

THE OBSERVER NETWORK
PROCEDURES AND MONITORING MANUAL

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INTRODUCTION

The Observer Network is a group of woodland owners who participate in a biodiversity monitoring network. The network has three main goals:

1. To help woodland owners become more aware of biodiversity on their land;
2. To help woodland owners maintain and restore native biodiversity by providing a tool to assist in
 - choosing management programs and activities,
 - assessing the success of activities regarding biodiversity targets, and
 - monitoring changes in biodiversity in their woodlands;
3. To provide a means of monitoring native woodland biodiversity across Eastern Ontario.

The Observer Network is based on the principle that indicators can be used to monitor environmental conditions. In this project, wildlife species and habitat parameters have been chosen as indicators of native woodland biodiversity in Eastern Ontario. A variety of species have been identified which by their presence and numbers provide confirmation that certain conditions exist. Habitat indicators, on the other hand, are actual measurements or estimates of the number or amount of features or habitat units present in a woodlot.

Most of the indicators chosen are usable for all forest cover types. However, open oak woodlands, cedar stands, plantations, and swamp forests may score low for some indicators (such as forest interior birds and spring ephemeral wildflowers).

To participate, the landowner carries out the activities specified in the management plan and completes a monitoring record every year. As biodiversity goals are met, the number of positive indicators should increase, and the number of negative indicators decrease.

Detailed information on the Observer Network is contained in the document “Biodiversity Indicators for Woodland Owners” prepared by S. Hamill in 2001. This document and more information on the project are available from:

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Web: www.eomf.on.ca

This “Procedures and Monitoring Manual” was produced as a guide to the project. It is based on the same principles used in the Managed Forest Tax Incentive Program. For more information and details, consult “A Guide to The Managed Forest Tax Incentive Program (MFTIP)”. Landowners who already participate in MFTIP can easily convert much of the information contained in their MFTIP management plan to a Biodiversity Monitoring Plan for the Observer Network.

PARTICIPATION

Any person who wishes to monitor a woodland property in Eastern Ontario may participate in the Observer Network. The requirements are as follows:

- sign up with the Eastern Ontario Model Forest (see contact information above);
- prepare or have prepared a biodiversity monitoring plan for the woodland;
- monitor the indicators as described in this manual;
- report findings to EOMF.

HOW TO PREPARE A BIODIVERSITY MONITORING PLAN

The sections of the Biodiversity Monitoring Plan correspond to those of a MFTIP management plan. Complete each of the following sections as described in the MFTIP Guide.

Observer: name(s), address, telephone, e-mail

Plan author: name, address, telephone, e-mail

Location and identification of property: county, township, lot, concession, roll number, total area

General description of property history: Briefly describe past activities relating to the woodland.

Importance of property to surrounding landscape: Describe any features of the woodland that may have an affect on or be affected by surrounding areas.

Management objectives and priority: List your objectives for the entire property.

Explanation of objectives: Explain the objectives listed above.

Strategy for plan implementation: Describe how will the activities of this plan be carried out.

Monitoring map: This is a map of the property which corresponds to the Managed Forest Compartment Map in a MFTIP plan. To prepare this map you must divide your property into compartments, based on forest cover type. Each compartment has a different history and composition and may be suited to a different type of management. Give each compartment a number and name, and measure its area. Identify monitoring stations on this map.

Compartment descriptions: For each compartment, record the following information:

- compartment number, name, and area.
- forest cover type. The Ministry of Natural Resources has identified seven main forest cover types in Southern Ontario. These are:
 - *Upland tolerant hardwoods*
 - *Upland oaks*
 - *Lowland hardwoods & swamps*

- *Early successional hardwoods*
- *Pines*
- *Cedar*
- *Hemlock*

More information is available in “A Silvicultural Guide to Managing Southern Ontario Forests”, OMNR, 2000.

- general description. Briefly describe the appearance of the compartment.
- tree inventory, giving species, % composition, diameter at breast height (dbh), and indicate whether it is one of the identified uncommon species.
- average tree height, age, and basal area.
- other vegetation, giving species and whether it is an indicator species.
- wildlife habitat inventory, indicating the presence of snags, cavity trees, stick nests, downed woody debris, mast trees, supercanopy trees, conifer thickets, surface water, and dens or dug holes.
- long term (20 year) compartment management objectives.
- wildlife inventory. List species by compartment or by group of compartments.

HOW TO MEASURE TREE DBH, HEIGHT, AGE, BASAL AREA, & WOODLOT AREA

Measuring Diameter at Breast Height (dbh)

Tree diameters are measured at 1.3 metres up from the base of the tree. This is the dbh. The most simple and accurate way to measure dbh is with a diameter tape. Just wrap the tape around the tree and read the diameter. Other methods include:

- Measure the circumference with an ordinary tape measure and divide by 3.14.
- Use tree calipers which measure the diameter directly from the tree.

Measuring Tree Height

Tree height can be approximated by using a height pole or person of known height, and estimating the total height of the tree.

Advanced method: Use a hypsometer as follows.

- *Make sure the observer is at least as far from the tree as it is tall.*
- *Decide on an appropriate distance scale.*
- *Measure the horizontal distance to the tree and plant a pole at that point.*
- *Rest the hypsometer on top of the pole and read the upper and lower sightings. Take the average of two or three readings.*

Measuring Tree Age

If trees have been cut recently in the woodlot, count the annual rings on several stumps to obtain a relationship between diameter and age. Remember to add three to ten years to account for the years it took the tree to grow to the stump height. Use this relationship to estimate the ages of other trees.

Advanced method: Use an increment borer to take a core sample of a representative tree's growth rings. Take the core at stump or breast height, and add the number of rings it took the tree to grow to the height of the core.

Measuring Basal Area

Advanced methods:

1. Fixed area plot cruise

Using data from a number of sample plots in the woodlot, generate the number of trees per hectare and the average dbh for the stand. Calculate the average basal area per hectare using the following formula: (trees per hectare) \times (average dbh)² \times (0.00007854).

2. Prism cruise

The prism is a thin wedge of glass which bends light rays to create a split image of a tree. A tree for which the image is completely offset is out and is not counted. A tree for which the image overlaps is counted in. A tree for which the two images just touch is counted as a half. The wedge used in Ontario is called a factor-two. After counting the number of trees in the prism plot, multiply by 2.

To create a prism plot, choose a random spot in the stand far enough from the boundary to eliminate edge effects. View all trees through the prism at breast height on the tree in a 360⁰ sweep, with the prism held directly over the chosen point. Rotate your body around the spot, rather than standing and spinning. Count all trees that are "in". Trees which are obscured can be viewed by temporarily moving a sufficient distance at a right angle to the direction of sighting. Trees less than 10 cm dbh and dead trees are usually excluded.

Basal area per hectare is the number of trees counted in the sweep multiplied by 2. Normally, at least three sweeps in different random locations within the stand would be done, and the results averaged to give a final basal area.

Measuring Woodlot Area

Area can be calculated or estimated from a map or aerial photo if the scale is known.

Advanced method:

Dot grid

A dot grid is a set of dots on a sheet of transparent material which is superimposed over an aerial photo or map of known scale. The grid gives a conversion factor for number of dots per area for various map or photo scales. To measure area, place the grid over the map or photo, count all of the dots which are contained within the area to be measured, and multiply by the conversion factor on the grid to compute the total area. If dots fall on a boundary, count alternate dots.

HOW TO RECORD MONITORING DATA

Biodiversity Monitoring Record: This is a record of the indicator species and habitat features found on the property, with space for inserting data each subsequent year. This is the monitoring form which provides a record of changes in the indicators from year to year. For each indicator species noted, record the species name, number of individuals, compartment location, and date. See the Appendix for an example of a Biodiversity Monitoring Record form.

HOW TO SUBMIT MONITORING DATA

to be determined

HOW TO MONITOR SPECIES INDICATORS

1. Amphibians

Chorus Frog

Chorus Frogs breed in shallow wetlands where there are few or no fish predators. Such areas are vulnerable to pollution by pesticides, and to drainage and filling operations. Male Chorus Frogs begin calling as soon as the ice melts in the spring (as early as March) and continue through May. They call both night and day, but are most consistently heard in the evening after dark. A monitoring station should be established near a potential wetland for annual monitoring. Listen for calls at the station for 3 minutes on a spring evening and record presence or absence. Several visits would be necessary to confirm absence; only one visit and record is necessary to confirm presence. Record the level of calling, and the number of males calling, by the number or an estimate (Level 1: individuals can be counted, calls not overlapping; Level 2: Calls overlap, individuals can be counted or estimated; Level 3: full chorus, calls continuous and overlapping, individuals not distinguishable).

Example for Level 1 calling: record Level 1 and the number of frogs calling;

for Level 2 calling: record Level 2 and the number or an estimate of the frogs calling;

for Level 3 calling: record Level 3.

Leopard Frog

Leopard Frogs undertake major annual migrations, which is why they are indicators of good connections. As cold weather approaches they migrate to deep waters where they spend the winter on the bottom. In early spring they move to shallower water for breeding, sometimes moving up to a kilometre from the hibernation site. After breeding they disperse away from water into meadows. Males call from wetlands from April to early May. The same monitoring station could be used for both Chorus Frogs and Leopard Frogs and both species may be heard at the same time. Record the number calling during a 3-minute period as described above. Leopard Frogs should also be noted in any grassy area throughout the summer.

Bull Frog

Bull Frogs live only in permanent waters, as their tadpoles require two or even three summers to develop into adults. Males call both night and day, but most consistently on warm nights in the

late evening. Calling begins in late June and extends into July. A monitoring station should be established near a permanent water body for annual monitoring, and calling recorded during a 3-minute period as described above.

Salamanders

Terrestrial salamanders live in woodlands where they take refuge under leaf litter, rotting logs, boards, rocks, and other objects. At least three stations representative of the forest and its various components should be established, each one at least 50 metres from the forest edge. At each of these place a board on the ground in a shady spot. The board should be rough cut, 30 cm by 30 cm, and at least 2.5 cm thick. Place the board flat on the ground on top of a layer of wet leaf litter. As summer is usually too dry for salamander activity, check the boards once in the spring and once in the fall every year. At those times, turn over the board to look for salamanders. Record the species, date, location, and number. Also record if none were found.

2. Reptiles

Snakes

Snake hibernacula are located in dry rocky areas where cracks or holes in the rocks allow access underground for snakes. Such areas should be observed on warm spring days when snakes are emerging and on warm fall days when they are congregating. Record a count or an estimate of the number of snakes seen, the species, the date, and the location.

3. Mammals

Flying Squirrels

Flying squirrels live in holes in trees and are nocturnal. As such, they are rarely seen. They occasionally visit bird feeders and can sometimes be startled into the open by knocking on potential den trees with a stick. Another monitoring method is to watch a den tree at dusk. Record a count or estimate of the number living in the woodlot.

Fisher

Fisher inhabit wooded areas and are occasionally seen during the day. They have long hunting circuits and large home ranges, making them good indicators of connections. They seem to follow established routes on their travels; if you see one, note the location for future monitoring. The best method to check for Fisher presence is to watch for tracks during the winter. Record an estimate of the number of tracks. Because Fisher are known to prey on porcupines, also note the population level of porcupines in your area each year. This may also provide an indication of Fisher activity.

Snowshoe Hare

Hares live in a variety of wooded habitats with closed canopies. Monitoring can be done either by observations made while walking through woodlands (particularly in late fall if the hares turn white before the snow falls), or by watching for tracks in the winter. As the number of hares varies in a rising and falling cycle, record an estimate of the number of animals each year. Also watch for evidence of Hare feeding; in the spring, observe and record an estimate of the number of young hardwood trees which have had bark chewed off during the winter.

4. Birds

Songbirds

Male songbirds call to defend a territory and to attract a mate. The best way to monitor these species is to listen in the morning (between 05:00 and 10:00) during the “dawn chorus” and identify species by ear. At least three stations should be established at locations representative of the woodland. These should be at least 100 metres from the forest edge and at least 100 metres from each other. Once or twice, between May 24 and July 10 each year, spend ten minutes at each station listening for the indicator species. These stations could be the same as those for salamanders. Refer to the list of indicator species, and record the species, date, location, and an estimate of the number of individuals of each species heard calling.

Pileated Woodpecker

Pileated Woodpeckers can be monitored by call the same as songbirds. Their presence can also be recorded by noting large rectangular holes pecked in trees, and piles of large chips on the ground beneath such trees.

Barred Owl

This owl’s distinctive call can be heard at night during the summer in its breeding areas. Listen late at night, possibly even at 01:00 or 02:00 in the morning.

Stick Nests

The stick nests of Red-shouldered Hawks and other raptors should be recorded whenever seen. Activity at such nests can be monitored and recorded during the breeding season by observations at the nest site. Red-shouldered Hawks may not use the same nest every year, but may return in a future year to an existing nest.

5. Plants

Trees

If not already available, a tree inventory of the property should be completed to determine if any rare or uncommon species are present. This inventory should identify the location of significant trees or species and can be added to if and whenever a new species is found. Record an estimate of the number of each uncommon species (<20, 20-100, >100). Check any rare and uncommon species every year to monitor health and change in numbers.

Advanced method: Canopy trees (those at least 10 cm dbh) are monitored using a minimum of five 20m x 20m quadrats, randomly located with at least one quadrat per compartment. Quadrats should be at least 50 m apart, and at least 3 times the canopy height from the forest edge, avoiding roads and trails. To lay out a 20m x 20m square, randomly choose a centre point in typical vegetation. Measure 14.14 metres diagonally to each corner. Mark the corners with permanent stakes and label the quadrat on one of the stakes.

Survey in fall or early spring every five years. Record:

- *species*
- *dbh*
- *total height*
- *height to the lowest branch*
- *condition*
- *number of all living and standing trees.*

Condition is recorded as one of the following:

- *standing alive (AS)*
- *broken alive (AB)*
- *leaning alive (AL)*
- *fallen alive (AF)*
- *standing alive dead top (AD)*
- *standing dead (DS)*
- *broken dead (DB)*
- *leaning dead (DL)*
- *fallen dead (DF).*

Do not record any fallen dead trees on the initial measurement.

Wildflowers

During forest outings and while monitoring other species, watch for spring ephemerals in early spring before and just as the tree leaves are expanding. Refer to the list of indicator species and record species, number, date, and location.

Advanced method: Ground vegetation is monitored by means of 1m x 1m quadrats. A minimum of 20 quadrats is required, at least 5m apart. These may be stand-alones, or nested within 20m x 20m or 5m x 5m quadrats. If nested, they must not be disturbed during activities related to those plots. If nested, they should be along the sides, not on the corners, to reduce the possibility of trampling. Stand-alones can be randomly placed along random parallel lines. Alternatively, randomly select points, random distances out on a compass star centred on a randomly selected base stake.

Use a 1m x 1m frame to delineate the quadrat area and to set corner stakes. Record every 5 years the name and number of each herbaceous species. During the first 2-3 years, visit several times to ensure that all species are identified. Record dates for future use. Visit during late spring, mid-summer, and fall. After 2-3 years, two visits per year every five years would be sufficient.

Lichens and Mosses

During forest outings and while monitoring other species, note whether and where there are any thick mats of mosses, particularly on fallen logs, or large patches of ground lichens. Record the location and an indication of the abundance, size of patch, or diversity of species.

Advanced method: Follow the instructions for 1m x 1m quadrats given under “Wildflowers”.

Tree Lichens

Advanced method: Choose a site with 5 large (>30 cm dbh) maple trees in the interior of the forest, and a second site with 5 large maple trees on the forest edge. Tag each tree, and record species, tree number, and dbh. A suite of 17 lichen species has been chosen for monitoring based on sensitivity to air quality and ease of identification. Monitoring should be done annually in any season, the same time every year, as follows:

- Tie flagging tape around the tree at 1.0 metre and at 1.3 metres from ground level. Lichens within this 30 cm space will be recorded.
- Divide the tree vertically into north and south halves by placing nails at the 1 metre mark on the east and west sides of the tree.
- Identify all lichens on the north side of the tree. Record the percentage of space each species occupies.
- Repeat for the south side of the tree.
- Record if no lichens are observed.

Invasive Plants

Invasive species should be noted whenever and wherever found. They should then be marked or targeted for control or eradication programs, or monitored for expansion or contraction. Monitoring of invasives can be used to document occurrence, abundance, expansion, biology, or impact on native plants.

Advanced methods:

1. Quadrat

The standard method for monitoring invasive plants is by using a quadrat. For invasive trees, the 20m x 20m square quadrat described above under “Trees” is recommended. For invasive herbaceous plants the 1m x 1m quadrat described above under “Wildflowers” would be used. For invasive shrubs such as buckthorn, the standard quadrat is a 5m x 5m square. A minimum of 10 is needed, at least 2 per compartment, separated by at least 15 metres. These may be randomly distributed stand-alones, or randomly selected corners of the 20m x 20m quadrat.

To lay out a 5m x 5m quadrat, measure 3.54 metres from the centrepoint diagonally to each corner. Permanently mark the corners and label the quadrat. During data collection it helps to outline the quadrat with string strung around the corner stakes. Survey in the fall after leaves have fallen, every five years. A shrub is defined as any woody specimen less than 10 cm dbh which is at least 1 metre tall. Record:

for all shrubs ≥ 4 cm dbh

- species, number, and dbh
- condition (same as that given for trees above)
- height and height to lowest living branch

for all species < 4 cm dbh and ≥ 1 metre tall

- species and number.

2. Route

Establish a route, which could be a trail or the perimeter of the woodlot. The length is at the discretion of the observer. Monitor annually at the height of the growing season, as follows:

- Begin the route, looking for invasives within 10 metres of the trail. Do not step away from the trail.
- Assign each invasive plant a discrete number (e.g., 02 for the year 2002, 001 for the first plant).
- Record the location of each plant with GPS.
- Record information on species, habitat, condition, presence of seedlings, and the number of plants within 10 metres of the route at each location.
- Continue to the end of the route.

HOW TO MONITOR HABITAT INDICATORS

1. Old Growth

During the woodlot inventory, note the presence and location of any large (>50 cm dbh) or old (>120 years) trees. These trees indicate old growth. Estimate the area of old growth present to determine whether the 10 hectare or 30% minimum has been met.

Advanced method: Using data from the 20m x 20m quadrats described under “Trees”, identify those sections of the woodlot which would qualify as old growth. Measure the area of each, using the procedure described under “Measuring Woodlot Area”. Record the total area of old growth on the “Biodiversity Monitoring Record” form.

2. Forest Interior Size

Using an aerial photo of the property, estimate or measure (See “Measuring Woodlot Area” above.) the area of the woodlot which is more than 100 metres from any edge of the stand.

3. Size or Connections

Using an aerial photo of the property, estimate or measure (See “Measuring Woodlot Area” above.) the total area of the contiguous wooded area, including that owned by others. From the photo, identify connections (ravines, watercourses, wooded fencerows) to other woodlands. If there are none or not enough, identify areas where connections could be created or improved.

4. Downed Woody Debris

During the woodlot inventory, note the presence and abundance of large (>40 cm dbh) fallen logs. Using the total area of the woodlot, estimate the number per hectare.

Advanced method: Create transects by extending the west, north, and east edges of the 20m x 20m forest plot until each transect reaches 45.15 m. Identify each as line 1, 2, or 3. Record the following information for each piece of downed woody debris that intersects a transect and has a diameter of at least 7.5 cm at the point of intersection.

- line number and distance to point of intersection.
- diameter at point of intersection.

- *species, if known (if not, enter "0").*
 - *type of debris (log or stump).*
 - *log decomposition class* - Class 1: texture intact, log elevated on support points
 - Class 2: texture intact to soft, log sagging slightly
 - Class 3: texture hard, large pieces, log sagging
 - Class 4: texture small soft pieces, log on ground
 - Class 5: texture soft & powdery, log on ground
 - *evidence of: burned, hollow, wildlife presence.*
- Monitor downed woody debris annually at the same time of year.*

5. Closed Canopy

From at least 10 random points in the woodlot (at least two points representative of each compartment), look straight up at the canopy. Estimate the percentage of sky which is not visible due to the canopy.

Advanced method: Use a dot grid and an aerial photograph to estimate canopy closure. Count the number of dots which fall on tree crowns compared to the total number of dots in the area sampled. Tree canopy cover can then be calculated from the following formula:

% canopy closure = 100 x (dots falling on tree canopy / total number of dots within sampled area).

6. Supercanopy Trees, Conifers (in non-conifer compartments), Snags, Mast Trees, Cavity Trees

During the woodlot inventory, note the presence and abundance of these trees. Using the total area of the woodlot, estimate the existing number of each of these per hectare.

Advanced method: Using data from the 20m x 20m quadrats described under "Trees", calculate the number of each of these trees per hectare.

HOW TO DO A HABITAT ASSESSMENT

On the "Habitat Assessment" page of the "Biodiversity Monitoring Record" record the measurements, calculations, or estimates for each feature. Based on the standards or minimums given, rate each feature as to adequate or inadequate and the year this was completed. Repeat annually, but only record if there is a change and note the year of the change.

HOW TO PREPARE BIODIVERSITY MANAGEMENT STRATEGIES

Based on the "inadequate" ratings given in the "Habitat Assessment", investigate and determine the management activities or changes needed to convert each "inadequate" to an "adequate". Write these as strategies and insert them into your management plan.

REFERENCES

- Bonin, J. and Y.Bachand. 1997. The use of artificial covers to survey terrestrial salamanders in Quebec. In D.M. Green, ed. *Amphibians in Decline: Canadian Studies of a Global Problem*.
- Biodiversity Science Board of Canada. *Monitoring Biodiversity Change: Protocols to measure species diversity (mini-cd)*. Ecological Monitoring and Assessment Network Coordinating Office. Burlington.
- Haber, E. 1997. *Guide to Monitoring Exotic and Invasive Plants*. Ecological Monitoring and Assessment Network Coordinating Office. Burlington.
- Hayden, J., E.Boysen, M.Woods, and J.Rice. 1998. *Making Cents out of Forest Inventories: A Guide for Small Woodlot Owners*. Ontario Woodlot Association. Kemptville.
- Lichen Abundance and Diversity. EMAN protocol. Ecological Monitoring and Assessment Network Coordinating Office. Burlington.
- Ontario Ministry of Natural Resources. 2000. *A Guide to the Managed Forest Tax Incentive Program (MFTIP)*. Ontario Woodlot Association, Kemptville or Ontario Forestry Association, Toronto.
- Ontario Ministry of Natural Resources. 2000. *A Silvicultural Guide to Managing Southern Ontario Forests*. OMNR. Peterborough.
- Promoting a Healthy Forest Through Tree Marking. 2003. Extension Note. LandOwner Resource Centre, Manotick.
- Roberts-Pichette, P. and L.Gillespie. 1999. *Terrestrial Vegetation Biodiversity Monitoring Protocols*. EMAN Occasional Paper Series Report No. 9. Ecological Monitoring and Assessment Network Coordinating Office. Burlington.
- Williams, J. 1997. *A True Picture - Taking Inventory of Your Woodlot*. Eastern Ontario Model Forest. Kemptville.
- Zorn, P. and V.Blazeski. 2002. *Joint EMAN - Parks Canada National Monitoring Protocol for Terrestrial Salamanders*. Parks Canada. Ottawa.

IDENTIFICATION GUIDES AND REFERENCE BOOKS

A Field Guide to Reptiles & Amphibians: R.Conant, 1958, Houghton Mifflin Co., Boston.

Amphibians and Reptiles of the Great Lakes Region: J.H.Harding, 1997, University of Michigan Press, Ann Arbor.

A Field Guide to the Mammals: W.H.Burt & R.P.Grossenheider, 1964, Houghton Mifflin Co., Boston.

Atlas of the Mammals of Ontario: J.Dobbyn, 1994, Federation of Ontario Naturalists, Don Mills.

A Field Guide to the Birds East of the Rockies, 5th Edition: R.T.Peterson, 1980, Houghton Mifflin Co., Boston.

National Geographic Field Guide to North American Birds, 3rd edition: National Geographic Society, Washington.

Atlas of the Breeding Birds of Ontario: M.D.Cadman, P.F.J.Eagles, F.M.Helleiner, 1987, Federation of Ontario Naturalists, Don Mills.

More Birding By Ear Eastern / Central: R.K.Walton & R.W.Lawson, 1994, Houghton Mifflin Co., Boston.

A Field Guide to Wildflowers of Northeastern and North-central North America: R.T.Peterson & M.McKenny, 1968, Houghton Mifflin Co., Boston.

Newcomb's Wildflower Guide: L.Newcomb, 1977, Little Brown & Co., Toronto.

Trees in Canada: J.L.Farrar, 1995, Fitzhenry & Whiteside Ltd., Markham.

Criterion	Indicator	previous years			2001			2002
		#	location	year	#	location	date	
forest interior & closed canopy	Hairy Woodpecker	1 pair	W3	2000				
	White-breasted Nuthatch	1 pair	various	2000				
	Brown Creeper	1	W3	1999				
	Winter Wren							
	Black-throated Green Warbler	1	W3	2000				
	Ovenbird	several	W1, P1	2000				
forest interior, size, & closed canopy	Red-shouldered Hawk							
closed canopy	Yellow-bellied Sapsucker	1	W1	2000				
	Least Flycatcher	1	W3	1998				
	Wood Thrush	few	W1, P1	2000				
	Red-eyed Vireo	few	W1, P1	2000				
	Snowshoe Hare	many	all	2000				
	Northern Flying Squirrel	present	W1	1980				
canopy species / closed canopy	Scarlet Tanager	1	C1	1998				

protection from disturbance	stick nest							
	snake hibernaculum	present	W1	2000				
	Red-shouldered Hawk							
good undergrowth spring ephemerals	Foamflower							
	Solomon's-seal	few	P1	2000				
	Blue Cohosh							
	White Trillium	few	W1, P1	2000				
	Bloodroot							
	Dutchman's-breeches							
	Wild Leek	few	W3	2000				
	Wild Lily-of-the-valley	few	W1	2000				
recovery from clearing	Buckthorn	many	all	2000				
invasive species	Buckthorn	many	all	2000				
uncommon trees	Bitternut Hickory	few	W1, W3	2000				
	Butternut	few	W1, W3	2000				
	Bur Oak	few	W1, W3	2000				
temporary pools	Chorus Frog	many	W3	2000				

little: < 10 % ground covered

some: 11-30 %

ample: 31-60 %

heavy: > 60%

Habitat Assessment

habitat indicator	2001	year of noted change
woodlot size (contiguous forest) (minimum 40 ha)	okay (34 ha owned, more adjacent)	
forest interior size (minimum 4 ha)	okay (4 ha)	
old growth = age 120, or trees > 50 cm dbh (minimum 10 ha or 30% of stand)	inadequate present only in W1	
down woody debris (5 large logs/ha)	inadequate	
canopy closure (minimum 70%)	adequate where canopy present	
supercanopy trees (1 per 4 ha)	okay	
conifers (10/ha)	okay	
cavity trees (7/ha)	inadequate	
snags (5/ha)	okay	
mast trees (8/ha)	inadequate	

Biodiversity Management Strategies

1. Allow natural growth and regeneration to create more closed canopy, more interior forest, more trees suitable for cavities, more mast trees, more down woody debris, and, over the longterm, more old growth. This will create more habitat for bird indicators.
2. When cutting, do not open the canopy below 70% and do not remove down woody debris for firewood. This should create more habitat for salamanders. Continue to protect uncommon trees.
3. Continue plantation management to promote hardwood growth. This should allow more mast trees to grow and provide more habitat for spring ephemerals.