

BIODIVERSITY INDICATORS FOR WOODLAND OWNERS

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BIODIVERSITY INDICATORS FOR WOODLAND OWNERS

OBJECTIVE

To maintain and/or increase the native natural biodiversity of Eastern Ontario woodlands, while promoting sustainable forest management.

GOALS

1. To help landowners become more aware of biodiversity on their land.
2. To assist landowners in initiating or modifying management activities which will maintain or increase native natural biodiversity in their woodlands as measured by regular monitoring of species and habitat indicators.
3. To provide a simple tool for landowners to use in assessing the success of activities regarding biodiversity targets, and in monitoring changes in biodiversity in their woodlands.
4. To develop a network of observers who will regularly report on the status of wildlife species in their woodlands, thereby providing a means of monitoring biodiversity in Eastern Ontario.

INTRODUCTION

The Canadian Biodiversity Institute's Observer Network Project has the goal of increasing awareness of biodiversity among landowners. One method of doing this is to provide biological indicators which can be used by individuals to assess and monitor their woodlands.

The Eastern Ontario Model Forest is also promoting biodiversity awareness and has been working on indicators for several years. In 1995 (EOMF Information Report No. 13, "**Ecological Properties for the Evaluation of Eastern Ontario Forest Ecosystems**"), Dr. Paul Keddy and Chris Drummond produced a list of Forest Health Indicators which could be used to evaluate the health of Eastern Ontario deciduous forest ecosystems. The list includes: tree size, canopy composition, coarse woody debris, herbaceous layer, corticolous bryophytes (mosses, liverwort, lichens), wildlife trees, fungi (but without data because of lack of information), birds, large carnivores, and forest area. Many of these are suitable for use in a private woodlot, although most measurements given as required to make the assessment are too complicated for ordinary landowners.

In 1998, the Model Forest continued its work on indicators with the production of Information Report No. 43 ("**Local Level Indicators for the Eastern Ontario Model Forest**"). In it, Martin von Mirbach and Lorne Johnson draw together all previous EOMF works (including that of Keddy and Drummond) and the results of a workshop held on June 10, 1998. The product is a set of criteria and indicators which the EOMF can use to assess and monitor the state of the forest in

Eastern Ontario. The first assessment was carried out and the **“1998-1999 State of the Forest Report”** was produced as EOMF Information Report No. 42.

It was recognized that the indicators used for the State of the Forest Report were suitable on a landscape level only, and could not easily be adapted for use in a woodlot. Several case studies were therefore included in Report No. 43 in an attempt to “tell the part of the story that the landscape level indicators miss” (von Mirbach and Johnson, 1998). One of these case studies is that of Paul and Cathy Keddy, professional ecologists who are managing their woodlot for the restoration of native biodiversity. The list of indicators being used by the Keddy’s is very close to what could be used by any woodlot owner, although the amount of detailed measurement required, and the level of identification skills needed, would be beyond such an owner.

Another component of this project is the promotion of good forest management in Eastern Ontario while protecting and restoring native biodiversity. The Great Lakes-St. Lawrence Regional Forest Stewardship Initiative Steering Committee produced a draft report (**“Standards for Well Managed Forests in the Central and Southern Great Lakes-St. Lawrence Forest of Ontario”**, March 2000) containing a list of principles and indicators. Some of these are suitable for use by individuals to use in monitoring their cutting operations for adequate biodiversity retention.

A number of documents have been produced by the LandOwner Resource Centre in Manotick as part of the Extension Note series to assist landowners in managing their woodlands. **“Do You Have a Healthy Woodlot”** explains how to improve wildlife habitat; **“The Old Growth Forests of Southern Ontario”** and **“Restoring Old-growth Features to Managed Forests in Southern Ontario”** describe old growth and how to restore it; **“Management Options for Abandoned Farm Fields”** provides options for improving biodiversity through reforestation; **“Managing Regeneration in Conifer Plantations to Restore a Mixed Hardwood Forest”** explains how to restore native biodiversity in a plantation; **“Conserving the Forest Interior”** focuses on the importance of the interior forest habitat; and **“Cavity Trees are Refuges for Wildlife”** describes the benefits of protecting wildlife trees.

Another component of protecting and restoring native biodiversity is the management of invasive plants. The Ontario Invasive Plants Working Group has prepared a strategic plan for managing invasive plants in Southern Ontario (**“Sustaining Biodiversity”**, Donna Havinga and the Ontario Invasive Plants Working Group, 2000). This document contains strategies, actions, and species lists which can be used to prevent the spread of invasive plants or to remove existing invasives.

All of these documents give information on how to restore or increase native biodiversity, and some contain management prescriptions for retention of habitat features; but none deal with assessing the success of activities, monitoring biodiversity over time, or using indicators as a guide.

PROJECT DESCRIPTION

The project consists of:

- 1) identifying those criteria which are important for consideration by individual landowners when carrying out management operations in their woodlots;
- 2) choosing specific indicators which could be used by individual landowners to monitor their success in achieving or maintaining biodiversity as described by the criteria;
- 3) developing a network of participants, as described under Observer Network.

OBSERVER NETWORK

Landowners participating in monitoring of their woodlands using the indicators described below will become part of an Observer Network. Each observer will be encouraged to involve his or her family in the program. By means of site visits, a **Monitoring Plan** will be prepared for each participant. Each plan will be tailored to the specific woodland in question and will consist of:

- a map dividing the land into compartments based on forest cover type and showing monitoring stations;
- a description of the property and the management goals of the owner;
- inventories of trees, vegetation, and wildlife;
- a **monitoring record form** with a list of indicators to be monitored, based on the characteristics of the land and what indicators should be expected;
- an assessment of the woodland based on existing indicators;
- goals and objectives for the woodland based on any changes or improvements which would improve biodiversity.

The monitoring plan will be based on the outline for the Managed Forest Tax Incentive Program management plan. If the landowner has a MFTIP plan already, it will be used as a base. If no MFTIP plan is available, the monitoring plan will be prepared using original field work.

Each participant will be given a **Monitoring Manual** with instructions for installing monitoring stations and with guidelines for monitoring. Tapes of frog and bird calls will be available.

CRITERIA

The criteria were chosen based on the biodiversity issues discussed in the above cited literature. These are the habitat components and forest features which have been identified as important for landowners to consider in order to protect, maintain, and restore native biodiversity when carrying out forest management.

SPECIES INDICATORS

The species indicators listed were chosen on the basis of three factors. First, they must be accurate indicators of the criteria which they represent. That is, they must be predominantly present when the appropriate criteria conditions are met, and generally absent when not met.

Secondly, they must be sufficiently abundant and widespread in distribution throughout Eastern Ontario that the average LandOwner will have them and be able to find them if the conditions are met. Thirdly, they must be easy to find and identify or measure by an average LandOwner. For example, a bird species must be easily seen and identified by sight, or easily heard and recognizable by song or call.

HABITAT INDICATORS

Habitat indicators are actual measurements or estimates of the number or amount of features or habitat units present in a woodlot. Information on these would normally take longer and more effort to gather than that for species indicators, where simple presence is often sufficient as a measure. Analysing habitat indicators, however, can provide a double function in that it may both identify if sufficient habitat is present, and indicate why a species indicator may be absent. For example, if Pileated Woodpeckers are not present, the amount of downed woody debris could be measured. This could indicate whether enough wood is being left on the ground, and could identify why Pileated Woodpeckers are not there.

CAVEATS

Forest Type

Most of the indicators chosen are usable in all forest types. Open oak woodlands, cedar stands, and swamp forests, however, may score low for some indicators (such as forest interior birds and spring ephemeral wildflowers), as discussed by Keddy and Drummond (1995).

Plantations

Plantations are unnatural ecosystems which do not fit easily into the system of indicator analysis. Some of the indicators (the presence of spring ephemerals, a decrease in Buckthorn and other invasives) can be used to measure the progress of a plantation towards a natural situation. As a plantation is pruned and thinned, and more native species invade, more of the other indicators can be used. Plantations are particularly good at increasing woodlot size, and interior forest size quickly, and may therefore increase the presence of indicator species in adjacent woods and the local landscape. The use of closed canopy species would be a good indicator of the habitat value of a plantation.

Chance

Some woodlands may by chance not have certain indicators even though conditions may be right. An analysis of habitat requirements could be carried out, if warranted, to determine if other factors are in play. The appropriate document for this purpose is “**Eastern Ontario Matrices Linking Wildlife to Habitat: A Biodiversity Management Tool**” by Jacques Bouvier and Lesley-Anne Howes (EOMF Information Report No. 47, 1999).

Change

As changes to the landscape (urbanization, agriculture, reforestation, fragmentation by roads, corridors, and buildings) and to the climate (global warming) occur, the range and distribution of species change. Such changes may affect the ability to use certain indicators. The observations made of some indicator species may be useful in documenting range and distribution changes.

BIODIVERSITY ISSUES

1. Old Growth, Cavity Trees, Snags, Downed Woody Debris

Old growth or mature forest refers to stands at least 120 years old. Such stands usually contain numerous large trees (at least 50 cm dbh), large amounts of downed woody debris (fallen trees, limbs, and branches on the forest floor), and abundant snags (standing dead trees) and cavity trees (live or dead trees with holes which can be used by wildlife). Because mosses and lichens grow slowly, they are more likely to be found in abundance and diversity in undisturbed old growth forest.

Old growth stands contain species (such as some mosses, lichens, and fungi) which are now uncommon or rare due to limited old growth forest habitat, and provide habitat for some wildlife species (such as Cerulean and Hooded Warblers, Redback and Yellow-spotted Salamanders) with specialized habitat requirements. A Lungwort lichen (*Lobaria*) needs unpolluted air and old growth forest to survive.

Large trees are important in providing cavities for large species of wildlife, such as Pileated Woodpecker, large Owls, Wood Duck, and Fisher.

Downed woody debris provides feeding habitat for woodpeckers, nesting sites for snakes, cover for salamanders, and a growth medium for fungi, mosses, and lichens.

Snags contain feeding and nesting sites for woodpeckers and owls, and perching locations for birds.

Cavity trees of all sizes are important for a wide range of wildlife which use them for nesting, escape, and hibernation.

2. Forest Interior, Size, Connections

Forest interior habitat is that portion of a stand which is at least 100 metres from any edge of the stand. A stand with suitable interior habitat should be at least 300 metres in diameter (a 100-metre buffer around the outside and an interior which is 100 metres across). In order to provide one hectare of interior habitat a circular woodlot would need to be seven hectares in total size.

Interior habitat is vital for certain species (particularly some warblers) which need solitude and shelter away from the disturbances and nest predators (Raccoons, Blue Jays) which are more frequent and abundant around the edges. These birds are also very susceptible to nest parasitism from Cowbirds, having never evolved mechanisms to deal with foreign eggs in their nests.

Cowbirds live along forest edges only, shunning interior habitats.

Other species of wildlife (Fisher, Red-shouldered Hawk) require large forested blocks or connections to other forest stands in order to provide sufficient travel routes and home range size. A minimum of 40 hectares (100 acres) is suggested as the size of a “significant” woodlot. Large forest stands provide more interior habitat and are therefore more important to interior

species of wildlife. Connections are important for all species in order to maintain genetic transfer within the species, and to ensure that the dispersal of individuals will provide replacements for those which die.

3. Closed Canopy, Disturbances, Invasive Species

Large disturbances, such as land clearing and clear-cutting, remove native species and allow the entry of exotic or **invasive species** such as Buckthorn. Invasives may crowd out more native species as they expand in the absence of their normal controlling parasites and predators. The presence and abundance of invasives can be used as an indicator of past disturbance, while their absence or the presence of native species can indicate natural conditions. Smaller disturbances such as grazing in the forest or harvesting operations which open the canopy too much can have a similar effect on a smaller scale. Reforesting activities which use only native species and programs to remove invasives will help to restore native biodiversity. Success and progress can be monitored using indicator species. A full list of invasives is available in **Sustaining Biodiversity** (Havinga et al, 2000).

A number of wildlife species, some which live right in the canopy, but many others which use other parts of the forest, require a **closed canopy** (greater than 70% closure). This factor can be used in planning harvesting operations.

The nests or wintering areas of some species are very sensitive to disturbance and need protection. Raptors (hawks, eagles, owls, falcons) usually build **stick nests** to raise their young. These are platforms in trees made with branches and sticks. Other species of wildlife may use them also. Birds which nest in colonies (colonial birds) are particularly sensitive to disturbance because of the number of nests in one location. A colony of Great Blue Herons is called a **heronry** or rookery, and is usually located in trees over standing water. Some snakes spend the winter together in an underground hole called a **hibernaculum**. Because of the large number of snakes in one location, the potential for impacts due to disturbance is heightened.

4. Tree Biodiversity and Rare Vegetation Communities

Maintaining a variety of tree species in woodlots provides for a diversity of wildlife and habitats, protects against attacks (disease, insects) on one species, and helps to ensure the continued presence of rare and uncommon tree species. Some trees are uncommon because they are near the limits of their geographical ranges. Such trees may have genetic adaptations different from individuals in the main species range. They should therefore be protected for their genetic variability. Species that are uncommon in the local landscape should also be accorded protected status. Ironwood has in the past been marked for complete removal. No native species should be thus targeted; a representative number of trees of all native species should be maintained. Reforesting programs should include a variety of native species, and nurseries should ensure that seed collections come from a variety of sources, individual trees, and locations within the woodlot.

The Natural Heritage Information Centre of the Ontario Ministry of Natural Resources in Peterborough has identified rare vegetation communities of Southern Ontario (Bakowsky, 1996). For woodland communities, these contain rare tree species or combinations of species which should be identified and protected wherever they occur.

5. Special Wildlife & Special Habitats

Certain species of wildlife are naturally uncommon or have become rare due to human activities. These species and their habitats need protection wherever they are found. Programs exist to identify and classify wildlife species by category according to their abundance and the threats to them. In Ontario, the Committee on the Status of Species at Risk in Ontario (COSSARO) uses three main categories: Vulnerable, Threatened, and Endangered species (**VTE species**). For Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) uses the categories Special Concern, Threatened, and Endangered.

Special habitats are important in providing for specific wildlife needs. Some of these habitats are:

supercanopy trees - living trees that stick up above the main canopy of a stand. These are used as perches, lookouts, refuges, and landmarks by wildlife;

conifer patches - A patch of conifers in a hardwood stand provides thermal protection and food variety for wildlife. In addition, they provide a seed source for regeneration of those conifer species which may be uncommon in that area;

mast trees - trees which produce edible fruits, such as nuts and berries, which are eaten by wildlife;

cavity trees - trees with hollows or holes used by wildlife;

snags - standing dead trees for perches, lookouts, food sources for woodpeckers, potential holes for cavity nesters, and future downed woody debris.

6. Aquatic Habitats

Water in a woodlot provides an added component of diversity in both habitat and species. Wetlands provide important habitat, particularly for rare or uncommon species. They serve to maintain the hydrological regime of the surrounding area and are overwintering habitat for reptiles and amphibians such as turtles and frogs.

TABLE 1: BIODIVERSITY CRITERIA AND SPECIES INDICATORS

criterion (refer to numbered description above)	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
1. adequate old growth	Redback Salamander	x	x	x	x	x	x	x	3 11 FS
	Yellow-spotted Salamander	x		x				x	
	! Southern Flying Squirrel	x	x						
1. protection of old growth	large White Pine (over 120 yrs), any trees over 50 cm dbh	x	x	x	x	x	x	x	10 16
1. protection of old growth	abundance and diversity of mosses & lichens	x	x	x		x	x	x	LL, IB 4
1. protection of old growth, unpolluted air	Lungwort lichen (<i>Lobaria</i>)	x							IB 4
1. adequate downed woody debris	any salamanders	x	x	x	x	x	x	x	2 DS
1. adequate old growth, downed woody debris, & 2. forest interior	Pileated Woodpecker	x	x	x	x	x	x	x	2 SH
! Denotes a rare or restricted species useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
2. adequate forest interior	Barred Owl	x	x	x	x	x	x	x	3 16 30
	Veery	x	x	x	x	x	x	x	
	Hermit Thrush	x		x	x				
2. adequate size or good connections	Leopard Frog			x					FS
	Fisher	x	x	x	x	x	x	x	16, JM
2. adequate forest interior & 3. closed canopy	Hairy Woodpecker	x	x	x	x	x	x	x	3 16
	White-breasted Nuthatch	x		x	x				
	Brown Creeper	x		x	x				
	Winter Wren	x	x	x	x				
	Black-throated Green Warbler	x	x	x	x	x	x	x	
	Ovenbird	x	x	x	x	x	x	x	
2. adequate forest interior, adequate size, & 3. closed canopy	Red-shouldered Hawk	x	x		x				3
! Denotes a rare or restricted species useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
3. closed canopy	Yellow-bellied Sapsucker	x	x	x	x	x	x	x	3
	Least Flycatcher	x	x	x	x		x		
	Wood Thrush	x		x	x				
	Red-eyed Vireo	x	x	x	x	x	x	x	
	Snowshoe Hare	x	x	x	x	x	x	x	
	Northern Flying Squirrel	x	x		x	x	x	x	
	! Marten	x	x		x	x	x	x	
3. canopy species needing closed canopy	! Cerulean Warbler	x	x						3
	Scarlet Tanager	x	x	x	x	x	x	x	
3. protection from disturbance	Red-shouldered Hawk; continued use of stick nest, heronry, snake hibernaculum, or nest of any raptor	x	x	x	x	x	x	x	10
! Denotes a rare or restricted species useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
3. protection or recovery from grazing, good undergrowth	at least 4 of the following spring ephemerals (wildflowers)*** Foamflower Solomon's-seal Blue Cohosh White Trillium Bloodroot Dutchman's-breeches Wild Leek Wild Lily-of-the-valley	x							16 28 29
3. recovery from past clear-cutting or heavy harvesting	absence of, or decrease in Buckthorn	x	x	x	x	x	x	x	SH
3. control of invasive species	freedom from, or elimination of listed species, especially: Siberian Elm Buckthorn Manitoba Maple Norway Maple White Poplar Garlic Mustard Dog-strangling Vine Asian Long-horned Beetle	x	x	x	x	x	x	x	10 11 25
! Denotes a rare or restricted species useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
4. protection of uncommon trees & tree diversity	Bitternut Hickory	x		x					10
	Butternut	x		x					10
	Black Walnut			x					22
	Bur Oak	x	x	x					10
	White Oak	x	x						22
	Ironwood	x	x						SH
	! Gray Birch				x				22
	! Black Maple			x					22
	! Hackberry	x		x					22
	! Red Spruce	x				x		x	22
! Pitch Pine					x			22	
! Denotes a rare or restricted species useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
4. protection of rare woodland communities	! Swamp White Oak swamp			x					1
	! Bur Oak swamp			x					1
	! Red Maple-Hemlock swamp			x				x	1
	! White Cedar-Hemlock swamp						x	x	1
	! Oak-Hickory deciduous		x						1
	! mixed Oak deciduous		x						1
	! Hickory deciduous		x						1
	! Sugar Maple-Black Maple	x							1
	! Oak-Pitch Pine mixed		x				x		1
! Denotes a rare or restricted species or community useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
5. protection (regular presence or continued residency) of any EOMF VTE species V: vulnerable (COSSARO*) T: threatened (COSEWIC*) E: endangered (COSEWIC or COSSARO) SC: special concern (COSEWIC)	! Bald Eagle E (COSSARO)					x	x	x	35
	Red-shouldered Hawk SC	x	x	x	x	x		x	13
	! Peregrine Falcon T	x	x	x	x	x	x	x	13
	! Red-headed Woodpecker SC	x	x	x	x				34
	! Cerulean Warbler SC	x	x	x					13
	! Eastern Wolf SC	x	x	x	x	x	x	x	34
	! Grey Fox SC	x	x	x	x		x		34
	! Southern Flying Squirrel SC	x	x						13
	! Black Rat Snake T	x	x	x	x	x		x	13
	! West Virginia White Butterfly V	x							35
	! American Ginseng E (COSEWIC)	x							34
! Eastern Prairie White-fringed Orchid SC			x					34	
! Denotes a rare or restricted species or community useful as an indicator to only a few landowners in special circumstances.									

criterion	species indicator	ELC forest type used for reproduction **							source
		hard	oak	swamp	early	pine	cedar	hem	
6. good water quality in shallow or temporary pools	Chorus Frog			x					FS
6. protection of permanent water habitat: pond, shoreline	Bull Frog								SH

*** **Spring Ephemerals**

Foamflower	<i>Tiarella cordifolia</i>
Solomon's-seal	<i>Polygonatum biflorum</i>
Blue Cohosh	<i>Caulophyllum thalictroides</i>
White Trillium	<i>Trillium grandiflorum</i>
Bloodroot	<i>Sanguinaria canadensis</i>
Dutchman's-breeches	<i>Dicentra cucullaria</i>
Wild Leek	<i>Allium tricoccum</i>
Wild Lily-of-the-valley	<i>Maianthemum canadense</i>

* **COSSARO**: Committee on the Status of Species at Risk in Ontario

* **COSEWIC**: Committee on the Status of Endangered Wildlife in Canada

** **ELC forest type** (from **A Silvicultural Guide to Managing Southern Ontario Forests**, OMNR, 2000)

hard:	Upland Tolerant Hardwoods - stands primarily composed of shade-tolerant deciduous trees such as Sugar Maple, American Beech, Yellow Birch, White Ash, Black Cherry, Basswood, Ironwood, and other associates
oak:	Upland Oaks - stands comprised of at least 50% oak and hickory species
swamp:	Lowland Hardwood & Swamps - lowland hardwood forests with Red Maple, Silver Maple, Black Ash, White Elm, and Yellow Birch as dominants
early:	Early Successional Hardwoods - stands of fast-growing, but short-lived, shade-intolerant deciduous species such as poplars and White Birch
pine:	Pines - stands dominated by pine species
cedar:	Cedars & Cedars Swamps - both upland and lowland cedar stands
hem:	Hemlock - stands dominated by Eastern Hemlock

TABLE 2: BIODIVERSITY CRITERIA AND HABITAT INDICATORS

criterion (refer to numbered description above)	habitat indicator	source
1. adequate old growth	at least 10 ha of old growth (trees over age 120 or over 50 cm dbh) or 30% of the stand in old growth	19 22
1. adequate downed woody debris	both solid & crumbly large (>40 cm dbh) logs, at least 5/ha	16 19
2. adequate forest interior size	minimum 4 hectares	19 22
2. adequate woodlot size	at least 40 hectares of contiguous forest (either owned or in the adjacent landscape)	22
3. closed canopy	minimum 70% closure	3
5. protection of special wildlife habitats	presence of supercanopy trees: 1 per 4 ha conifers: 10/ha cavity trees: 7/ha snags: 5/ha mast trees: 8/ha	10 22 26 27 31

TABLE 3: STRATEGIES AND MANAGEMENT PRESCRIPTIONS

criterion	strategy or prescription
old growth	identify an existing or potential old growth stand for protection from cutting and dead wood removal; protect at least 10 ha or up to 30% of the stand as old growth if available
downed woody debris	do not disturb large rotting or hollow logs; keep 5 large (>40 cm dbh) fallen logs/ha; cut off branches and tree tops at the felling site rather than at the landing; do not remove, windrow, pile, chip, crush, or burn fallen or cut off branches; leave cull logs and log portions at the felling site
forest interior	reduce or eliminate harvesting in the forest interior; avoid creating gaps in the interior; gaps create less edge if they are round or square; protect at least 4 hectares of undisturbed interior habitat; reforest or regenerate clearings or fields in the forest; reduce edge and increase forest size by planting or regenerating trees around the woodlot edges
stand size	protect woodlands greater than the “significant” 40 hectare size; increase the size of woodlots by reforestation or natural regeneration
connections	connect woodlots by maintaining wooded fencerows (10 m

	<p>wide), and creek edges (10 m of natural vegetation on either side);</p> <p>amalgamate woodlots by reforesting or regenerating clearings and fields to create contiguous woodlands of at least 40 ha;</p> <p>cooperate with neighbours to create compatible management plans</p>
disturbance to forest environment	<p>do not allow livestock to graze in woodlots;</p> <p>harvest in the winter to avoid soil disturbance;</p> <p>minimize the number and total length of forest access roads such that roads occupy less than 2% of the stand;</p> <p>minimize clearcutting to ensure retention of 70% canopy closure;</p> <p>stop harvest if vehicles create ruts more than 15 cm deep;</p> <p>do not build roads on slopes greater than 10%;</p> <p>avoid pesticides; otherwise use non-broadcast methods (band or spot treatment) and use them late season or dormant season</p>
uncommon trees & rare woodland communities	<p>protect uncommon trees such as Bitternut Hickory, Butternut, Black Walnut, Bur Oak, White Oak, and White Pine;</p> <p>protect species which are near the edges of their geographic ranges, such as Gray Birch, Black Maple, Hackberry, Red Spruce, and Pitch Pine;</p> <p>retain any species, such as conifers, which are uncommon in the area;</p> <p>do not selectively harvest or remove any one native species;</p> <p>when planting, include a diversity of native species;</p> <p>protect rare woodland communities</p>
mast trees	<p>retain 8 mast trees per hectare with dbh greater than 25 cm;</p> <p>retain as many large oaks as possible;</p> <p>when planting, include mast trees</p>

VTE species and special wildlife habitats	<p>do not disturb stick nests (nests built by large birds, such as raptors);</p> <p>protect a circle with a radius of 150 metres around any active stick nest;</p> <p>do not schedule harvesting activities during the Mar.1 - July 31 breeding season;</p> <p>harvest during the winter to avoid disturbing plant roots;</p> <p>no forestry operations within 50 metres of a snake hibernaculum;</p> <p>use single tree selection if harvesting is done in a stand with a known hibernaculum;</p> <p>no forestry operations within 1 km of a heronry during the nesting season (Mar. 1-Aug. 31);</p> <p>do not remove trees within a heronry;</p> <p>protect a buffer of 150 metres around a heronry.</p>
supercanopy trees	retain at least 1 (with dbh of over 50 cm) per 4 hectares
conifers	<p>retain at least 10 per hectare if possible, as large as possible, in clumps if possible;</p> <p>retain 10-30% of deer yard area in conifers;</p> <p>when planting, include conifers appropriate to the ecosystem</p>
snags	<p>retain 5 snags per hectare (1 larger, 4 smaller than 50 cm dbh);</p> <p>leave unmerchantable trees standing in the forest</p>
cavity trees	<p>retain at least 6 cavity trees over 25 cm dbh per hectare and 1 cavity tree per hectare over 40 cm dbh;</p> <p>leave unmerchantable trees standing in the forest</p>
wetlands	<p>do not cut within 10 metres of water;</p> <p>maintain a 300-metre buffer zone of amphibian habitat;</p>

	keep equipment above the high water mark of wetlands; avoid locating roads or landings near or across water; maintain 70% canopy closure over wetlands, creeks, springs
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REFERENCES

1. Bakowsky, W.D. 1996. Natural Heritage Resources of Ontario: Vegetation Communities of Southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. Peterborough.
2. Bellhouse, T. & B. Naylor. 1996. The Ecological Function of Down Woody Debris in the Forests of Central Ontario. Technical Report No. 43 (revised). Ontario Ministry of Natural Resources. North Bay.

3. Bouvier, J. & L.-A. Howes. 1999. Eastern Ontario Matrices Linking Wildlife to Habitat: a Biodiversity Management Tool. Information Report No. 47. Eastern Ontario Model Forest. Kemptville.
4. Brodo, I.M., S.D. Sharnoff, & S. Sharnoff. 2001. Lichens of North America. Yale University Press. New Haven.
5. Cadman, M.D., P.F.J. Eagles, & F.M. Helleiner. 1987. Atlas of the Breeding Birds of Ontario. Federation of Ontario Naturalists. Toronto.
6. Canadian Forest Service. 1997. Biodiversity in the Forest. The CFS Three-year Action Plan Implementing the Canadian Biodiversity Strategy. Natural Resources Canada. Ottawa.
7. Dobbyn, J. 1994. Atlas of the Mammals of Ontario. Federation of Ontario Naturalists. Toronto.
8. Elliott, B. & B. Shiels. 1994. The Application of Geographic Information Systems for the Interpretation of Historical Land Surveys. Information Report No. 8. Eastern Ontario Model Forest. Kemptville.
9. Farrar, J.L. 1995. Trees in Canada. Canadian Forest Service. Ottawa.
10. Great Lakes - St. Lawrence Regional Forest Stewardship Council, Initiative Steering Committee. 2000. Standards for Well Managed Forests in the Central & Southern Great Lakes - St. Lawrence Forests of Ontario. The Wildlands League. Toronto.
11. Havinga, D. 2000. Sustaining Biodiversity. A Strategic Plan for Managing Invasive Plants in Southern Ontario. Ontario Invasive Plants Working Group. City of Toronto.
12. Hilts, S. & P. Mitchell. 1994. Caring for your Land. University of Guelph. Guelph.
13. Johnson, L. & P. Heaven. 1999. The Eastern Ontario Model Forest's 1998-1999 State of the Forest Report. Information Report No. 42. Eastern Ontario Model Forest. Kemptville.
14. Keddy, C. 1994. Forest History of Eastern Ontario. Information Report No. 1. Eastern Ontario Model Forest. Kemptville.
15. Keddy, C. 1994. Forest Structure in Eastern North America. Information Report No. 9. Eastern Ontario Model Forest. Kemptville.
16. Keddy, Dr. P. & C. Drummond. 1995. Ecological Properties for the Evaluation of Eastern Ontario Forest Ecosystems. Information Report No. 13. Eastern Ontario Model Forest. Kemptville.
17. Lompart, C., J. Riley, & J. Fieldhouse. 1997. Woodlands for Nature. Federation of Ontario

Naturalists. Toronto.

18. McLaren, M.A. (ed). 1998. Selection of Wildlife Species as Indicators of Forest Sustainability in Ontario. SCSS Technical Report #100. Ontario Ministry of Natural Resources. North Bay.

19. Minnesota Forest Resources Council. 1999. Sustaining Minnesota Forest Resources: Voluntary Site-level Forest Management Guidelines. Minnesota Forest Resources Council. St. Paul, Minnesota.

20. Oldham, M.J., W.D. Bakowsky, & D.A. Sutherland. 1995. Floristic Quality Assessment System for Southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. Peterborough.

21. OMNR. 1999. Natural Heritage Reference Manual. Ontario Ministry of Natural Resources. Toronto.

22. OMNR. 2000. A Silvicultural Guide to Managing Southern Ontario Forests. Ontario Ministry of Natural Resources. Peterborough.

23. Schueler, F.W. & A. Karstad. 1998. Landscape - Ten Documents Relevant to Planning Sustainable Human Occupancy of the Township Municipality of North Grenville. Canadian Biodiversity Institute. Ottawa.

24. The Nature Conservancy of Canada & The Nature Conservancy. A Report on the Great Lakes Biodiversity Data System.

25. LRC. Do You Have a Healthy Woodlot? Extension Note #LRC 30. LandOwner Resource Centre. Manotick.

26. LRC. 1996. The Old-Growth Forests of Southern Ontario. Extension Note #LRC 26. LandOwner Resource Centre. Manotick.

27. LRC. 1996. Restoring Old-Growth Features to Managed Forests in Southern Ontario. Extension Note #LRC 27. LandOwner Resource Centre. Manotick.

28. LRC. Management Options for Abandoned Farm Fields. Extension Note #LRC 65. LandOwner Resource Centre. Manotick.

29. LRC. 1996. Managing Regeneration in Conifer Plantations to Restore a Mixed Hardwood Forest. Extension Note #LRC 25. LandOwner Resource Centre. Manotick.

30. LRC. Conserving the Forest Interior: A Threatened Wildlife Habitat. Extension Note #LRC 70. LandOwner Resource Centre. Manotick.
31. LRC. 1995. Cavity Trees are Refuges for Wildlife. Extension Note #LRC 8. LandOwner Resource Centre. Manotick.
32. Semlitsch, R.D. & J.R. Bodie. 2003. Biological Criteria for Buffer Zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5):1219-1228.
33. Von Mirbach, M. & L. Johnson. 1998. Local Level Indicators for the Eastern Ontario Model Forest. Information Report No. 43. Eastern Ontario Model Forest. Kemptville.
34. Canadian Wildlife Service website: www.sis.ec.gc.ca
35. Royal Ontario Museum website: www.rom.on.ca/ontario/risk.html

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IB: Irwin Brodo, Lichenologist, Ottawa

LL: Linda Ley, Botanist, Ottawa

SH: Stew Hamill, Wildlife Biologist, consultant, Merrickville

Observer Network Participants, Location, and Physiography

Paul and Vivian Catling	Metcalfe	clay plain
Marianna Van Cruyningan	Kinburn	Carp Ridge shield
Stew and Mary-Lou Hamill & family	Wolford	limestone plain
Ted and Linda Mosquin	Lanark	shield
Dan and Dale Odorizzi	Perth	shield edge
Jim and Carol Poushinsky & family	Edwards	Metcalfe rock outcrop
Doug Thompson and Linda Christianson & family	Richmond	clay plain

Potential Demonstration Sites

Limerick Forest

Kemptonville College Forest

Ferguson Forest Centre

Irish Lake Conservation Club

NCC Greenbelt

Domtar Forest