fill intolerant.

**Rationale for direction**

Rationale for direction is described below (note: there are no *Standards* in this section):

| **Direction** | **Rationale** |
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| *Guideline* – Decommission main skid trails constructed on steep slopes by installing water bars, diversion ditches, straw bales, etc. at appropriate intervals or critical landform junctures to filter runoff water through surrounding vegetation. | This *Guideline* is intended to both maintain the integrity of skid trails for future use and to minimize the risk of sediment deposition within water features. By installing diversion structures at appropriate intervals the runoff water does not have the chance to build up “a head of steam”. As the volume or speed of water increases it can pickup and carry more sediment. Allowing for strategically placed exit points helps to manage the speed and volume of water, particularly at down slope locations. |

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|---|---|
| *Guideline* – Minimize mineral soil exposure to that required for efficient operations and effective silviculture (consistent with SGR for the site). | Limiting the exposure of mineral soil will limit the area potentially susceptible to erosion. A numeric limit has not been included as erosion is not common in Ontario and normal operations do not create erosion hazards outside of very localized areas. Machine limitations, common sense, and specific prescriptions will ensure these localized areas are treated appropriately. |
| *Guideline* – Mitigate or rehabilitate areas of significant erosion that are transporting, or are likely to transport, sediment into a water feature. | This *Guideline* is intended to reduce or eliminate sediment, or the potential for sediment from entering water systems. |
| *Best management practices* | The BMPs recognize that any forest operation will have an impact on the site and provide strategies and directions to help to limit those impacts, stabilize affected sites, and minimize erosion and sedimentation.<br><br>BMPs are based on the material presented in the section background (see above) and supported by ongoing research and monitoring of practices in Ontario conditions.<br><br>Appendix 5.2c(ii) in the Guide supports the BMPs by providing practical approaches to reduce erosion through planning, working on slopes, equipment choices, time of operations, and tools to reduce erosion potential. |

### 5.2.3 Nutrient loss

#### Background

Part of the nutrient capital on a forest site is held in tree biomass, particularly in the branches and foliage. On nutrient poor sites, the percentage of total site nutrients found in the above ground parts of trees is much greater than on nutrient rich sites (Morris 2003). Forest operations remove some nutrients from the site in the form solid wood and bark, but can also concentrate nutrients in the form of slash and debris piles. Similarly, forest disturbances, particularly fire, can remove nutrients through volatization, fly ash, and increased leaching. Natural processes tend to replace these nutrients over time and there is a continuous cycle of input, retention, and release (Worrell and Hampson 1997). Forest operations on nutrient poor sites have the potential to reduce nutrient levels such that the replacement time is increased and may have a noticeable affect on short and long-term ecosystem productivity.

The impact of harvesting, particularly full tree-harvesting, on long-term site productivity is probably one of the most notable and intensively studied research areas in North American forests. As a general rule, this research suggests that sites with deep, medium to fine textured soils, intermediate moisture levels, and level to moderate slopes are at low risk of reduced productivity related to nutrient removal (Wiensczyk 1992). On the other hand, results suggest that consequences of nutrient loss tend to increase for those sites that have extremes of one or more of these factors. Within the context of soil fertility and stand nutrition, both shallow-soil sites and dry, coarse-textured sites have been prone to nutrient loss and subsequent lessening of productivity after forest operations involving full-tree logging. This sensitivity has been recognized in our current silvicultural guides with either a Not Recommended (NR) designation for very shallow sites or Conditionally Recommended (CR) for sandy sites for full-tree harvesting (NR treatments require an exceptions monitoring protocol and CR treatments must satisfy conditions such as use of best management practices to minimize disturbance of surface organic layers) (OMNR 1997a, OMNR 1998a, OMNR 1998b, OMNR 2003).

It is important to note that nutrient management should be considered not just from a tree productivity point of view but the productivity and function of the entire ecosystem. Further, the function of some ecosystems may be dependent on relatively nutrient poor conditions. Development of standard operating procedures for nutrient management needs to consider the full suite of ecosystem values and management objectives.

**Rationale for direction**

There are no *Standards* or *Guidelines* since nutrient loss is already adequately addressed in the silvicultural guides. Following the direction in the silviculture guides, as updated from time to time, will ensure that operational decisions, such as matching the appropriate logging method to a specific site, will occur with a consideration for the impact on site nutrients. Although the silviculture guides are, by design, tree-centric, the direction will ensure productivity of the whole ecosystem is maintained.

The BMPs direct users to the appendices in the Guide. Specifically to Appendix 5.2b which helps to identify sites that may be susceptible to nutrient loss, and to Appendix 5.2c(iii) which provided suggested strategies and techniques to minimize nutrient loss.

### 5.2.4 Loss of productive land

**Background**

In the process of conducting forest operations, some productive land is removed from production on a long-term or permanent basis as a result of the construction of roads, landings, and aggregate pits and due to coverage by piles of slash or chipper debris. This reduction in productive area, if significant, can affect the overall productivity of the landbase. In addition to affecting productivity, the conversion of forest to non-forest can provide a substrate for the establishment of alien/exotic species but can also provide unique habitats for native wildlife. Access planning and selection of logging method greatly influences the amount of area that will be converted to non-forest. Access development with excessively wide rights-of-way, excessive use of landings, and failure to maximize skidding/forwarding distances will result in more area converted to non-productive land than necessary. Logging methods that require processing at roadside (e.g., full-tree delimbing or chipping) often result in piles of debris and unutilized fibre. If these piles are not re-distributed, burned, or removed (i.e., utilized), the area cannot revert to a productive forest for extended periods of time. It is not uncommon for roadside slash from previous full-tree logging operations to be visible on 1:20,000 aerial photographs 20 years or more after harvest.

Logging methods that require processing in the forest (e.g., cut-to-length systems) may also adversely affect the supply of available forest land. For example, slash management may damage advance regeneration or limit seedbed availability (Meek and Plamondon 1996).

The amount of unutilized fibre and debris is often related to the available or economical uses of the fibre. As the forest industry continues to evolve, new or expanded uses of currently under-utilized fibre (e.g., energy production) provide an additional tool to minimize the area in debris and unutilized fibre piles (see Section 6.2).

Even with advanced planning and efficient operations, some area will be converted temporarily to non-forest. Forest operations often include a level of mitigation as a standard practice (e.g., regenerating operational roads and landings, piling and/or burning slash) to minimize the area being converted non-forest, or the length of time it takes for the converted areas to return to productive forest.

**Rationale for direction**

Rationale for direction is described below (note: there are no *Standards* as the current *Forest Management Planning Manual* already addresses the overall impact of loss of productive land as well as the overall road density for the unit through specific measurable indicators):

| Direction | Rationale |
|---|---|
| *Guideline* – Minimize the amount of area being converted to non-forest (e.g., roads and landings) to that required for efficient operations. | Operational planning requires balancing a number of factors related to ground conditions, economic efficiency, and impacts on other values. This *Guideline* is intended to ensure the area affected by roads, landings, piles, etc, is minimized. The loss of productive land, particularly to slash and debris piles, is a recurring concern in many independent forest audits. |
| *Guideline* – Unutilized woody material, which accumulates at roadside, is smothering productive land, and is expected to remain unutilized, will be piled, redistributed, or otherwise treated to increase the area available for regeneration. | If the accumulation of woody material is not adequately managed it can lead to significant areas that are not available for regeneration and will become generally non-productive for extended periods of time. A significant number of independent forest audits have identified the loss of growing space associated with slash piles as an issue and several audits have included specific recommendations to pile, burn, utilize, or otherwise manage slash piles.<br><br>This *Guideline* is included to address this issue. The specific wording allows for a variety of approaches to be utilized based on local circumstances. For example it may be adequate to have a machine (e.g., backhoe) create some holes in the slash/debris to allow access to a suitable microsite for regeneration. |
| *Best management practices* | Loss of productive landbase can have long term impacts of forest productivity and habitat availability.<br><br>Where possible area dedicated to roads, extraction trails, landings, and piles of unutilized wood material should be minimized through effective planning and location of these features, and then rehabilitated quickly after their use.<br><br>The BMPs are supported by Appendix 5c(iv) which outlines many strategies and techniques to meet this goal. |

**5.2.5 Hydrological impacts**

**Background**

Water moves through the soil, plants, and atmosphere of a forested ecosystem along pathways termed the hydrological cycle. This cycle fluctuates naturally in response to normal ecosystem development and can change significantly after a disturbance or more gradually as the forest ages and matures (Smerdon et al 2009). Similar to natural disturbances, forest management activities may affect the hydrological cycle (see discussion below) (Buttle et al 2009). Effects are assumed to be acceptable, even desirable, when consistent with what is expected naturally. However, poorly conducted forest management operations have the potential to cause changes in the hydrological cycle that are not consistent with what is expected naturally.

Sites with a high susceptibility to adverse hydrological change can be summed up as sites with excessively dry moisture regimes and very rapid drainage and sites with extremely wet moisture regimes and poor drainage. In general, sites that are susceptible to compaction and rutting are also susceptible to hydrological change.

Typical hydrological impacts resulting from natural disturbances and forest operations include:

*Watering up:* Removal of tree cover by harvesting can raise the water table as transpiration is reduced (by removing the trees). This affect is greatest immediately after harvest, increases with the amount of tree removal, and is most pronounced in stand replacing disturbances and clearcuts. Raising the water table effectively reduces the rooting zone available to plants and on wet sites, can hinder regeneration of some species and change vegetative characteristics.

*Surface drying:* Well-drained soils may be subject to excess drying when the removal of forest cover (through harvest or disturbance) accelerates evaporation rates.

*Increased water yield:* Extensive harvesting and/or natural disturbance in an individual watershed can greatly increase the flow of water through the watershed (e.g., resulting in greater stream flow). Increased water flows can introduce elevated nutrient levels in water features which can be detrimental to some fish species. Spring snow melt can occur earlier and more rapidly in recently disturbed areas (harvest or natural) which can result in increased potential for erosion, nutrient leaching, and downstream flooding (Buttle et al 2009).

Other hydrological impacts that are associated with forest operations, but not normally with natural disturbances include:

*Disruption of lateral flow through the soil:* Road construction, rutting, and occasionally furrowing resulting from site preparation can cause the surface and shallow groundwater movement of water in soil to be altered. Alteration can include interruption resulting in ponding or acceleration resulting in drainage. The lateral flow of water is a major source of nutrient flow on some sites (i.e. telluric flow) and disruption of this flow may result in nutrient deficiencies (Smerdon et al 2009).

*Disruption of infiltration rates in soil:* Soil compaction, rutting, and smothering by road and landing construction can effectively reduce or eliminate water infiltration into the soil and thereby affecting local site productivity.

**Rationale for direction**

Rationale for direction is described below (note: there are no *Standards* in this section because direction in Section 5.1 is generally considered to address the main concerns):

| **Direction** | **Rationale** |
|---|---|
| *Guideline* – Based on local conditions, explore reasonable alternatives to crossing organic and saturated mineral soils during the frost-free period. *Conditions on regular operations* will be developed to minimize the potential for hydrological disruption when crossing during the frost-free period cannot | Unfrozen organic and saturated mineral soils are highly susceptible to rutting, compaction, and related hydrological disruption. Where reasonable alternatives exist these areas should be avoided. However, it is recognized that there will be circumstances where skidding across these areas is unavoidable. In these cases the best location should be selected and precautions should be taken to minimize the potential for damage . |

| | |
|---|---|
| be avoided. | |
| *Guideline – Based on local conditions, take reasonable precautions …* | This *Guideline* is an extension of and related to the direction in section 4 on water features. The *Guideline* recognizes the importance of hydrological connectivity between terrestrial and aquatic areas.<br>At the same time it acknowledges:<br>• difficulty associated with interpreting the definition of “disruption of hydrological function”,<br>• that some disturbance of the forest floor will occur no matter how careful the operation, and<br>• not all springs, seeps, etc. will be recognizable in all operating conditions (e.g. deep snow) |
| *Best management practices* | The BMPs outlined in this section recognize the importance of the hydrological cycle in the health and productivity of forested landscapes. They also recognize that forest operations will impact local hydrological conditions and provide direction to reduce those impacts.<br>Focus is similar to those outlined in section 5.1 (rutting and compaction) – where follow that guidance will also help to limit hydrological impacts.<br>It’s also encouraged to use hydrological modeling tools to help identify potential unmapped springs, seeps, etc. These tools should compliment but not replace on-the-ground reconnaissance.<br>It’s also encouraged to regenerate sites quickly after disturbance to help stabilize and moderate any changes that have occurred on the hydrological cycle. |

### 5.3 Spread of Invasive Species

Invasive species are defined as any species that are found outside their normal range that compete with native species for space, water, or nutrients, or otherwise represent a threat to their health and well being.

Invasive species pose a range of impacts on the ecological, economic, and social well being of the province. Ecologically, they can damage or kill many terrestrial and aquatic native plants that don't have natural defence mechanisms against the invasive species. Examples of this include the introduction of butternut canker and garlic mustard that are impacting butternut trees (a presently an endangered species) and West Virginia white butterfly (presently a species of special concern).

Economically, invasive pests can reduce productivity of trees and other plants, and can degrade the quality of products (such as lumber). While it's hard to place a specific number on the value lost, slower growing trees producing poorer quality final products is difficult to ignore.

Socially impacts are tied to many of the economic ones. Reduction of productivity or health of the forests of trees may impact resource related communities through a reduction in forest operations and the lessening of fibre availability to mills.

Once an invasive insect, plant or disease is found in Ontario, efforts need to focus on the location of the species and the development of appropriate mitigative strategies and actions. Part of the challenge to this approach is the dynamic nature of invasive species' population sizes and locations.

The Guide specifically addresses 2 invasive species – butternut canker and garlic mustard. Butternut canker is affecting the health of the native butternut trees. Direction for butternut canker can be found in the Guide in section 4.3.2. Garlic mustard is causing the loss of suitable habitat for the West Virginia White butterfly. Direction for working in these environments can be found in the Guide in section 4.3.3.

Operators need to follow direction for these 2 species, and be aware of other species in their local areas and know how to react.

Many on-line resources are available to help identify these species and provide information on their ecology. Some of these internet sites include: Canadian Forest Service's *Forest Invasive Alien Species of Canada* website (www.exoticpests.gc.ca ), the Ontario Federation of Anglers and Hunters' *Invading Species Awareness Program* website (www.invadingspecies.com ), and the US Forest Service's *Nonnative Invasive Species* website (www.fs.fed.us/r9/wildlife/nnis ).

These websites should be consulted to help identify the species and provide operators with training on actions that can limit their spread.

Other OMNR Guides, like the Ontario Tree Marking Guide (OMNR 2004), and Silviculture Guides provide some direction on identifying and dealing with diseased trees in the forest.

No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

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# 6.0 SALVAGE AND BIOFIBRE HARVEST

## 6.1 Salvage Harvest

### Background

Ontario's *Forest Management Planning Manual* defines salvage harvest as "the harvesting of timber that has been killed or damaged by natural causes, such as fire, wind, flood, insects and disease".

Lindenmayer and Noss (2006) suggested the impacts of salvage harvest could be classified into three broad categories:

- impacts on the physical structure of forest stands and aquatic systems,
- impacts on key ecosystem processes (e.g., nutrient regimes), and
- impacts on particular elements of the biota and species assemblages.

Some key salvage logging impacts on the physical structure of forest stands and aquatic ecosystems include simplification of the structure of forest stands (e.g., Hutto 1995) and a reduction in future recruitment of coarse woody debris (Minshall 2003). Removal of coarse wood by salvage logging alters patterns of structural heterogeneity, significantly influencing litter decomposition and other ecosystem properties (Remsburg and Turner 2006).

Greene et al. (2006) reported that salvage logging of burned conifer dominated stands in the boreal forest results in a greater percentage of stands dominated by sprouting species (e.g., aspen) as compared to unsalvaged, burned forests. This occurs because salvage logging removes too many seed-bearing branches from the site.

In Quebec, Brais et al. (2000) reported that salvage logging on sites where high-intensity fires occurred depleted a number of soil nutrients, and nutrient levels were not expected to return to pre-fire levels within the planned rotation time of 110 years.

With respect to impacts on biota and species assemblages, Schmiegelow et al. (2006) summarized recent findings that identified clear differences in plant, invertebrate, bird and, to a lesser degree, mammal communities between post-fire and post-harvest boreal forests; in addition, a number of species found in post-fire forests were either absent or occurred at very low numbers in harvested forest.

Three-toed and black-backed woodpeckers are species that appear to be particularly dependent upon post-fire boreal habitats and possibly susceptible to increased fire suppression and intensified salvage logging (Hoyt and Hannon 2002, Nappi et al. 2003, Hannon and Drapeau 2005). Burned forest may also be important breeding habitat for northern hawk owls in the boreal forest (Hannah and Hoyt 2004).

Hutto (2006) asserted the ecological cost of a typical post-fire salvage logging operation on snags was almost completely negative, although he also re-iterated earlier comments (Hutto 1995) that said some savage harvest could still be justified if some areas were harvested and some were left. In essence, that is the position taken by Ontario with direction previously provided by the *Forest Management Guide for Natural Disturbance Pattern Emulation* for fire salvage operations.

While there are many reasons to harvest forests following natural disturbances, there are viable and different arguments supporting leaving the site with its dead and dying trees intact (Foster and Orwig 2006). Some salvage harvest can be deemed to be permissible provided ecosystem disruption is minimized. Most of the studies which identified issues with salvage logging have also stated that a complete prohibition of salvage logging is not required to address concerns regarding ecological process and maintenance of biodiversity. The question which remains is how is this to be accomplished?

OMNR (2003) provides some direction on the maintenance of biodiversity and ecological processes when a fire salvage operation is being considered. While Schieck and Song (2002) recommended salvage logging only when at least 3% of a management unit is burned and left unsalvaged in western Canada.

Another possible solution is to have representative ecosystems in an unmanaged state, referred to as ecological representation (Huggard 2000). Because constrained areas can include parks and protected areas (WAMWG 2003), landscapes which are largely excluded from the managed forest in Ontario, some protection from the potential negative impacts of salvage logging is assured. Still, reliance on specific areas has pitfalls, similar to those identified by Nappi et al. (2004), when they cautioned that it was dangerous to assume that in the boreal forest, intense harvesting of southern burned forests could be compensated for by leaving northern burned forests alone if the objective was maintenance of biodiversity.

In Ontario, salvage logging can also occur following other natural disturbances such as after a blowdown event, or as part of an insect pest management program, or after other events (e.g., disease, ice storms, etc.).

Blowdown events are generally believed to occur infrequently in Ontario, but they are not uncommon. The information available suggests most blowdowns are long and narrow, and generally >1000 ha in size (Canham and Loucks 1984).

While fire is the major disturbance agent in the boreal forest, wind is considered to be a common disturbance agent as well (Perera et al. 2000). In the boreal forest, wind tends to produce small to large gaps in the canopy, depending on the violence of storm events (Thompson 2000). Black spruce is more susceptible to blowdown than jack pine, trembling aspen or white birch (Fleming and Crossfield 1983). In addition, balsam fir forests, which tend to occur as a result of fire suppression, are quite susceptible to blowdown after being killed by spruce budworm outbreaks (Li 2000). Kneeshaw and Bergeron (1998) found the amount of boreal forest consisting of canopy gaps was directly related to the abundance of old balsam fir. Because balsam fir is so susceptible to spruce budworm, and then blowdown, landscapes where balsam fir is dominant are highly patchy (Thompson 2000).

In Ontario, an average of 40,924 ha was recorded as blowdown each year during the 10 year period 1990-99, with 220,000 ha occurring in 1992. Such a pattern could be normal; from 2000 to 2004, the annual amount of blowdown provincially ranged from only 107 ha to 9,563 ha; in 2005 there were two large blowdowns in northwestern Ontario, each one encompassing tens of 000's of ha.

The amount of salvage in blowdown areas varies, but tends to be only a small percentage of the area affected. In part, this is due to the nature of a blowdown, which can have considerable variability with respect to the amount of tree damage in a stand. Even high winds seldom topple young trees. Also, salvage harvest in blowdown areas can be limited because of the dangerous nature of the work, with trees often twisted and under pressure from other leaning and fallen stems.

In tolerant hardwood forests within the GLSL forest, catastrophic wind disturbance is a dominant feature, but the frequency of such events is fairly low (Lorimer 2001).

Insect infestations in Ontario forests can be substantial and these infestations can directly or indirectly result in changes to forest landscape patterns. Insects that have been particularly problematic in Ontario's forests and that have had landscape level effects are the spruce budworm, and jack pine budworm, possibly the gypsy moth (Thompson 2000) and, on at least one occasion, the forest tent caterpillar (Candau et al. 2002).

Severe insect infestations in Ontario can invoke special insect pest management programs, as per direction in the *Forest Management Planning Manual*.

In Ontario, balsam fir is not a commercially important species, in part because balsam fir tends to be attacked by spruce budworm before the trees reach merchantable size. Whether balsam fir suffers from spruce budworm infestations, are blown down, or both, such forests are seldom salvage harvested.

Other forest types that are susceptible to insect damage and are commercially valuable (e.g., jack pine and tolerant hardwoods), are more likely to be considered for salvage harvest during the development of an insect pest management program.

Disease or weather (e.g., ice storm, drought) can also result in tree mortality and stand decline, and can initiate a salvage harvest operation. However, in Ontario, salvage harvest due to these factors has only rarely been initiated.

**Rationale for direction**

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – Consistent with direction in Section 3.2.3.1, salvage harvest will normally retain a minimum average of ≥25 stems/ha ≥3 m in height and ≥10 cm dbh. This is the minimum average for the harvest block (or minimum average per 20 ha if the harvest block ≥20 ha) contingent upon sufficient numbers and types of standing stems being available and in a condition suitable for retention. | In general harvest areas, direction is provided to retain wildlife trees, as well as downed woody material, largely to emulate a natural disturbance and ensure areas where normal forest operations occur maintain their ecological integrity. In most situations, the natural disturbance being emulated is a wildfire, although in the GLSL forest, the emulation of gap dynamics are more closely linked to natural succession and wind events. These gap phase emulations are reflected in the use and choice of appropriate silvicultural systems (i.e., mostly clearcut in the boreal; mostly shelterwood and selection in the GLSL).<br><br>Because salvage logging occurs in the very stands that provide the template for much of the direction in the *Landscape Guide* as well as this forest management guide (i.e., salvage logging occurs in areas where a natural disturbance has occurred), there needs to be a cautious approach when approving operations in such areas. Schmiegelow et al. (2006) believed it was clearly incongruous to simultaneously promote harvest practices that emulate fire while continuing the practice of postfire salvage logging [under the auspices of forest renewal].<br><br>In Ontario, salvage logging for fibre has historically affected a relatively small portion of the area annually depleted by natural disturbances. Data from 18 wildfires during the period 1998-2005 supports the contention the rate of salvage harvest in Ontario has been relatively low in recent years (Table 6.1a). However, there is continued interest in salvage logging and the level of activity may grow in response to initiatives such as biomass harvesting.<br><br>Retaining trees in salvage areas, regardless of the type of natural disturbance being harvested, using similar wildlife tree direction as in areas where normal operations are planned, is intended to |

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| | address ecological function and integrity at the stand level.<br><br>Although boreal wildfires are almost certain to have standing stems far in excess of these minimum requirements (Perera et al. 2008), a blowdown might not. |
| *Guideline* – Salvage operations will consider strategic landscape objectives. | Regardless of the type of disturbance that initiates a salvage operation, planning for the salvage operation will consider strategic objectives. Fires, for example, may have implications with respect to caribou habitat objectives (see the *Landscape Guide*), which could suggest amendments to planned harvest areas. Areas disturbed with a high composition of balsam fir, - likely a reflection of past forest management practices, including logging and fire suppression (Thompson 2000) – could also benefit from management actions taken in concert with salvage operations. |
| *Guideline* – When finalizing boundaries of a salvage operation that results from wildfire, the area of undisturbed forest included in the salvage operation will be minimized. | This requires a judgment call, as the boundaries between burned forest and unburned forest will include trees with considerable variability in terms of fire related damage (e.g., Perera et al. 2007). The actual delineation of the perimeter of the burn is further complicated when salvage operations are initiated soon after a burn. Perera et al. (2008) found that only 13% of the trees that survived a fire were still standing in the third year after fire. ????<br><br>Despite these logistical difficulties, it would still seem prudent to try and retain the natural pattern of the of the fire when salvage operations are initiated, given that fire is a main driver of forest succession, particularly in the boreal forest, and it is the pattern as well as the post-fire composition forest managers are attempting to emulate. |
| *Guideline* – When finalizing boundaries of a salvage operation that results from blowdown, insect infestation, or other factors (e.g., ice storms), the area of the salvage operation can include undisturbed forest. When salvage operations include undisturbed area, Section 3.2.2 will apply. | This is largely in recognition of the need to respond to insect infestations in a proactive manner as provided for in the *Forest Management Planning Manual* (e.g., to mitigate, or control the spread of the infestation). In addition, non-fire natural disturbances can present even greater difficulties with respect to identifying the boundaries of the disturbance, including the extent and severity of damage. To address concerns that salvage operations associated with non-fire origin disturbances do not compromise landscape composition and pattern objectives, the direction in Sections 3.2.1 and 3.2.2 will apply. |
| *Guideline* – The trees retained following salvage operations will have a range of distribution patterns (relatively even-spaced to some clumping), recognizing operational limitations, and subject to the availability of standing trees. | This direction is also consistent with the wildlife tree direction in Section 3.2.3.1. Of particular importance is the retention of large diameter trees, such as cavity, veteran, and supercanopy trees. In part, the direction is intended to address habitat requirements for species such as northern hawk owls that appear to be dependent on recently burned stands in the boreal forest. Northern hawk owls are known to nest in areas with standing, burned, large-diameter trees with natural cavities (Hannah and Hoyt 2004).<br><br>Large diameter trees that remain standing provide high quality sites for cavity nesters (e.g., Naylor et al. 1996); supercanopy trees are favoured as perch sites by large raptors (DeGraaf et al. 1992, Rogers and Lindquist 1992); veteran trees (trees that survive the |

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| | disturbance event) are also, by definition, species that can grow into supercanopy trees. However, if these large trees have fallen, or need to be felled for safety concerns during harvest operations, they are still an important source of downed woody material and when left on site should not be crushed. Large trees on the ground can be particularly valuable as denning sites for species such as the marten (Lofroth and Steventon 1990).<br><br>The species of greatest concern in salvage harvests, particularly in burned forests, are habitat specialists that are heavily reliant on burned forest habitats. These species include the black-backed and three-toed woodpeckers, and olive-sided flycatcher (e.g., Hutto, 1995, Imbeau et al. 1999). These species are most likely to be impacted by fire-salvage, as they prefer the burns that occur in older forests with larger trees, the kind of forests that are more likely to be salvage harvested (Morissette et al. 2002). The species of trees killed by fire and preferred for feeding and nesting by these birds tend to be large and thick barked (Hutto 2006). However, the length of time a tree remains sound as it decays is also a factor, as dead but sound trees are used longest by the beetles the birds seek as forage (Nappi et al. 2003).<br><br>Because of the importance of natural disturbances in terms of their potential contribution to the general maintenance of forest biodiversity (Mönkkönen and Welsh 1994), some disturbances, or portion of disturbances, may be excluded from salvage. This decision is made independent of this guide – whether a disturbance or some portion of a natural disturbance should be salvage harvested will consider the appropriate strategic direction (e.g., an approved FMP; the *Landscape Guide*).<br><br>Although a number of authors have recommended disturbed areas be exempt from salvage operations (e.g., Hutto 1995, Morissette et al. 2002), there does not appear to be a necessity to restrict the amount of salvage operations occurring in Ontario at this time. Salvage operations are actually relatively uncommon, and in many areas where they do take place, the end result is only a partial salvage of the disturbance (see Table 6.1a below). A partial harvest which results in the retention of an array of forest types within the disturbed area can still contribute to maintenance of avian biodiversity and healthy bird communities (Mönkkönen and Welsh 1994; Hutto 1995; Hobson and Shieck 1999; Imbeau et al. 1999). |
| *Guideline* – Adjust the timing of entry and/or other operational factors to minimize unnecessary site disturbance that could potentially result in ecological damage (e.g., avoid salvaging a swamp in the frost-free period). | If the only consideration was maximizing product recovery, a poor choice could easily be made in terms of the type of machinery and/or the timing of harvest.<br><br>Site damage may occur as with normal forest operations (see Section 5.2). In some instances salvage may have a higher potential to cause site damage (e.g., reduction in the depth and/or coverage of the organic layers covering the forest floor from the movement of heavy machinery, depending on weather conditions might increase the risk of erosion). |
| *Guideline* – Reasonable efforts will be made to avoid windrowing or | See direction and rationale in section 3.2.3.2 (Downed Woody Material). |

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|---|---|
| crushing of downed woody material. | |
| *Best management practices* | The BMPs in this section follow direction provided for wildlife trees in section 3.2.3.1, and the principles for soil and water conservation outlined in section 5.2.1.<br><br>They encourage operators to follow the same criteria for selection of residual trees as in normal harvesting operations, and to plan trails carefully especially in instances where the salvage operation will take place over a multi-year period. |

**Table 6.1a. Salvage harvest data from Ontario forest fires.**

**Total Visible Numbers on Salvaged Fires 1996-2005 with 2002-2005 Salvage Data**

| | | | | Salvage Data (ha) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fire Num | Fire | Fire Year | Total Fire (ha) | 1998 /99 | 1999/ 00 | 2000/ 01 | 2001/ 02 | 2002/ 03 | 2003/ 04 | 2004/ 05 | 2005/ 06 | Total | Prop. |
| 1 | THU21 | 1998 | 26,978 | | | | | 2,140 | 123 | - | - | 2,263 | 8.4% |
| 2 | NIP10 | 1999 | 48,305 | | | 1,445 | 5,237 | 2,813 | - | - | - | 9,496 | 19.7% |
| 3 | NIP12 | 1999 | 28,961 | | | | | 698 | 19 | - | - | 717 | 2.5% |
| 4 | THU13 | 1999 | 627 | | | | | | 149 | | | 149 | 23.90% |
| 5 | KEM1 | 2000 | 70 | | | | | 1 | - | - | - | 1 | 1.7% |
| 6 | PEM3 | 2001 | 458 | | | | | - | - | - | - | - | 0.0% |
| 7 | DRY10 | 2002 | 1,206 | | | | | - | - | - | - | - | 0.0% |
| 8 | NIP20 | 2002 | 1,161 | | | | | - | - | - | - | - | 0.0% |
| 9 | NIP75 | 2002 | 11,667 | | | | | - | 480 | - | 111 | 591 | 5.1% |
| 10 | DRY57 | 2003 | 801 | | | | | - | - | 304 | - | 586 | 73.1% |
| 11 | KLK9 | 2003 | 102 | | | | | - | 59 | - | - | 59 | 57.7% |
| 12 | NIP58 | 2003 | 759 | | | | | - | 247 | 56 | - | 303 | 39.9% |
| 13 | SLK48 | 2003 | 31,824 | | | | | - | 1,415 | 3,286 | 1,297 | 6,200 | 19.5% |
| 14 | WAW13 | 2003 | 26,299 | | | | | - | 735 | 3,429 | 1,788 | 5,952 | 22.6% |
| 15 | WAW21 | 2003 | 5,810 | | | | | - | 1,430 | - | - | 1,430 | 24.6% |
| 16 | NIP20 | 2005 | 13,572 | | | | | 564 | 100 | 973 | 337 | 1,975 | 14.5% |
| 17 | THU57 | 2005 | 6,026 | | | | | - | - | - | - | - | 0.0% |
| 18 | TIM19 | 2005 | 3,109 | | | | | - | - | - | 271 | 271 | 8.7% |
| TOTALS – | | | 207,735 | | | 1,445 | 5,237 | 6,217 | 4,757 | 8,048 | 3,804 | 29,508 | 14.2% |

## 6.2 Biofibre Harvest

### Background

Recently there has been an increase in the interest in the use of biofibre for use as an energy source and to support an emerging bioeconomy.

With this interest are a number of concerns about the impacts that the use of biofibre might have on maintaining ecological status and function of harvested stands. This includes concerns around nutrient levels, micro-organism populations, and overall diversity in the harvested stands (Benjamin et al. 2010, Hesselink 2010).

Computer models exist that can calculate the estimated amount of nutrients removed during a biofibre harvest. These estimates are based on the stand's species composition, age, and site conditions. However, these models are limited by the current knowledge of an ecosystem's nutrient needs and cycling capabilities (Thiffault et al. 2010).

Following the Guide's principle of taking a precautionary approach in areas of uncertainty or incomplete scientific direction, biofibre harvest and use from crown lands in Ontario is limited to materials that have already been made available for harvest and use under an approved FMP. This includes materials from allocated stands that are not being utilized for conventional forest products (OMNR 2008). Using this approach, biofibre products are identified as a use for wood fibre (similar to sawlogs, pulp, etc), from allocated stands that have already passed the tests for sustainability.

Examples of material available for biofibre includes unmerchantable trees (undersized, cull trees or portions of trees), individual allocated trees and stands that are merchantable but not being utilized, and trees that may be salvaged after a natural disturbance (fire, wind, etc.) (OMNR 2008).

Section 6.2 is also clear about what is not available for harvest on any site. Organic materials that are not part of the harvested tree, plus stumps and below ground materials will stay on site and contribute to the local nutrient pool and ecological functions of the site.

### Rationale for direction

Rationale for direction is described below:

| **Direction** | **Rationale** |
|---|---|
| *Standard* – Unless otherwise specified, the direction in this and other forest management guides will apply equally to all planned harvest areas regardless of the product derived. | MNR's directive for biofibre allocation and use (OMNR 2008) states that all biofibre harvests must come from stands allocated within a FMP, and that biofibre is one use of forest resource that is being harvested – similar to saw logs, veneer, pulp logs, etc.<br>Since utilization may be greater in biofibre harvests, there is a greater need to ensure that the direction for the retention of wildlife trees, DWM, residual patches, etc. outlined in the Guide are followed. |
| *Guideline* – Stumps and all below ground portions of a tree are not available for utilization | Stumps and below ground portions of trees are not available for harvest because whole tree harvesting (where stumps and roots are removed) was not in the scope of the original class environmental assessment hearings and therefore is not an approved logging |

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|---|---|
| as a forest product. Movement or removal associated with normal operations (construction of roads, landings, and skid trails; renewal and tending; slash piling; etc.), including incidental movement or removal during harvest operations, is permitted but will be minimized to that required for efficient operations. Removal for forest health purposes is permitted. | method.<br><br>This *Guideline* recognizes that movement and removal of some stumps may be required during the course of forest operations. An additional clause is included to allow for removal of stumps for forest health purposes, as part of a pest management plan. |
| *Guideline* – Organic matter that is not part of a harvested tree (including boles, branches, roots, bark, leaves, needles, debris, soil carbon, etc) will remain on site. Movement of such material for access or silvicultural purposes is permitted. | This *Guideline* helps to provide guidance for the MNRs directive on biofibre – emphasizing what may not be removed from the forest in a biofibre harvest. |

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## 7.0 EFFECTIVENESS MONITORING

Section 7 outlines:

- the legal and conceptual framework for effectiveness monitoring,
- principles of effectiveness monitoring,
- direction that is a high priority for effectiveness monitoring, and
- MNR's approach to delivering an effectiveness monitoring program and acquiring new knowledge.

No *Standards*, *Guidelines*, or *Best Management Practices* are presented.

**Appendix 1. Scientific names of species mentioned in the Stand & Site Guide (based primarily on the Natural Heritage Information Centre website – www. nhic.mnr.gov.on.ca).**

| Common name | Scientific name |
|---|---|
| **Woody Plants** | |
| Alder | *Alnus* spp. |
| Alternate-leaf dogwood | *Cornus alternifolia* |
| American beech | *Fagus grandifolia* |
| Balsam fir | *Abies balsamea* |
| Balsam poplar | *Populus balsamifera* |
| Basswood | *Tilia americana* |
| Birch | *Betula* spp. |
| Bitternut hickory | *Carya cordiformis* |
| Black ash | *Fraxinus nigra* |
| Black cherry | *Prunus serotina* |
| Black spruce | *Picea mariana* |
| Bur oak | *Quercus macrocarpa* |
| Butternut | *Juglans cinerea* |
| Cedar (Eastern) | *Thuja occidentalis* |
| Chokecherry | *Prunus virginiana* |
| Dogwood | Co*rnus* spp. |
| Douglas fir | *Pseudotsuga menziesii* |
| Green ash | *Fraxinus pennsylvanica var. subintegerrima* |
| Hemlock (Eastern) | *Tsuga canadensis* |
| Ironwood | *Ostrya virginiana* |
| Jack pine | *Pinus banksiana* |
| Labrador tea | *Rhododendron groenlandicum* |
| Leatherleaf | *Chamaedaphne calyculata* |
| Maple | *Acer* spp. |
| Mountain ash | *Sorbus* spp. |
| Norway spruce | *Picea abies* |
| Oak | Quercus spp. |
| Poplar (Aspen) | *Populus* spp. |
| Red ash | *Fraxinus pennsylvanica* |
| Red maple | *Acer rubrum* |
| Red oak | *Quercus rubra* |
| Red pine | *Pinus resinosa* |
| Red spruce | *Picea rubens* |
| Saskatoon berry | *Amelanchier* spp. |
| Scots pine | *Pinus sylvestris* |
| Silver maple | *Acer saccharinum* |
| Sugar maple | *Acer saccharum* |
| Tamarack | *Larix laricina* |
| Trembling aspen | P*opulus tremuloides* |
| White ash | *Fraxinus americana* |
| White birch | *Betula papyrifera* |
| White elm | *Ulmus americana* |
| White pine | *Pinus strobus* |
| White spruce | *Picea glauca* |
| Willow | *Salix* spp. |
| Yellow birch | *Betula alleghaniensis* |

**Non-woody plants**

| | |
|---|---|
| Algae-like pondweed | *Potamogeton confervoides* |
| American ginseng | *Panax quinquefolius* |
| Big bluestem | *Andropogon gerardii* |
| Branched bartonia | *Bartonia paniculata* |
| Broad beech fern | *Phegopteris hexagonoptera* |
| Broad-leaved toothwort | *Cardamine diphylla* |
| Carolina yellow-eyed-grass | *Xyris difformis* |
| Clover | *Trifolium* spp. |
| Dandelion | *Taraxacum officinale* |
| Drummond’s thistle | *Cirsium drummondii* |
| Eastern prairie fringed-orchid | *Platanthera leucophaea* |
| Engelmann’s quillwort | *Isoetes engelmannii* |
| False solomon’s seal | *Maianthemum racemosum* |
| Flooded jellyskin | *Leptogium rivulare* |
| Garlic mustard | *Alliaria petiolata* |
| Hall’s fescue | *Festuca hallii* |
| Hazel | *Corylus* spp. |
| Hidden-fruited bladderwort | *Utricularia geminiscapa* |
| Hoary puccoon | *Lithospermum canescens* |
| Indian grass | *Sorghastrum nutans* |
| Jack-in-the-pulpit | *Arisaema triphyllum* |
| Little bluestem | *Schizachyrium scoparium* |
| Northern maidenhair-fern | *Adiantum pedatum* |
| Ogden’s pondweed | *Potamogeton ogdenii* |
| Panic grass | *Dichanthelium acuminatum* |
| Peavine | *Lathyrus* spp. |
| Pitcher’s thistle | *Cirsium pitcheri* |
| Prairie sage | *Artemisia ludoviciana* |
| Raspberry | *Rubus* spp. |
| Rattlesnake fern | *Botrychium virginianum* |
| Richardson’s alum-root | *Heuchera richardsonii* |
| Ridged yellow flax | *Linum striatum* |
| Rigid sunflower | *Helianthus rigidus* |
| Small-flowered lipocarpha | *Lipocarpha micrantha* |
| Small white lady's-slipper orchid | *Cypripedium candidum* |
| Spring beauty | *Claytonia virginica* |
| Switchgrass | *Panicum virgatum* |
| Toothcup | *Rotala ramosior* |
| Toothwort | *Cardamine* spp. |
| Trout lily | *Erythronium americanum* |
| Tuckerman’s quillwort | *Isoetes tuckermanii* |
| Vetchling | *Lathyrus ochroleucus* |
| Western ragweed | *Ambrosia psilostachya* |
| Western silvery aster | *Symphyotrichum sericeum* |
| White baneberry | *Actaea pachypoda* |
| White snakeroot | *Polygala senega* |

**Invertebrates**

| | |
|---|---|
| Carpenter ant | *Camponotus pennsylvanicus* |
| Emerald Ash Borer | *Agrilus planipennis* |
| Forest tent caterpillar | *Malacosoma disstria* |
| Gypsy moth | *Malacosoma disstria* |
| Jack pine budworm | *Choristoneura pinus* |

| | |
|---|---|
| Monarch | *Danaus plexippus* |
| Rainbow mussel | *Villosa iris* |
| West Virginia white | *Pieris virginiensis* |
| Spruce Budworm | *Choristoneura fumiferana* |

**Fish**

| | |
|---|---|
| American eel | *Anguilla rostrata* |
| Aurora trout | *Salvelinus fontinalis timagamiensis* |
| Bigmouth buffalo | *Ictiobus cyprinellus* |
| Brook trout | *Salvelinus fontinalis* |
| Channel darter | *Percina copelandi* |
| Kiyi | *Coregonus kiyi* |
| Lake herring | *Coregonus artedi* |
| Lake trout | *Salvelinus namaycush* |
| Lake sturgeon | *Acipenser fulvescens* |
| Lake whitefish | *Coregonus clupeaformis* |
| Largemouth bass | M*icropterus salmoides* |
| Muskellunge | *Esox masquinongy* |
| Northern brook lamprey | *Ichthyomyzon fossor* |
| Northern pike | *Esox lucius* |
| Pacific salmon | *Oncorhynchus gorbuscha*, *O. kisutch*, & *O.tshawytscha* |
| Rainbow trout | *Oncorhynchus mykiss* |
| Redside dace | *Clinostomus elongatus* |
| River redhorse | *Moxostoma carinatum* |
| Shortjaw cisco | *Coregonus zenithicus* |
| Shortnose cisco | *Coregonus reighardi* |
| Smallmouth bass | M*icropterus dolomieu* |
| Walleye | *Sander vitreus* |

**Reptiles**

| | |
|---|---|
| Blanding's turtle | *Emydoidea blandingii* |
| Eastern foxsnake | *Elaphe gloydi* |
| Eastern hog-nosed snake | H*eterodon platirhinos* |
| Eastern ratsnake | *Elaphe obsoleta* |
| Eastern ribbonsnake | *Thamnophis sauritus* |
| Five-lined skink | *Eumeces fasciatus* |
| Massasauga | *Sistrurus catenatus* |
| Milksnake | *Lampropeltis triangulum* |
| Northern map turtle | G*raptemys geographica* |
| Spiny softshell | *Apalone spinifera* |
| Spotted turtle | *Clemmys guttata* |
| Stinkpot | *Sternotherus odoratus* |
| Wood turtle | *Glyptemys insculpta* |

**Birds**

| | |
|---|---|
| American black duck | *Anas rubripes* |
| American crow | *Corvus brachyrhynchos* |
| American kestrel | *Falco sparverius* |
| American white pelican | *Pelecanus erythrorhynchos* |
| American wigeon | *Anas americana* |
| Bald eagle | *Haliaeetus leucocephalus* |
| Bank swallow | *Riparia riparia* |
| Barred owl | *Strix varia* |

| | |
|---|---|
| Black-backed woodpecker | *Picoides arcticus* |
| Black-throated green warbler | *Dendroica virens* |
| Black tern | *Chlidonias niger* |
| Blackburnian warbler | *Dendroica fusca* |
| Blue-winged teal | *Anas discors* |
| Bonaparte’s gull | *Larus philadelphia* |
| Boreal owl | *Aegolius funereus* |
| Broad-winged hawk | B*uteo platypterus* |
| Brown-headed cowbird | *Molothrus ater* |
| Brown creeper | *Certhia americana* |
| Bufflehead | *Bucephala albeola* |
| Canada goose | *Branta canadensis* |
| Cerulean warbler | *Dendroica cerulea* |
| Chestnut sided warbler | Dendroica pensylvanica |
| Chimney swift | *Chaetura pelagica* |
| Chipping sparrow | *Spizella passerina* |
| Common goldeneye | *Bucephala clangula* |
| Common grackle | *Quiscalus quiscula* |
| Common merganser | *Mergus merganser* |
| Common raven | *Corvus corax* |
| Common yellowthroat | *Geothlypis trichas* |
| Cooper’s hawk | *Accipiter cooperii* |
| Eastern kingbird | *Tyrannus tyrannus* |
| Eastern screech-owl | *Megascops asio* |
| European starling | *Sturnus vulgaris* |
| Gadwall | *Anas strepera* |
| Golden eagle | *Aquila chrysaetos* |
| Golden-winged warbler | *Vermivora chrysoptera* |
| Great blue heron | *Ardea herodias* |
| Great gray owl | *Strix nebulosa* |
| Great horned owl | *Bubo virginianus* |
| Green-winged teal | *Anas crecca* |
| Hooded merganser | *Lophodytes cucullatus* |
| House sparrow | *Passer domesticus* |
| Kirtland’s warbler | *Dendroica kirtlandii* |
| Least bittern | *Ixobrychus exilis* |
| Lesser scaup | *Aythya affinis* |
| Loggerhead shrike | *Lanius ludovicianus* |
| Long-eared owl | *Asio otus* |
| Louisiana waterthrush | *Seiurus motacilla* |
| Mallard | *Anas platyrhynchos* |
| Merlin | *Falco columbarius* |
| Mourning warbler | *Oporornis philadelphia* |
| Northern goshawk | *Accipiter gentilis* |
| Northern harrier | *Circus cyaneus* |
| Northern hawk owl | *Surnia ulula* |
| Northern pintail | *Anas acuta* |
| Northern saw-whet owl | *Aegolius acadicus* |
| Northern shoveler | *Anas clypeata* |
| Olive-sided flycatcher | *Contopus cooperi* |
| Osprey | *Pandion haliaetus* |
| Ovenbird | *Seiurus aurocapillus* |
| Peregrine falcon | *Falco peregrinus* |
| Pileated woodpecker | *Dryocopus pileatus* |
| Piping plover | *Charadrius melodus* |
| Red-breasted merganser | *Mergus serrator* |

| | |
|---|---|
| Red-breasted nuthatch | *Stitta canadensis* |
| Redhead | *Aythya americana* |
| Red-headed woodpecker | *Melanerpes erythrocephalus* |
| Red-shouldered hawk | *Buteo lineatus* |
| Red-tailed hawk | *Buteo jamaicensis* |
| Red-winged blackbird | *Agelaius phoeniceus* |
| Ring-necked duck | *Aythya collaris* |
| Ruddy duck | *Oxyura jamaicensis* |
| Ruffed grouse | *Bonasa umbellus* |
| Sharp-shinned hawk | *Accipiter striatus* |
| Sharp-tailed grouse | *Tympanuchus phasianellus* |
| Short-eared owl | *Asio flammeus* |
| Spruce grouse | *Falcipennis canadensis* |
| Three-toed woodpecker | *Picoides dorsalis* |
| Turkey vulture | *Cathartes aura* |
| White throated sparrow | *Zonotrichia albicollis* |
| Wild turkey | *Meleagris gallopavo* |
| Wood duck | *Aix sponsa* |
| Yellow rail | *Coturnicops noveboracensis* |

**Mammals**

| | |
|---|---|
| American badger | *Taxidea taxus* |
| Beaver | *Castor canadensis* |
| Big brown bat | *Eptesicus fuscus* |
| Black bear | *Ursus americanus* |
| Bobcat | *Lynx rufus* |
| Cougar | *Puma concolor* |
| Coyote | *Canis latrans* |
| Eastern pipistrelle | *Pipistrellus subflavus* |
| Eastern wolf | *Canis lupus lycaon* |
| Elk | *Cervus canadensis* |
| Fisher | *Martes pennanti* |
| Grey fox | *Urocyon cinereoargenteus* |
| Hoary bat | *Lasiurus cinereus* |
| Least weasel | *Mustela nivalis* |
| Little brown bat | *Myotis lucifugus* |
| Long-tailed weasel | *Mustela frenata* |
| Lynx | *Lynx canadensis* |
| Marten | *Martes americana* |
| Mink | *Mustela vison* |
| Moose | *Alces americanus* |
| Muskrat | *Ondatra zibethicus* |
| Northern grey wolf | *Canis lupus occidentalis* |
| Northern long-eared bat | *Myotis septentrionalis* |
| Raccoon | *Procyon lotor* |
| Red-backed vole | *Clethrionomys gapperi* |
| Red bat | *Lasiurus borealis* |
| Red fox | *Vulpes vulpes* |
| Red squirrel | *Tamiasciurus hudsonicus* |
| River otter | *Lontra canadensis* |
| Short-tailed weasel | *Mustela erminea* |
| Silver-haired bat | L*asionycteris noctivagans* |
| Small-footed bat | *Myotis leibii* |
| Southern flying squirrel | *Glaucomys volans* |
| Striped skunk | *Mephitis mephitis* |

| | |
|---|---|
| White-tailed deer | *Odocoileus virginianus* |
| Wolf | *Canis lupus* |
| Wolverine | *Gulo gulo* |
| Woodland caribou | *Rangifer tarandus caribou* |

**Diseases**

| | |
|---|---|
| Beech bark disease | *Nectria coccinea* var. *faginata* |
| Butternut canker | *Sirococcus clavigignenti-juglandacearum* |
| White pine blister rust | *Cronartium ribicola* |

**Appendix 2. Amount of shoreline burned around lakes and streams in the boreal and transition forests of Ontario based on analysis of 42 fires.**

<table>
<tr><td>Data</td><td>During the development of the Forest Management Guide for Natural Disturbance Pattern Emulation (2001), a digital dataset describing the characteristics of 42 fires was assembled (see OMNR 1997). Fires studied occurred between 1920 and 1960 and were selected based on the following criteria:<br>• stand replacing fires,<br>• variation in size (54 to 52,772 ha),<br>• no overlapping fire events,<br>• no salvage harvest,<br>• no fire suppression, and<br>• widely distributed across the boreal and transition forests.<br>Using contemporary black and white aerial photography (1:15,840), the boundary of each burn event was delineated and patches (as small as 0.25 ha) of burned and residual forest were mapped (see OMNR 1997 for criteria). Fires were then digitally transferred onto OBM coverages at a scale of 1:20,000.</td></tr>
<tr><td>Analysis</td><td>Lakes - All lakes (includes ponds) entirely or partly contained within burn events were considered in the subsequent analysis. A 30 or 90 m buffer (coinciding with the range of AOC widths prescribed in Section 4.1.1) was delineated around each lake. The percent of this buffer that burned was summarized in 2 ways:<br>• percent of area in entire buffer that burned and<br>• percent of area in buffer within burn event that burned.<br>Results were summarized for all lakes and for 3 size classes: <10 ha; 10-99 ha; ≥100 ha. Total sample size was 1823 lakes for the 30 m buffer analysis and 1875 lakes for the 90 m buffer analysis. The latter analysis included a larger sample because lakes within 30 and 90 m of the burn perimeter were included in the former and latter analyses, respectively.<br>Streams – Single line permanent streams were considered for analysis. Streams were clipped at the burn perimeter. A 30 or 90 m buffer (coinciding with the range of AOC widths prescribed in Section 4.1.2) was delineated around each stream segment; overlapping buffers were dissolved. The percent of this buffer that burned was summarized for all streams. Total sample size was 2072 segments for the 30 m buffer analysis and 1326 segments for the 90 m buffer analysis. The disparity in sample size between the two analyses occurred because the smaller buffer used in the former analysis resulted in less amalgamation of short segments that were separated by small water polygons.<br>All spatial analysis was conducted using ArcView®.</td></tr>
<tr><td>Results and discussion</td><td>Lakes - Overall, the median percent of shoreline area burned around lakes was about 45 to 60% (see Tables AP2a and AP2b). However, there was tremendous variation with individual lakes ranging from 0 to 100%. Some of this variability was an artifact of the width of shoreline area sampled; median values were about 10% higher when a 90 m, rather than a 30 m, buffer was used to delineate shoreline area. Some of the variability was related to size of lakes. Lakes ≥100 ha generally had a lower percent of shoreline area burned (about 10-35%) than lakes <100 ha (about 35-65%). Method of defining percent of shoreline burned (entire shoreline vs shoreline within burn event only) had little effect on estimates for lakes <100 ha (which were predominantly contained within events) but had a substantial effect on estimates for lakes ≥100 ha (which often formed the boundary of burn events). For</td></tr>
</table>

lakes ≥100 ha, estimates based on the entire shoreline (about 10%) may underestimate the total amount of shoreline potentially influenced by fire because large lakes may be affected by multiple fire events. Conversely, estimates based on the shoreline within events only (about 30-35%) may overestimate the total amount of shoreline potentially influenced by fire because portions of large lakes may remain undisturbed by fire. The true value may lie somewhere between 10 and 35%.

Much of the residual variation in percent of shoreline burned may be attributable to variation in topography, fire behaviour, and forest composition.

**Table AP2a. Median percent of shoreline burned within 30 m of lakes in 42 fires (25th to 75th percentile range in brackets) in the boreal and transition forests of Ontario.**

| | Percent shoreline burned | | |
|---|---|---|---|
| Size of lake | Entire shoreline | Within burn event | Sample size |
| 0.0 to 9.9 ha | 48% (2-98%) | 49% (2-99%) | 1538 |
| 10.0 to 99.9 ha | 37% (4-78%) | 39% (6-78%) | 228 |
| 100.0+ ha | 10% (3-27%) | 30% (10-57%) | 57 |
| All lakes | 44% (2-95%) | 47% (3-96%) | 1823 |

**Table AP2b. Median percent of shoreline burned within 90 m of lakes in 42 fires (25th to 75th percentile range in brackets) in the boreal and transition forests of Ontario.**

| | Percent shoreline burned | | |
|---|---|---|---|
| Size of lake | Entire shoreline | Within burn event | Sample size |
| 0.0 to 9.9 ha | 62% (8-94%) | 63% (9-94%) | 1577 |
| 10.0 to 99.9 ha | 37% (2-80%) | 42% (5-80%) | 241 |
| 100.0+ ha | 12% (4-31%) | 34% (12-59%) | 57 |
| All lakes | 56% (6-91%) | 58% (8-92%) | 1875 |

Percent shoreline burned did not follow a normal distribution. Around lakes <10 ha, fires tended to burn either <20 or >80 % of the shoreline (Fig. AP2a). Around lakes ≥100 ha, fires generally burned <20% of the shoreline; few lakes had >50% of their shoreline burned (Fig. AP2b).

*Streams* - A median of 44% ($25^{th}$ to $75^{th}$ percentiles: 1-90%) and 49% ($25^{th}$ to $75^{th}$ percentiles: 7-85%) of 30 and 90 m shoreline buffers burned, respectively.

As for lakes, percent shoreline burned did not follow a normal distribution. For relatively short stream segments (<250 m), fires tended to burn either <20 or >80% of the shoreline buffer (Fig. AP2c). Longer stream segments (≥1000 m) were more likely to have intermediate amounts of burned and unburned shoreline buffer (Fig. AP2d).

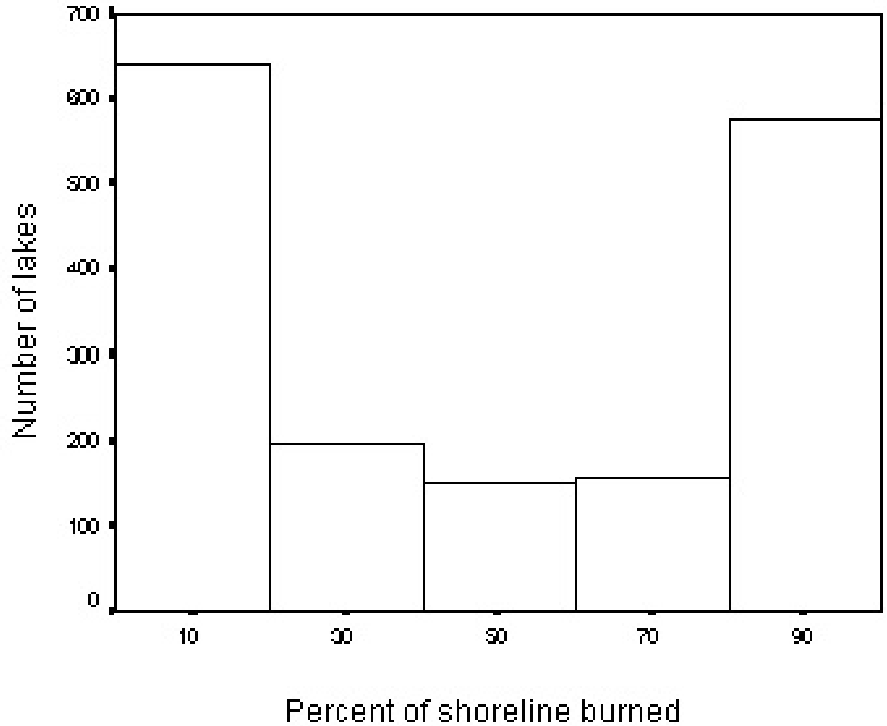


**Fig. AP2a. Percent of entire shoreline burned within 30 m around lakes <10 ha in size.**

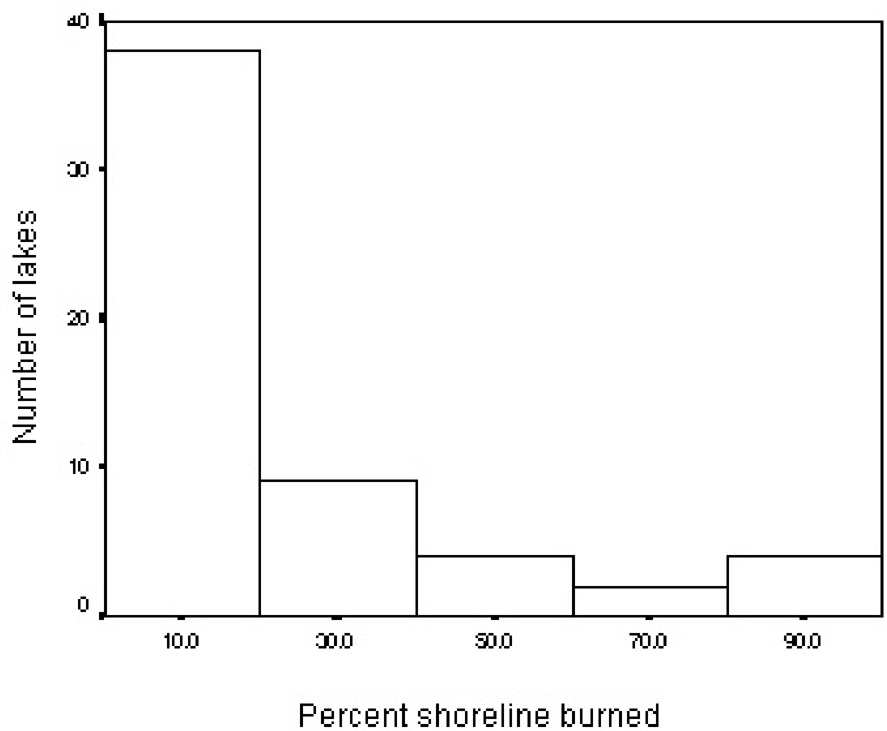


**Fig. AP2b. Percent of entire shoreline burned within 30 m around lakes ≥100 ha in size.**

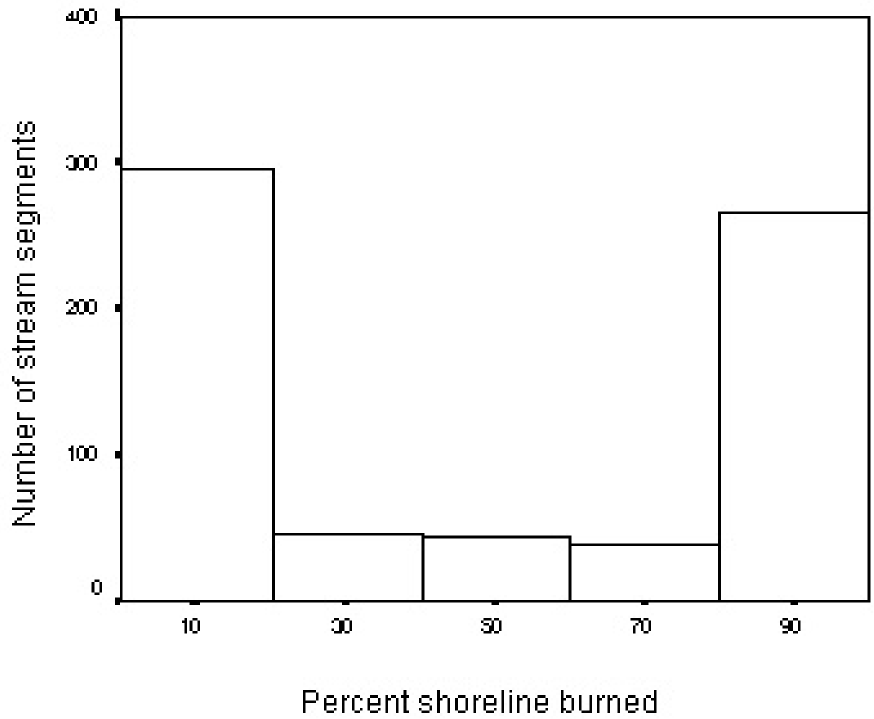


**Fig. AP2c. Percent shoreline burned within 30 m of stream segments <250 m in length.**

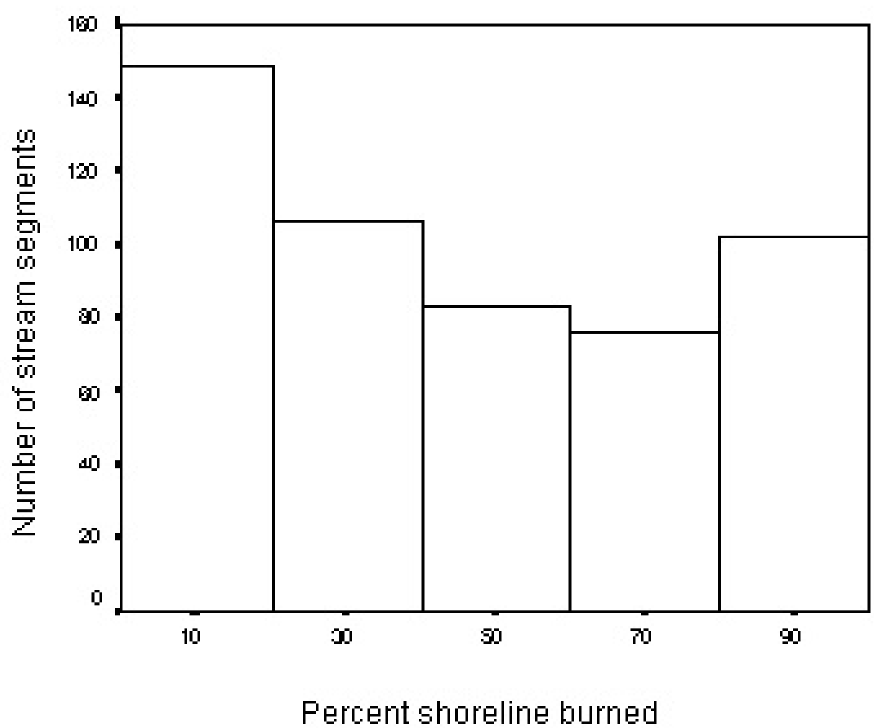


**Fig. AP2d. Percent shoreline burned within 30 m of stream segments ≥1000 m in length.**

| | |
|---|---|
| Literature cited | OMNR. 1997. Forest management guidelines for the emulation of fire disturbance patterns – analysis results. Unpubl. Rpt., OMNR, Northwest Science & Information Section, Thunder Bay, ON. |

**Appendix 3. Estimating the amount of coarse woody material potentially contributed by trees retained along shorelines.**

Probability of a tree falling into the water ($P_{FALL}$)[1]

$$= \{[\text{cosine}^{-1} (DFW/LMT)]/180\}*1.5$$

Where
DFW = distance from water
LMT = linear m of coarse wood per tree

For example, for a tree right on the water's edge, $P_{FALL}$

$$= \{[\text{cosine}^{-1}(0m/12.0m)]/180\}*1.5$$
$$= 0.75$$

$P_{FALL}$ for trees 5 and 10 m from water are 55 and 28%, respectively.

The number of logs contributed by each tree (LPT) on the water's edge is

$$= P_{FALL} * (LMT\text{-}DFW) /MLL$$

Where MLL = mean log length

For example, for trees right at the water's edge, LPT

$$= 0.75 * (12.0 – 0) / 2.9$$
$$= 3.1 \text{ logs}$$

LPT for trees 5 and 10 m from water are 1.3 and 0.2 logs, respectively.

Assuming trees are uniformly distributed between 0 and 10 m from the water's edge[2], the average amount of coarse wood contributed by each tree within this zone is about 4.2 linear m and 1.4 logs.

---

[1] Basic equation from Robison and Beschta (1990) assumes trees fall in random directions. Empirical evidence suggests this is not accurate (e.g., Bragg et al. 2000). Thus, the adjustment proposed by Welty et al. (2002) was applied.

[2] The direction in Sections 4.1.1 and 4.1.2 requires shoreline trees to be at least 15 m tall and preferentially retained within ½ the height of the tree from the shoreline. These calculations assume that all trees are 15 m tall and retained within 10 m of the shoreline.

**Literature cited**

Bragg, D.C., J.L. Kershner, and D.W. Roberts. 2000. Modeling large woody debris recruitment for small streams of the central Rocky Mountains. USDA For. Ser. Gen. Tech. Rpt. RMRS-GTR-55.

Robison, E.G., and R.L. Beschta. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. For. Sci. 36:790-801.

Welty, J.J., T. Beechie, K. Sullivan, D.M. Hyink, R.E. Bilby, C. Andrus, and G. Pess. 2002. Riparian aquatic interaction simulator (RAIS): a model of riparian forest dynamics for the generation of large woody debris and shade. For. Ecol. Manage. 162:299-318.

**Appendix 4. Defining restrictions on timing of operations around occupied nests.**

Human activities conducted in the vicinity of occupied nests can disturb nesting birds, and, in some cases, result in nest desertion, and/or increased egg, nestling, or adult mortality (Knight and Skagen 1988, Hockin et al. 1992, Hill et al. 1997, Richardson and Miller 1997). Buffers that restrict activities within a specified distance of occupied nests have been suggested for many raptors and colonial birds as a way to mitigate potential effects of human activities (Rodgers and Smith 1995, Richardson and Miller 1997). Unfortunately, most recommended buffers (including those used in Ontario since the 1980s) have been based largely on expert opinion. While considerable research has quantified the response of hunting raptors to pedestrian and vehicular activity (e.g., Knight and Knight 1984, Holmes et al. 1993), rigorous studies describing the influence of different activities on nesting raptors have been conducted for a few species only (e.g., Grubb and King 1991, Grubb et al. 1992). Moreover, these studies have rarely examined the effects of forest management operations. This appendix describes a quantitative approach to estimating buffer requirements for the species considered in Section 4.2.2 based on one objective measurable behavioral response of nesting birds to human disturbance.

Our approach follows Rodgers and Smith (1995), who defined buffers for recreational activities around nests of various species of colonial waterbirds based on the distance birds flushed (flew) from their nests when approached by pedestrians or watercraft. Flushing of nesting birds by humans is considered potentially detrimental to reproductive output because flushing birds may attract nest predators or absence of parent birds may render eggs or young more vulnerable to predators or environmental stress. We recognize that using flushing distance to define buffer requirements may be a conservative approach because birds may leave nests for a variety of reasons and flushing by itself does not necessarily result in a measurable impact on productivity (e.g., Marks 1986, Hannon et al. 1993, Verboven et al. 2001). None the less, our objective was to define buffers that would minimize the likelihood that various forest management operations would flush nesting birds.

Unfortunately, for most species discussed in Section 4.2.2, there is little published information on flushing distance. However, the distance at which birds react to human activities is thought to be correlated with body size (Holmes et al. 1993, Blumstein et al. 2005). When mean flushing distance for 12 species (bald eagle, Fraser et al. 1985; osprey, Mullen 1985; ferruginous hawk, White and Thurow 1985; common raven, Knight 1984; northern goshawk, Kennedy and Stahlecker 1993; peregrine falcon, Kurvitis 1989; European golden-plover, Eurasian dotterel; Byrkjedal 1987; northern cardinal, yellow-breasted chat, indigo bunting, field sparrow; Burhans and Thompson 2001) was plotted against their respective mean body mass (from Sibley 2000) a strong relationship emerged (Fig. AP4a). The functional relationship fit to the data in Fig. AP4a (flushing distance = $10^{(0.994 \cdot \mathrm{LOG}_{10}(\text{body mass}) - 1.092)}$, $P < 0.000$, $R^2 = 0.955$) suggested that the mean distance most birds flushed (in meters) was about 10% of their mean body mass (in grams).

The functional relationship fit to the data in Fig. AP4a was used to estimate flushing distance for each of the species addressed in Section 4.2.2. Estimated flushing distance represents the expected mean for each species; using this value to define a buffer might only protect 50% of nests. To identify the buffer distance needed to protect 95% of nests, we followed the approach used by Rodgers and Smith (1995). They multiplied mean flushing distance by 1.6495 standard deviations and added 40 m (to account for the distance birds became agitated prior to flushing). We had no species-specific measure of standard deviation. However, data in Rodgers and Smith (1995) suggest that standard deviation of flushing distance is typically about 30 to 40% of the mean; for our calculations we assumed standard deviation was 35% of mean flushing distance for each species.

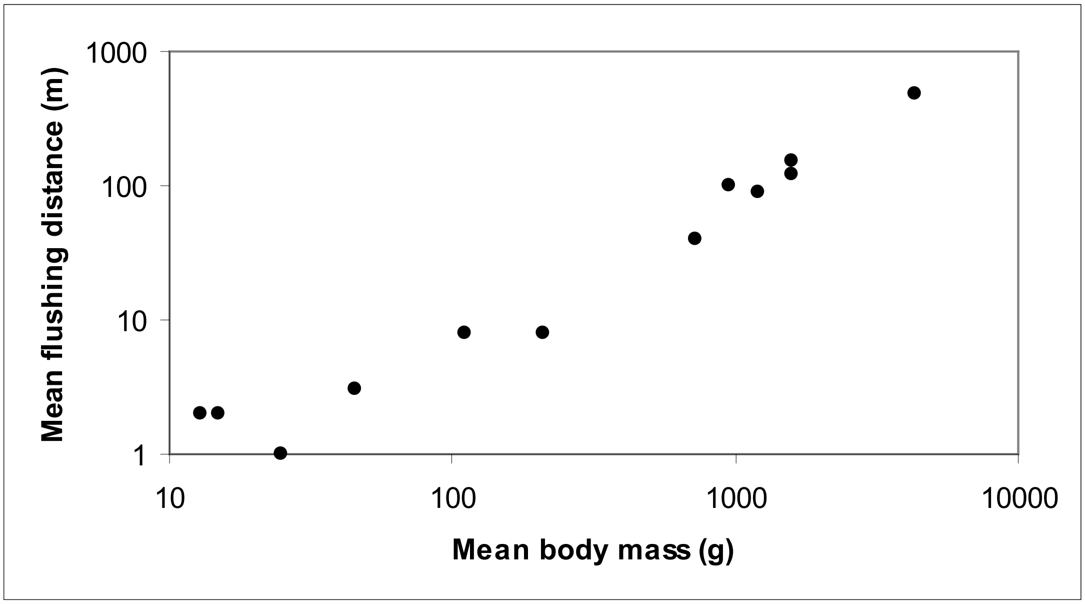


**Fig. AP4a. Relationship between mean flushing distance and mean body mass for 12 species of open-nesting non-colonial birds ranging from field sparrows to bald eagles (see text for references).**

The buffer derived from this analysis is an estimate of the separation distance required to mitigate the effects of highly visible pedestrian activities that deliberately approach a nest. Numerous studies suggest that pedestrian activities disturb large birds as much or more than vehicular activities (cars, trucks, ATVs, watercraft) (e.g., Holmes et al. 1993, Rogers and Smith 1995, Grubb and King 1991, Carlson and McLean 1996). Thus, it was assumed that this buffer would be adequate for most pedestrian and mechanized forest management operations where operations were expected to be frequent, of long duration, and/or highly visible or highly audible. These types of disturbances are referred to as High Impact Operations and include most operations typically associated with forest management operations such as tree felling, skidding or forwarding, roadside processing, road construction, and large scale tree planting. The likelihood of human activities disturbing large stick-nesting birds is typically reduced (by about 50%) when events are infrequent, of short duration, or are not highly visible or audible (see Grubb and King 1991, Grubb et al. 1992). Less disturbing operations are referred to as Moderate or Low Impact Operations and include small scale tree planting, small scale motor-manual tending, tree marking, hauling, and road grading. Buffers prescribed for Moderate and Low Impact Operations were set at 50% and 25%, respectively, of the buffer defined for High Impact Operations.

Recommended buffers for High, Moderate, and Low Impact Operations are summarized by species in Table AP4a. To simplify the number of different rules, species were placed into 4 broad groups based on body mass (small, <250 g; medium, 250 – 500 g; large, 500 - 1500 g; extra-large, >1500 g) and each species was assigned values based on the maximum for the group (rounded to the nearest 50 m for High Impact Operations). Buffers were halved for species that are abundant and adaptable to human activities (e.g., red-tailed hawk), or species that are generally less likely to flush because their nests are concealed in cavities (e.g., American kestrel) or dense vegetation on the ground (e.g., short-eared owl).

Based on estimated flushing distance, the buffer around bald eagle nests for High Impact Operations should be 560 m (Table AP4a). However, detailed research on the response of eagles to human activities suggests that only about 25% of nesting birds flush when disturbances are further than 200 (Grubb et al. 1992) to 300 m (Grubb and King 1991) from nests. Thus, a buffer of 400 m for High Impact Operations should likely be adequate to protect 95% of nests, and is thus prescribed.

**Table AP4a. Mean body mass, estimated mean flushing distance, and proposed buffers for occupied nests of various diurnal and nocturnal raptors, common ravens, and great blue herons.**

| Species | Mean body mass (g) | Estimated mean flushing distance (m) | Calculated buffer (m) | Proposed buffer (m) | | |
|---|---|---|---|---|---|---|
| | | | | High impact opera-tions | Moderate impact operations | Low impact opera-tions |
| *Small species* | | | | | | |
| Northern saw-whet owl[1] | 80 | 6 | 50 | 25 | 10 | 0 |
| American kestrel[1] | 120 | 9 | 55 | 25 | 10 | 0 |
| Boreal owl[1] | 140 | 11 | 57 | 25 | 10 | 0 |
| Sharp-shinned hawk | 140 | 11 | 57 | 50 | 25 | 10 |
| Eastern screech-owl[1] | 180 | 14 | 62 | 25 | 10 | 0 |
| Merlin | 190 | 15 | 63 | 50 | 25 | 10 |
| *Medium species* | | | | | | |
| Long-eared owl | 260 | 20 | 72 | 100 | 50 | 25 |
| Northern hawk owl[1] | 320 | 25 | 79 | 50 | 25 | 10 |
| Short-eared owl[2] | 350 | 27 | 83 | 100 | 50 | 25 |
| Broad-winged hawk | 390 | 30 | 88 | 100 | 50 | 25 |
| Northern harrier[2] | 420 | 33 | 92 | 50 | 25 | 10 |
| Cooper's hawk | 450 | 35 | 95 | 100 | 50 | 25 |
| *Large species* | | | | | | |
| Red-shouldered hawk | 630 | 49 | 117 | 200 | 100 | 50 |
| Barred owl[3] | 720 | 56 | 128 | 200(100) | 100(50) | 50(10) |
| Northern goshawk | 950 | 74 | 156 | 200 | 100 | 50 |
| Red-tailed hawk[3] | 1080 | 84 | 172 | 100 | 50 | 25 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Great gray owl | 1080 | 84 | 172 | 200 | 100 | 50 |
| Common raven[4] | 1200 | 93 | 186 | 50 | 25 | 10 |
| Great horned owl[3,4] | 1400 | 108 | 211 | 100(50) | 50(25) | 25(10) |
| *X-large species* | | | | | | |
| Osprey | 1600 | 123 | 235 | 300 | 150 | 75 |
| Turkey vulture[2] | 1800 | 139 | 259 | 150 | 75 | 40 |
| Great blue heron | 2400 | 185 | 331 | 300 | 150 | 75 |
| Bald eagle[6] | 4300 | 330 | 560 | 400 | 200 | 100 |

[1] Cavity-nesting species – buffers halved.
[2] Ground-nesting species - buffers halved (except for short-eared owl which is a species at risk).
[3] Species uses stick nests or cavities – buffers halved for nests in cavities.
[4] Abundant species that tends to be adaptable to human activity - buffers halved.
[5] Very abundant species that tends to be highly adaptable to human activity - buffers reduced to 25%.
[6] Smaller buffer prescribed based on information available in literature.

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