GUIDELINES FOR PROVIDING FURBEARER HABITAT IN TIMBER MANAGEMENT

ONTARIO MINISTRY OF NATURAL RESOURCES

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Summary of Guidelines For Providing Furbearer Habitat In Timber Management

These Habitat Management Guidelines are one of a series of such Guidelines that has been prepared to assist government and industry foresters and biologists develop appropriate forest management prescriptions. These prescriptions should allow for optimal timber harvest while maintaining or improving other related resource values such as fish and wildlife habitat or tourism.

It is recognized that not all wildlife species can be managed to maximum levels on the same land area. However, the legitimate concerns for other species will often be accommodated to a large degree within the prescription for the key species. Ministry of Natural Resources managers must make local decisions about which species is of primary importance in their circumstances. Then, these and the other Habitat Management Guidelines can be used to help formulate forest operating plans.

These particular Guidelines were developed using current knowledge about the habitat requirements of Ontario's major wetland associated and forest associated furbearers. They are meant to provide a broad consistent approach to protecting these furbearers throughout their range. In some circumstances the specific requirements of various species have not been thoroughly studied and an extrapolation of known information was necessary to create a particular guideline.

Because of the many local factors affecting requirements for protection, it is not possible to specify guidelines that will be adequate in every case. Local managers should therefore use their judgement in adapting the guidelines to the needs of site-specific situations. However, any alteration of the guidelines should be consistent with the objective of protecting furbearer habitat.

Further rationale for the Guidelines and additional useful information can be found within the Background Document.

Areas of Concern for furbearers are those habitat features that correspond with the important life processes of an animal - namely habitat for reproduction, feeding and the avoidance of predators.

Wetland Associated Furbearers

1.0 Avoid wetland drainage, channelization, and any other activities that modify water regimes and affect habitat diversity.

2.0 Forests bordering shorelines and wetlands (riparian areas) constitute Areas of Concern for wetland associated furbearers. These areas may be delineated in accordance with the following table:

Slope%	Slope Angle (^{o})	Width of Area of Concern
0 - 30	0 - 17	50 metres
31 - 45	18 - 24	70 metres
46 - 60	25 - 31	90 metres

The widths specified apply to each side of a stream or as measured from the high water mark for other water bodies.

3.0 Avoid constructing roads within areas of concern. Where road building is necessary, as in the case of stream crossings, erosion and flooding effects should be minimized.

4.0 Avoid constructing log landings within areas of concern. Where log landings are necessary, erosion should be minimized.

5.0 Timber harvesting within wetland Areas of Concern should be restricted as to the method and size of cut needed to create or maintain a diverse pattern of vegetation. A 50%, or less, removal system may be appropriate (also see section 9.0). Cutting should be done to minimize erosion such as by winter cutting and by minimizing damage to stream banks. Possible harvesting options are:

(a) no harvesting;
(b) selection cutting;
(c) shelterwood cutting; and
(d) limited clearcutting in strips or blocks.

Where possible, management practices should favour the retention of snags and woody debris for denning sites.

6.0 Mechanical site preparation should generally be avoided within Areas of Concern unless measures are taken to ensure that erosion is minimized and structural diversity along shorelines is maintained. Downed logs and debris should be left on site to provide denning sites for furbearers. Prescribed burning should be restricted to areas where muskrat habitat management is important.

7.0 Natural regeneration to deciduous species should generally be allowed to occur or be encouraged within areas of concern particularly where beaver management is important.

8.0 Site tending operations in Areas of Concern should maintain a significant amount of deciduous growth.

9.0 Specific management prescriptions for wetland furbearers.

9.1 To enhance beaver habitat, forest openings created by cutting practices should belarge enough to promote early successional growth. Block clearcuts or strip cuts should be at least forty (40)m wide.

9.2 To maintain habitat for mink, otter and their associated prey species, harvesting andsubsequent timber operations should maintain structural diversity, such as snags, woody debris and downed logs within wetlands and along shorelines.

9.3 As safety considerations allow, retain existing and potential snags for raccoon den trees within 200m of wetlands.

Forest Associated Furbearers

1.0 If it is desirable to reduce trapping pressures on furbearer populations, carefully consider access road locations and measures to limit vehicle use. It may be desirable to undertake such measures as winter extraction or scarification of roads after timber operations are complete.

2.0 To maintain forest associated furbearer habitat, timber cutting systems should maintain habitat diversity. Possible harvesting options include:

(a) reserve;
(b) clearcutting;
(c) shelterwood cutting; and
(d) selection cutting.

Clearcutting in strips and blocks and shelter-wood cutting produce areas of early successional vegetation. Potentially large clearcuts should be broken down into smaller cuts. A fifty (50) percent removal system may be appropriate (also see Section 4.0). Patches of older trees should be left within cutovers to maintain vegetative diversity and to provide shelter. As well, leaving residual patches larger than five (5) ha in size may encourage future timber harvest.

As safety concerns allow, retain existing and potential snags (diseased and decadent trees) within cutovers to provide denning sites and cavities.

3.0 The potential impacts that site preparation, regeneration and tending efforts may have on furbearer habitat depends on the proximity and quantity of good habitat, in the form of residual patches and uncut stands, surrounding the harvested area.

3.1 Retain logging debris and slash on approximately ten (10) percent of the cutover area unless the accumulation of slash impedes regeneration success. Alternatively, slash may be accumulated in large piles or windrows. Mechanical site preparation should not destroy residual patches within cutover areas unless the trees seriously interfere with regeneration success.

3.2 Natural or artificial regeneration of a cut area may be used to benefit furbearers depending on the habitat requirements of the species being managed, site vegetation and timber management objectives.

3.3 The use of herbicides that greatly reduce deciduous vegetation for extended periods of time should be carefully evaluated as either a site preparation or tending technique.

4.0 Specific Management Prescriptions for Forest Associated Furbearers

4.1 T o provide fisher and marten habitat, the emphasis should be on protecting blocks of mature forest stands, particularly on sites of varied topographic relief. Selection cutting should maintain thirty (30) to forty (40) percent of the forest canopy. Small east-west oriented strip clearcuts or small shelterwood cuts will encourage the growth of shade-tolerant softwood.

Thinning mature aspen and birch will enhance the growth of coniferous habitat to benefit marten.

4.2 To provide habitat for predatory furbearers, such as lynx, fox and wolf, harvesting operations that open up the forest stand (eg., clearcuts and shelterwood cuts) to create areas of early successional vegetation should be employed. Similarly, as a site preparation technique, prescribed burning can enhance the habitat of prey population to the benefit of their predators.

4.3 To provide denning habitat for raccoons and as safety concerns allow, snags within 200 m of a wetland should be retained.

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Background Document

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1.0 The Furbearer Program in Ontario

The goal of the Ontario Ministry of Natural Resources is stated as follows:

"To provide opportunities for outdoor recreation and resource development for the continuous social and economic benefits of the people of Ontario and to administer, protect and conserve public lands and waters."

Within this framework, Strategic Land Use Plans for Northwestern and Northeastern Ontario and the Coordinated Program Strategy for Southern Ontario indicate in general terms how the Ministry of Natural Resources intends to manage furbearers. Although stated in various ways in the three documents, they contain the objectives of:

i) full utilization of the furbearer resource on a maximum sustained yield basis with resultant social and economic benefits;

ii) maintaining diverse health furbearer populations; and

iii) encouraging efficient and humane trapping practices.

To meet objective (ii) requires protecting and managing furbearer habitat.

Table I summarizes the presently stated targets for furbearer utilization in Ontario.

Table 1 Furbearer Harvest Targets by Planning Area

AREA	SPECIES	CURRENT HARVEST (1981)	TARGET TO YR. 2000	COMMENTS
Northeastern (1) Planning Area	Beaver Fisher Marten Lynx	61,900 350) 16,260) 1,070)	93,000 to maintain current harvest levels	Most important furbearers in economic terms are beaver, coloured fox, lynx, marten, otter, muskrat
	Mink Otter Coloured Fox Red squirrel Muskrat Weasel Wolf	)))) 103,000)))	 to encourage a substantial increase beyond current levels	Value of total furbearer harvest $2.04 million (1981) 4,100 trappers in area Economic benefits are especially significant to trappers in remote areas
Northwestern (2)	Beaver	50,200	102,600 to increase populations and utilization to the capability of the land	Most important furbearers in economic terms are beaver, marten, lynx, otter, fisher Value of total furbearer harvest - $4.4 million (1981) Economic benefits are especially significant to Northern Indian communities
Southern (3) Planning Areas	All furbearers		650,000 pelts	

Sources: (1) M.N.R. 1982. Northeastern Ontario Strategic Land Use Plan 111 pp.
(2) M.N.R. 1982. Northwestern Ontario Strategic Land Use Plan 71 pp.
(3) M.N.R. 1982. Southern Ontario Coordinated Program Strategy 44 pp.

2.0 Habitat Management for Furbearers

Despite the fact that habitat is the ultimate factor in determining the health and size of furbearer populations (Storm and Tzilkowski 1982, as cited in Allen in press), little work has been done to describe the specific habitat requirements of furbearers. Most past work has focussed on the distribution, population dynamics, harvest statistics and behaviour of furbearers (Payne 1980). As a result, the response of furbearers to changing habitat conditions is little known and guidelines describing alternatives to mitigate habitat loss are generally unavailable (Storm and Tzilkowski 1982, as cited in Allen in press).

However, some organized data gathering has occurred and much observational information has been collected. Mink (*Mustela vison*), marten (*Martes americana*), fisher (*Martes pennanti*), beaver (*Castor candensis*) and muskrat (*Ondatra zibethicus*) have been the subjects of comparatively large amounts of habitat related research. In contrast, the habitat requirements of coyotes (*Canis latrans*) in Ontario, weasels (*Mustela spp*), and skunks (*Mephitis mephitis*) have not been intensively investigated. Further study to determine habitat requirements and to develop or refine habitat management guidelines for all furbearers is obviously required.

The breeding and foraging habitat requirements of furbearers vary with the species. The diet, size, reproductive requirements and behavioural peculiarities of furbearers determine their demands on the environment. Denning habitat includes tree cavities, ground burrows, rock crevices, woody debris, man-made structures and river banks. Feeding activity may occur on the ground surface, within understorey vegetation, or in overstorey vegetation. The plant and flesh eating diets of some furbearers, such as the raccoon (*Procyon lotor*), makes them adaptable to a wide variety of habitats. Herbivorous furbearers (e.g., muskrat) require relatively small areas to meet their habitat needs. In contrast, such large carnivores as the wolf (*Canis lupus*) and lynx (*Felis lynx*) require extensive areas of habitat as determined generally by prey distribution and abundance.

It is difficult to generalize the effects of altering individual habitat features because of the diverse habitat requirements of furbearers. It can be stated that irreversible habitat loss by urban development or wetland drainage, or long term habitat alterations, such as the creation of vegetative monocultures, will adversely affect furbearer populations. It is also true that alteration of habitat may cause a decline in the numbers of one species while encouraging large populations of another species. For example, timber harvesting in a mature forest stand may result in a loss of marten habitat. The subsequent early successional growth will, however, result in increased numbers of hare and grouse, which will encourage lynx and fox populations.

This document attempts to summarize what is known about the habitat needs of economically important furbearers (Table 2) that are most likely to be impacted by timber harvesting. As well, within the limitations of available information, forest management measures to protect and enhance furbearer habitat are recommended. It should be noted that management actions to maintain or enhance habitat should imitate natural conditions and meet the basic biological requirements of furbearers. However, in many instances, these requirements are not well defined. Thus, as Allen (in press) notes, furbearer habitat management is not an exact science but is the application of the best available knowledge in an effort to achieve desired results.

The application of management tactics should be preceded by an adequate inventory and followed by an analysis of the effects on furbearers and forest harvesting operations. This analysis should indicate if new measures are required. The Guidelines should be revised accordingly.

3.0 Wetland Associated Furbearers

Wetlands are defined as "lands that are seasonally or permanently covered by shallow waters as well as lands where the water table is close to or at the surface" (Environment Canada and the Ontario Ministry of Natural Resources 1984). Characteristic of wetlands is the presence of hydrophytic or water-tolerant vegetation. For the purpose of these guidelines, the term wetlands will be used, not only to describe typical wetland habitats (marsh, swamp, bog, etc.), but also to describe watercourses (rivers and streams) and water bodies (ponds and lakes).

Wetland associated species include beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), mink (*Mustela vison*), and river otter (*Lutra canadensis*). The raccoon (*Procyon lotor*) is included as both a wetland associated and forest associated furbearer because of its dependency on both types of habitats.

3.1 Habitat Requirements

3.1.1 Beaver

Beaver feed upon the leaves, twigs and bark of woody plants as well as the more preferred aquatic and terrestrial herbaceous vegetation. Woody vegetation, because it is most highly utilized from late fall through early spring, is more limiting on beaver populations than herbaceous vegetation. Across North America, beaver select in order of preference - aspen (*Populus tremuloides*), willow (*Salix spp*.), and balsam poplar (*Populus balsamifera*). Of course, small populations of beaver may be found where these trees are absent (Allen 1982) and they may even feed on coniferous trees.

Alder is an often used construction material and although it can be found weighting down material in feedbeds, its usefulness as a food source is questionable (M. Novak pers. comm.).

Table 2 1983-84 Ontario Fur Harvest*

	Harvest	Average Price	Total Value
Wetland Associated Furbearers			
Beaver	119,080	$22.93	$2,730,504.40
Muskrat	450,634	5.47	2,464,967.98
Raccoon**	72,844	15.56	1,133,452.60
Mink	16,183	32.44	524,976.52
Otter	7,576	58.80	445,468.80
Major Forest Associated Furbearers			
Marten	65,545	$ 53.44	$3,449,284.80
Raccoon**	72,844	15.56	1,133,452.60
Coloured Fox	19,629	55.83	1,095,887.00
Fisher	3,725	160.68	598,533.00
Lynx	1,707	330.90	564,846.30
Timber Wolf	884	58.95	52,111.80
Other Species			
Coyote	2,718	$ 27.85	$75,696.30
Black Bear	132	123.92	16,357.44
Polar Bear	19	450.00	8,550.00
Weasel	3,281	0.99	3,248.19
Bobcat	26	102.50	2,665.00
Arctic Fox	44	57.28	2,520.32
Wolverine	12	171.66	2,059.92
Red Squirrel	3,229	0.36	1,162.44
Skunk	264	3.08	813.12
Opossum	89	5.00	445.00
Grey Fox	11	37.50	412.50
Badger	7	5.00	35.00

* Excludes harvest by hunters. Source. Wildlife Br. OMNR. 1985.

** Raccoon considered both as a wetland associated and as a forest associated furbearer.

3.1.1 **Beaver** (continued)

Physiographic and hydrologic factors may be as important in determining habitat suitability as the availability of food (Allen 1982). Beaver generally prefer forest areas of early deciduous successional growth. Rivers and lakes with relatively constant water levels, streams, tributaries and small seepages with adequate water flow are suitable aquatic habitat areas (Hill 1982). Trees and shrubs utilized are generally within thirty (30)m of the water's edge but use may extend to 200m from the water in some cases (Allen 1982).

3.1.2 **Muskrat**

Although muskrats may eat animal matter in winter, they are primarily vegetarians; cattail (*Typha latifolia*) is often cited as the most preferred food. Other food items include bulrush (*Scirpus validus*), pondweed (*Potamageton spp*.), water horsetail (*Equiseturn spp*.), and reed (*Phragmites spp*.) (Perry 1982).

Muskrat are most numerous in wetland habitats with permanent surface water of relatively constant depth, dense emergent vegetation (fifty [50] to eighty [80] percent) and bordered by terrestrial vegetation (Allen and Hoffman 1984). In stream environments high quality muskrat habitat is associated with intermediate sized watercourses, slow water velocity, an abundance of pools and sources of herbaceous cover or emergent vegetation. Heavily forested stream banks with less herbaceous vegetation results in fewer muskrat burrows than occur under more open canopy situations (Brooks and Dodge 1981).

3.1.3 **Raccoon**

The raccoon is adaptable to and dependent on a variety of habitats, including wetlands. For this reason, it is discussed briefly here as a wetland associated furbearer. It is also discussed later in this document as a forest associated furbearer.

The raccoon's association with water is indicated by its diet preferences and its den site location. The raccoon prefers crayfish as a food item, especially in spring, when other food items are not as available. Most particularly, the raccoon selects den sites that are generally less than 200m from water (Kaufmann 1982).

3.1.4 Mink

The mink is a semi-aquatic animal that may feed upon aquatic and semi-aquatic organisms such as fish, crayfish, frogs, waterfowl, muskrats and to a lesser extent, terrestrial animals e.g., rodents, rabbits. The mink is an opportunistic feeder as the importance of prey items in the diet varies with availability.

The mink inhabits various types of wetlands including banks of rivers and streams, lakes, swamps and marshes. The presence of den sites is an important factor in determining habitat preference. Mink den sites are generally located under roots of trees, rocks or stumps, or in hollow logs and in crevices. Mink numbers are highest in wetlands with potential den sites located close to concentrations of prey species or preferred foraging areas (Linn and Birks, Melquist et al. 1981). Dense woody cover, debris and vegetation provide escape and foraging cover and den sites (Allen 1983). Such features as dead falls, stumps, hummocks, boulders, log jams and terrestrial and aquatic shoreline vegetation attract mink populations and encourage mink activity (Racey and Euler 1982, Melquist et al. 1981). The majority of mink activity occurs within l00m from streams, rivers and lakes (Allen 1983).

3.1.5 River Otter

The otter is a semi-aquatic carnivorous mammal that feeds primarily on fish. Otter may also feed upon crustaceans, amphibians, insects, birds and mammals. Prey selection is dependent on availability (Toweil and Tabor 1982).

Otter rely upon unpolluted waterways and various types of wetlands (Toweil and Tabor 1982). They generally seek out sites that offer food, shelter and freedom from human disturbance. Felled timber in and around beaver ponds, beaver lodges as well as bank dens, log jams and hollow logs provide denning sites and shelter. Generally, otter populations benefit from the presence of beaver (Brown and Parsons 1983).

3.2 Effects of Habitat Alterations

Obviously if wetlands disappear or are significantly altered, aquatic furbearer populations will decline and perhaps disappear locally. Wetland drainage, filling and channelization are the most serious negative factors presently affecting the quantity

and quality of furbearer habitat. These factors help to change the physical and vegetative diversity of wetlands which may eliminate these areas as habitat for furbearers (Burgess and Bidder 1980, Racy and Euler, 1982).

Typically, but not exclusively a problem of agricultural areas, channelization of water courses creates wetter or drier conditions. Within or adjacent to new channels, channelization, decreases flooding duration, frequency and depth (Fredrickson 1980). As flooding effects decrease on areas adjacent to newly formed channels, the plant composition changes towards species characteristic of drier areas. The same situation exists when wetlands are drained (Fredrickson 1980). Correspondingly, such changes in plant community structure may be detrimental to some furbearers. For example, a shift from wetland associated vegetation to a drier type, such as conifer, would adversely affect beaver. Within channels, the loss of vegetation, den/sites and structural variety causes a decrease in the abundance of aquatic furbearers (Grey and Arner 1979). Fish-eating furbearers, such as the mink and otter, may also suffer because of the loss of physical diversity in the surrounding fish habitat (e.g., pools, riffles, bank cover) (Marzolf 1978). Channelization also encourages the removal of forest cover along the channels which has negative effects on terrestrial furbearers.

Controlled flows encourage the conversion of wetland vegetation to agricultural crops. As well, beaver food caches may be frozen in the snow and bank den entrances may be exposed under conditions of controlled flows.
Access roads can affect wetland associated furbearers. Within wetlands, access roads are a major source of soil disturbance and thus, are the major cause of soil erosion and sedimentation in wetlands (Trimble and Sartz 1957). Excessive sedimentation in a wetland can destroy emergent aquatic vegetation which may adversely affect the muskrat. In addition to the destruction of vegetation, sedimentation can have negative effects on fish populations. This will adversely affect such fish-eating furbearers as the mink and the otter. Further information on the effects of factors such as sedimentation and access roads on fish production may be found in the Background Document to the Guidelines for the Protection of Fish Habitat in Timber Management (Fisheries Branch 1985).

A direct effect of roads on furbearers may be an increase in mortality resulting either from road accidents or from increased trapping. In addition, roads can encourage an influx of predators thereby affecting furbearer populations.

Log landings are also a significant potential source of erosion within a wetland.

Timber harvesting can have many diverse, beneficial or detrimental impacts on the habitat of wetland associated furbearers. Logging in areas adjacent to wetlands can be conducive to erosion and sedimentation. As well, logging can directly or indirectly influence the quality of furbearer habitat.

Harvesting within or near a wetland results in the destruction of the vegetation structure of the area. Herbaceous food availability will be reduced immediately. However, beaver and muskrat will eventually benefit from cutting practices that create early successional deciduous growth at the water's edge. Streamside overhead cover may also be reduced or eliminated. This reduction in cover may indirectly affect fish-eating furbearers, such as the mink and otter, by changing the stream temperature thus affecting fish population. A change in overhead cover may also cause the streamflow to be increased as a result of a decrease in interception and transpiration water loses by vegetation, (Everest and Harr 1982). Mink which generally prefer dense overhead cover will be negatively affected by the loss of cover.

Timber harvesting operations may involve the removal of snags, downed logs and other woody material in and around wetlands. This removal results in the loss of denning and foraging sites for such species as the mink, raccoon and river otter. As well, an accumulation of woody material in streams may act as a barrier to fish passage, thereby affecting fish-eating furbearers. Also streambank erosion may be aggravated (Pierovich et al., as cited in Maser et al. 1979).

In general, site preparation has detrimental effects on wetland areas. Mechanical site preparation and prescribed burning may cause soil erosion, wetland sedimentation and the destruction of denning escape, foraging cover and sites (e.g., herbaceous vegetation, hollow logs, debris, stumps, deadfalls and snags). However, burning encourages the growth of early successional vegetation which benefits beaver and muskrat. Fire has, in the past, had a major role in preparing an area for the natural regeneration and colonization of aspen. This would directly benefit beaver, although the possibility of using fire for aspen regeneration has not been used (Slough and Sadleir 1977).
Regeneration or tending efforts used near wetland area to promote the growth of uniform stand of conifers will adversely affect furbearers, such as the beaver, that feed upon herbaceous or deciduous growth. This effect may be mitigated by the degree of success of such operations and by the proximity of areas of more suitable furbearer habitat.

3.3 Habitat Management Tactics

As Allen (in press) notes, "Vegetative structure, species diversity, surrounding land use, water permanence, fluctuation of water levels, aquatic habitat diversity, and the amount and type of cover both within and immediately adjacent to wetlands determines the amount and type of food available to furbearers. The ultimate management option for most wetland associated furbearers would be to protect wetlands habitat from drainage, channelization and other activities that modify water regimes and habitat diversity."

Additionally, timber management activities adjacent to wetlands can impact upon furbearers and may have to be modified.

3.3.1 Channelization and Drainage

Avoid wetland channelization, drainage or other activities that modify water regimes. These activities reduce habitat diversity and change the vegetative structure to the detriment of some furbearer species.

3.3.2 Areas of Concern Bordering Wetlands

Modify timber management within forests that border shorelines and wetland areas. These areas are designated as Areas of Concern. The dimensions may be determined from the following table (adapted from Trimble and Sartz 1957).

Slope%	Slope Angle (°)	Width of Area of Concern
0 - 30	0 - 17	50 metres
31 - 45	18 - 24	70 metres
46 - 60	25 - 31	90 metres

These Areas of Concern apply to each side of the wetland area and the width should be measured from the banks of streams or from the high water level mark of other bodies of water.

3.3.3 Roads

Avoid the construction of roads in Areas of Concern. If a road is to be constructed, it should be located at the periphery of the area of concern (as determined by the table in Section 3.3.2). Erosion should be minimized in the case of wetland (stream) crossings.

3.3.4 Log Landings

Avoid building log landings within areas of concern. If log landings are necessary, erosion should be minimized.

3.3.5 Timber Harvesting

Modify timber harvesting within Areas of Concern bordering wetlands. As well, any cutting at the periphery of such Areas should minimize

damage to streambanks and minimize effects of erosion by such tactics as winter cutting and the use of light equipment.

Possible harvesting options within the Area of Concern are:

a) reserve;

b) selection cutting;

c) uniform or strip shelterwood cutting; and

d) limited clearcutting (e.g., strip or patch).

Large scale or extensive clearcutting is not compatible with providing furbearer habitat. A fifty (50) percent (or less) harvesting of an area may be necessary to minimize adverse impacts. Maintenance or enhancement of habitat for such furbearers as mink, raccoon and otter should involve snag management. Where safety considerations allow, management practices should favour the creation or retention of snags and downed logs for denning sites.

For species-specific harvesting options, refer to section 3.4.

3.3.6 Site Preparation

Site preparation operations that reduce naturally occurring debris and structural diversity should be restricted within wetland Areas of Concern. Such features provide cover for wetland furbearers and their associated prey species.

If mechanical site preparation does occur, erosion and the destruction of habitat should be minimized. Prescribed burning can be useful to encourage the growth of herbaceous vegetation to benefit muskrat.

3.3.7 Regeneration

Natural regeneration should be allowed to occur in Areas of Concern, especially where beaver management is important. Artificial regeneration of conifers within thirty (30)m of the water's edge should be avoided.

3.3.8 Tending, Protection and Improvement

The use of herbicides and other operations, such as cleaning or thinning, to inhibit deciduous growth and promote the growth of conifers should be avoided within Areas of Concern.

3.4 Specific Habitat Management Tactics

3.4.1 Beaver

For the most part, beaver are able to maintain a water level appropriate to their survival. Therefore, the priority for habitat management for beaver should be to provide a food source, particularly for winter use, close to their aquatic habitat.

Beaver will benefit from timber harvesting operations that result in early successional deciduous trees and shrubs (Slough and Sadleir 1977). Selection cutting, strip shelterwood cuts and strip clearcuts can be used to create openings in the canopy adjacent to the beaver's habitat. A fifty (50) percent removal system may be appropriate and strip cuts should be at least forty (40)m wide.

Restocking of openings with conifers should be avoided within thirty (30)m of the water's edge. Natural regeneration of deciduous species should be encouraged in the openings. Artificial regeneration of aspen by planting may be used to enhance beaver habitat. Herbicide spraying to prevent or inhibit deciduous growth should be avoided.

3.4.2 Muskrat

Muskrat are most numerous in early seral stages of wetlands. Thus, muskrat habitat management primarily involves efforts to slow down or set back vegetative succession within the wetland. Such efforts include burning, mowing, dredging, and water control measures which would not generally be associated with timber management operations.

3.4.3 Raccoon

Measures to protect the aquatic habitat of other furbearers will generally maintain important food sources for the raccoon.

Additionally, providing den sites close to the water (less than 200m) is necessary for maintaining raccoon populations. Trees that are diseased or decadent may provide den/sites and thus, should be retained as safety concerns allow.

3.4.4 Mink and River Otter

Maintenance of habitat quality for beaver, muskrat and raccoon will have beneficial effects on the habitats of mink and otter. These carnivorous species depend on prey that rely upon diverse vegetation and structural characteristics (snags, downed logs, logging debris) found in, or bordering, on wetlands.

Within the limits provided by the fisheries management objectives, reduce the water velocity by such means as small dams, weirs, current deflectors and boulders to increase habitat diversity for the benefit of mink and river otter. These measures would not generally be associated with timber management operations.

4.0 Forest Associated Furbearers

Forest associated furbearers Include fisher (*Martes pennanti*), marten (*Martes americana*), lynx (*Felis lynx*), raccoon (*Procyon Lotor*), red fox (*Vulpes vulpes*) and timber wolf (*Canis lupus*). Other species of furbearers are not included because of their relative economic importance (e.g., weasels, red squirrel) or because of their dependence on non-forest habitat (e.g., coyote). In any case, most of the habitat needs of furbearers not included here will be largely met by routine timber management operations or by the application of special forest management measures devised for other species of wildlife.

4.1 Habitat Requirements

4.1.1 Fisher and Marten

Fisher adapt to a variety of forest types with food availability being the most important habitat factor. Foods eaten include porcupine (*Erethizon dorsatum*), snowshoe hare (*Lepus americanus*), small rodents and carrion. Birds, eggs, reptiles, amphibians and various nuts and fruits are also consumed (Strickland et al. 1982).

The fisher is always found in or near forested habitats that provide dense, continuous overhead cover (Powell 1982). Mature or mid-stage coniferous

or mixed forests fulfil the fisher's requirements for denning sites and prey items. The fisher uses two types of den sites: temporary dens and nesting dens. Temporary dens, used for two to three days, are found in a variety of sites, such as under logs, brush piles, hollow logs and in ground burrows, which provide cover and protection. Nesting dens are typically found high in hollow trees or on rocky ledges (Strickland et al. 1982).

Second growth forests may be used by the fisher if sufficient cover is available. Clear cuts adjacent to mature timber stands may be used during the summer when dense vegetation provides cover (Powell 1982).

Like the fisher, the marten is an opportunistic feeder. Staple foods include the redback vole (*Clethrionomys gapperi*) and the meadow vole (*Microtus pennsylvanicus*). Other small mammals, such as the chipmunk, squirrel and hare, are of less importance in the diet. Birds, bird's eggs, fruits and berries are important food items when in season (Strickland et al. 1982).

Compared to the fisher, the marten generally prefers more mature conifer and softwood dominated mixed forest stands (Strickland et al. 1982). Timber stands of various age and size classes provide hunting sites and protective cover (Hargis and McCullough 1984). Small stands of old growth forest may provide suitable marten habitat if interspersed with meadows, open areas or riparian areas (Spencer et al. 1983). However, marten generally avoid large forest openings or areas otherwise lacking vegetative cover, such as large meadows and clearcuts (Stevenson and Major 1982). Denning occurs both on the ground in rock piles, hollow logs or tree roots, and high in hollow trees.

An inverse relationship appears to exist between fisher and marten populations. This may be related to competition for den sites and food (de Vos 1951), or differences in habitat preference (Clem 1975). Marten populations increase as the forest matures; fisher populations decrease as the forest matures.

Old growth stands, upon which marten and fisher are partially dependent, have three primary components: live over-mature trees, dead standing trees or snags and large amounts of woody debris on the forest floor. The structural diversity of diseased and decadent timber, snags and downed logs in old growth forests contribute suitable denning habitat, foraging habitat and cover for marten, fisher and their prey (Allen in press).

4.1.2 Lynx

The lynx is a carnivorous animal that feeds primarily on snowshoe hare although the diet may be supplemented with rodents (e.g., mice and squirrels) and birds (e.g., grouse) in the summer. Some predation on white-tail deer and moose may occur but is not common (McCord and Condoza 1982).

4.1.3 Raccoon

Raccoons eat a wide variety of both plant and animal matter, the proportions varying with the season and locale. However, reports indicate that in most areas fruit, corn, grain, seeds and nuts are very important in the raccoon's diet. Only in spring do raccoons eat more animal (crayfish, various small mammals) than plant matter (Kaufmann 1982).

Throughout their range, raccoon have adapted to a wide variety of habitats for denning and foraging sites - woodlots, wetlands, even buildings. Hollow trees, snags, underground burrows and various other natural and man-created cavities function as denning sites and winter shelters. Den sites are generally located within 200m of water. Home ranges have been observed to vary from on to 6.4 km although one (1) to three (3) km is the average size (Kaufmann 1982).

4.1.4 Red Fox

The red fox is an opportunistic feeder selecting a wide variety of plant and animal material upon which to feed including: small mammals, birds, bird's eggs, livestock, carrion, insects, amphibians, grasses, grains, fruits and nuts. Rabbits and mice are often major food items in the diet (Samuel and Nelson 1982).

Fox are able to use a variety of habitats including intermixed cropland, farmland, mixed hard wood stands and edges of open areas. The distribution and nature of vegetation associated with agricultural areas is particularly suitable for red fox production. Dense forests are undesirable (Samuel and Nelson 1982). Fox use fencerows, forest edges and roads extensively for travel and hunting (I. Thompson pers. comm.).

4.1.5 Timber Wolf

Wolves are large predators that feed primarily on birds and mammals. The large size of the wolf and its habit of travelling in packs makes it adapted

to feed on large species of prey. In Ontario, whitetail deer, moose and beaver are staple food items (Paradiso and Nowak 1982).

Timber wolves occur in a wide variety of habitats including tundra, coniferous forests, mixed forests and deciduous forests. Habitat preference is related to prey availability. Dens are used only for the birth and care of pups and consist typically of a ground burrow, hollow log, rock crevice, or abandoned beaver lodge. Wolves wander extensively from late fall to the birth of the pups in April when travel becomes limited to the area surrounding the den (Paradiso and Nowak 1982).

4.2 Effects of Habitat Alterations

As Allen (in press) notes, the effect of timber harvest on forest furbearers varies with the species of animal, the site specific treatment, as well as the overall forest patterns produced from past forest operations. The type of cut, its size and shape, the spatial relationship to other cut areas and unharvested stands, and the resultant plant species composition determine the value of an area for terrestrial furbearers.

Access roads have many varied effects on forest associated furbearers. Roads are a major source of soil erosion and sedimentation which can lead to a loss in vegetation. Roads may cause an increase in mortality of some furbearers as the result of road related accidents and increased trapping pressures (Oxley et al. 1974, I. Thompson pers. comm.). Thompson, in his study on the effects of forest harvesting on furbearers, found that populations of the easy-to-trap marten declined as a direct result of improved trapper access and increased trapping effort. In periods of low food availability, trapping is particularly detrimental to marten populations because they produce no young and may move up to sixty-five (65) km away in search of food. In such unfamiliar areas, marten are more susceptible to trapping than under normal conditions (I. Thompson pers. comm.).

Oxley et al. (1974) found that roads may act as a barrier for some species of furbearers. He reported that the wider the opening in the forest, the more inhibited were some animals in crossing the road. For other animals, roads may facilitate access to food and may be used as travel corridors by wolves and foxes (Oxley et al. 1974, I. Thompson pers. comm.).

Timber harvesting in areas of furbearer habitat may have broad effects on resident populations. A change in the vegetative structure and composition of a forest stand may result in a change in the mammalian communities in the area. No species seems particularly well-adapted to living on logged areas (I. Thompson pers. comm.). However, because the site of each forest harvest operation is different and each

furbearer species has different habitat requirements, various cutting operations may benefit some species and be detrimental to others.

Thompson (pers. comm.) studied the effects of timber harvesting on populations of small mammals. He found that *Clethrionomys* populations declined immediately after cutting and that *Peromyscus* populations became extremely numerous for a short period of time after cutting and then declined to a population level below normal. In some areas, *Clethrionomys* have not recovered to previous population levels after forty (40) years. Snowshoe hare populations are increased by logging although they become most abundant in areas cut twenty (20) to thirty (30) years ago. Red squirrels are able to maintain their populations in logged areas if enough advanced growth of balsam fir or pole sized stands of conifer are present.

The way in which small mammals respond to timber harvesting determines the way in which their predators will also respond. A decline in a major prey species (e.g., *Clethrionomys*) will have a negative impact of the predator species (e.g., marten). On the other hand, cutting will likely benefit predator populations whose prey species are increased. For example, populations of hare and grouse are increased by logging which is advantageous to their predators, the lynx and fox (I. Thompson pers. comm.). Wolves are examples of other predators whose major prey species deer, moose and beaver can often be increased by logging operations.

Many studies have been done to determine the effects of timber harvesting on marten populations. Generally, the results showed that marten populations decline in response to harvesting. This decline is directly related to the loss of overhead cover, elimination of hunting sites and prey species and the loss of denning and resting sites (Strickland et al. 1982). Koehler (1979, as cited in Strickland et al. 1982) studied the effects of loss of cover on marten and found that where the forest canopy was maintained over thirty (30) percent on selectively cut mesic sites, marten were not affected. Campbell (1979, as cited in Allen in press) observed that cutting that removed less than fifty-seven (57) percent of harvestable trees had little negative impact on the quality of marten habitat. Thompson (pers. comm.) found that marten were able to use open areas of hazel and maple with no coniferous overstory provided sufficient levels of prey species were available. Thompson also found that ten (10) year old cutover sites with an advanced growth of balsam fir and a sufficient food biomass, supported a resident marten population at a density of one third that on uncut sites. Soutiere (1979) observed that marten seldom use clearcuts less than fifteen (15) years old but will inhabit partially harvested selectively cut stands.

Various site preparation operations have different effects of species of furbearers. Mechanical site preparation may contribute to soil erosion and the destruction of woody debris, downed logs, and brushpiles that provide denning sites.

Chemical site preparation may affect food availability for such species as grouse and hare with resultant effects on their predators (lynx and fox). In Thompson's (pers. comm.) opinion, spraying will reduce marten use of a logged area for three (3) to five (5) years if the spraying occurs at ten (10) or more years after logging. If spraying occurs before ten (10) years, effects on marten populations will be negligible unless extremely effective herbicides are used, such as "Roundup". Such effective herbicides will eliminate many of the berry producing plants which are important for building up furbearer fat reserves.

Prescribed burning has the most variable effects on furbearer populations. Although burning will remove snags and woody debris (denning and foraging sites) to the detriment of marten and fisher, burning stimulates prolific growth of early successional vegetation to the ultimate benefit of prey species and their predators (lynx, fox, and wolf).

The purpose of tending, protection, and improvement operations is to further reduce competition between the preferred tree species and other vegetation. Thus, the impacts of tending are similar to those of site preparation operations. Concern arises if efforts to control deciduous vegetation are effective over a large area for an extended period of time. Deciduous vegetation provides essential shelter, food, and forage cover for a large variety of furbearer prey species.

Herbicides are potentially of the greatest concern in this regard.

4.3 Habitat Management Tactics

Furbearer species diversity and habitat quality is primarily determined by the diversity of forest structure (Harris and Marion 1981). Thus, an appropriate objective for furbearer management is to optimize forest diversity over an area of sufficient size to meet the seasonal and territorial requirements of forest associated furbearers.

As well as the specific measures that may be needed to meet the habitat needs of an individual species, it is desirable to achieve a general diversity of vegetation. In a managed forest this may be accomplished by maintaining sufficient amounts of mature forest within or adjacent to the homogeneous stands resulting from even-aged timber management. The diversity created between stands will thus partially compensate for losses in habitat diversity within inensively managed stands (Allen in press). This interspersion of vegetation may be achieved, in some cases, by the combinations of routine forest silvicultural practices in some areas plus the retention of non-commercial and unallocated stands.

In other instances, modifications of cutting prescriptions (eg., smaller, irregular shaped cuts) may be required to adequately protect furbearer habitat as well as meet the timber production objective.

4.3.1 Roads

Where there is a concern that improved access may lead to overharvest of furbearers, particularly marten, carefully consider access road location and measures to limit vehicle use. It may be desirable to undertake winter extraction or the scarification and removal of roads after timber operations.

4.3.2 Timber Harvesting

Where there is a concern for creating or maintaining habitat for terrestrial furbearers, potentially large clearcuts should be broken into smaller cuts, and patches of older age-class trees should be left within cutovers. A fifty (50) percent removal system can be manipulated to leave shelter and varied habitat for most forest associated furbearers. Leaving large uncut patches (eg., > five (5) ha) may be necessary to encourage future harvest. Clearcutting in strips or blocks and shelter-wood harvesting can achieve this age-class diversity in a stand.

As safety concerns allow, retain non-merchantible existing and potential snags (diseased and decadent trees) within cutovers to provide denning cavities for the marten, fisher, and raccoon. (See also 4.4.1)

4.3.3 Site Preparation

Operations to remove logging debris and slash should be modified in Areas of Concern. The accumulation of slash in large piles or windrows will benefit predatory furbearers, particularly marten and fisher and their associated prey species. Slash should be retained on ten (10) percent of the cutover area (Pierovich et al. 1975, as cited by Maser et al. 1979).

Mechanical site preparation that minimizes erosion and damage to snags and slash will benefit marten and fisher.

Prescribed burning can damage uncut patches, residual stands, snags, and woody debris but it may enhance the habitat of prey species to the benefit of the wolf, lynx, and fox.

4.3.4 Regeneration

As furbearers have varied habitat needs, forestry practices which effectively promote large even-aged stands of timber will adversely affect furbearers in general. This effect is mitigated by the success of artificial regeneration efforts, the nature and proximity of both uncut patches and residual trees within the cutover, and uncut stands adjacent to the cutover. In some cases, attempts to regenerate conifer will provide diversity by contrasting with the naturally regenerated vegetation.

Thus, it is not possible to routinely advocate either artificial or natural regeneration of a cut area. Each situation requires an analysis of the site and the timber and wildlife management objectives for the area before a suitable regeneration option can be chosen.

4.3.5 Tending, Protection, and Improvement

The use of herbicides that suppress deciduous growth for long periods of time should be carefully considered in relation to the proximity of the sprayed site to untreated areas of deciduous growth. *(Note: Due to missing text in the original document, this paragraph was amended by Joe Churcher and Jim Baker in September 1999).*

4.4 Specific Management Tactics

4.4.1 Fisher and Marten

Both the fisher and marten live in areas of dense coniferous cover and mature age-class forest stands. Stands within physically diverse terrain, such as valleys and rock outcrops, are preferred to stands in a more uniform setting (Cline et al. 1980).

The fisher and marten will benefit most from uneven aged forest management practices (eg., selection cutting). Selection cuts should maintain thirty (30) to forty (40) percent of the forest canopy. However, clearcuts and shelterwood cuts may be used provided the cuts are as few and as small as possible, and the cutting rotation is long enough to maintain much of the forest in mature age-classes (Allen in press). Shelterwood cuts and east-west oriented clearcuts will encourage the growth of shade-tolerant softwoods (Kelly 1977, as cited in Strickland et al. 1982).

As safety concerns allow, retain all existing and potential snags within harvested areas. Thomas et al. (1979) found that the dimensional requirements of snags for the fisher and marten are as follows:

	Minimum height (m)	d.b.h. (cm)
fisher	9.1	50.8
marten	4.6	38.1

Thinning of mature aspen and birch to release the coniferous understory may be advantageous to marten (Shupback 1977, as cited in Allen in press).

4.4.2 Fox, Lynx, Wolf

Given that adequate cover exists nearby, second growth forest or early successional forest, as created by logging or fire, will encourage small and big game populations to the benefit of predatory species such as the timber wolf, lynx, and coloured fox.

However, Thompson (pers. comm.) found that the time lag from cutting to the recovery of lynx populations and their prey (hare and grouse) was twenty (20) to thirty (30) years.

4.4.3 Raccoon

Creating a diverse vegetative community will benefit the raccoon. Blocks of forest interspersed with cut or agricultural areas should be maintained. Existing or potential snags, within 200m of wetlands, should be retained as potential den sites. Thomas et al. (1979) found that the dimensional requirements of snags for raccoon are as follows:

	Minimum height (m)	d.b.h. (cm)
raccoon	1.8	50.8

5.0 References

Allen, A.W. 1982. *Habitat suitability index models: Beaver*. U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10-30. 20 pp.

….1983. *Habitat suitability index models: Mink*. U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10-61. 19 pp.

….and R.D. Hoffman. 1984. *Habitat suitability index models: Muskrat*. U.S. Dept. Int. Fish Wildl. Serv. FWS/OBS-82/10-46. 27 pp.

….in press. *Habitat Management for Furbearers*. Chap. 54. **in** M. Novak and J.S. Baker, eds. *Wildlife Furbearer Management and Conservation in North America*. Ont. Min. of Nat. Res. and Ont. Trappers Assoc. Toronto and North Bay.

Bendall, J.F. 1974. *Effects of Fire on Birds and Mammals*. Pages 73-138 **in** T.T. Kozlowski and C.E. Ahlgren, eds. Fire and Ecosystems. Acad. Press, New York 542 pp.

Brooks, R.P. and W.E. Dodge. 1981. *Identification of muskrat habitat in riverine e*nvironments. Page 113-127 **in** J.A. Chapman and D. Pursley, eds. Proc. Worldwide Furbearer Conf., Vol. I. Aug 3-11. Frostburg, MD.

Brown, M.K. and G.R. Parsons. 1983. *Otter management in New York – preliminary results*. Trans. Northeast Sect. Wildl. Sec. 40196 Abstract only.

Burgess, S.A. and J.R. Bidder. 1980. *Effects of stream habitat improvements on invertebrates, trout populations, and mink activity*. J. Wildl. Manage. 44(4):871-880.

Clem, M.K. 1975. *Interspecific relationship of fishers and martens in Ontario during winter*. Pages 165-182 **in** R.L. Phillips and C. Jonkel, eds. Proc. Predator Symp. June 16-19. Univ. Montana, Missoula.

Cline, S.P., A.B. Berg, and H.M. Wright. 1980. *Snag characteristics and dynamics in Douglas-fir forests, western Oregon*. J. Wildl. Manage.; 44(4):773-786.

deVos, A. 1951. *Recent findings in fisher and marten ecology and management*. Trans. N. Am. Wildl. conf. 16:498-505.

Environment Canada and Ministry of Natural Resources. 1984. *An Evaluation System for Wetlands of Ontario south of the Precambrian Shield*. Second Edition. 169 pp.

Errington, P.L. 1937. *Habitat requirements of stream-dwelling muskrats*. Trans. N. Am. Wildl. Conf. 2:411-416.

Everest, F.H. and R.D. Harr. 1982. *Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America-Silvicultural Treatments*. Gen. Tech. Rep. PNW-134. Portland, Oregon. 19 pp.

Fisheries Branch. 1985. *Guidelines for the Protection of Fish Habitat in Timber Management*. Min. of Nat. Res. Unpubl. Report.

Fredrickson, L.H. 1980. *Management of lowland hardwood wetlands for wildlife: problems and potential*. Trans. N. Am. Wildl. Nat. Res. conf. 45:376-386.

Gray, M.H. and D.H. Arner. 1979. *The effects of channelization on furbearers and furbearer habitat*. Proc. Anu. Conf. Southeast. Assoc. Fish Wildl. Agencies 31:259-265.

Grier, A.R. and L.R. Best. 1980. *Habitat selection by small mammals of riparian communities: evaluating effects of habitat alterations*. J. Wild. Manage. 44(1):16-24.

Hargis, C.D. and D.R. McCullough. 1984. *Winter diet and habitat selection of marten in Yosemite National Park*. J. Wild. Manage. 48(1):140-146.

Harris, L.D., and W.R. Marion. 1981. *Forest stand scheduling for wildlife in the multiple use forest*. Pages 209-214 **in** Proc. of 1981 convention of the Soc. of Am. Foresters.

Hill, E.P. 1982. *Beaver*. Pages 256-281 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management and economics.* John Hopkins Univ. Pres. Baltimore, M.S.

Kaufmann, J.H. 1982. *Raccoon and Allies*. Pages 567-585 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Koelher, G.M. and M.G. Hornocker. 1977. *Fire effects on marten habitat in the Selway-Bitterroot Wilderness*. J. Wildl. Manage. 41(3):500-505.

Linn, I.J. and J.D.S. Birks. 1981. *Observations on the home ranges of feral American mink (Mustela vison) in Devon, England as revealed by radio-tacking*. Pages 1088-1102 **in** J.A. Chapman and D. Pursley, eds. Worldwide Furbearer conf. Proc., Vol. II, Aug. 3-11 Frostburg, MD.

Marzolf, G.R. 1978. *The potential effects of clearing and snagging onstream ecosystems*. U.S. Fish Wildl. Serv. FWS/OBS-78/14. 32 pp.

Maser, C., R.G. Anderson, K. Cromack, Jr., J.T. Williams, and R.E. Martin. 1979. *Dead and down woody material*. Pages 78-95 **in** J.W. Thomas, ed. *Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington*. USDA for. Serv. Agric. Handbook 553. 512 pp.

McCord, C.M. and J.E. Cardoza. 1982. *Bobcat and Lynx*. Pages 728-766 **in** J.A. Chapman and G.A. Feldhamer, Eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press, Baltimore, M.D.

Melquist, W.E., J.S. Whitman, and M.G. Hornocker. 1981. *Resource partitioning and coexistence of sympatric mink and river otter populations*. Pages 187-200 **in** J.A. Chapman and D. Pursely, eds. Worldwide Furbearer Conf. Proc., Vol. 1, Aug. 3-11, 1980. Frostburg, M.D.

Ontario Ministry of Natural Resources. 1982. *Northwestern Ontario Strategic Land Use Plan*. OMNR. Toronto, Ont. 71 pp.

….1982. *Northeastern Ontario Strategic Land Use Plan*. OMNR. Toronto, Ont. 71 pp.

….1982. *Southern Ontario Coordinated Program Strategy*. OMNR. Toronto, Ont. 44 pp.

Oxley, D.J., M.B. Fenton, G.R. Carmody 1974. *The Effects of Roads on Populations of Small Mammals*. J. Appl. Ecol. 11(1):51-59.

Paradiso, J.L. and R.M. Nowak. 1982 *Wolves*. Pages 460-474 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Pres. Baltimore, M.D.

Payne, J.F. 1980. *Furbearer management and trapping*. Wildl. Soc. Bull. 8(4):345-348.

Perry, H.R., Jr. 1982. *Muskrats*. Pages 282-325 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Powell, R.A. 1982. *The Fisher: life history, economy, and behaviour*. Univ. Minnesota Press, Minneapolis. 217 pp.

Racey, G.D., and D.L. Euler. 1982. *Small mammal and habitat response to shoreline cottage development in Central Ontario*. Can. J. Zool. 60:865-880.

Samuel, D.E. and B.B. Nelson. 1982. *Foxes*. Pages 475-490 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Slough, B.G. and R.M. Sadleir. 1977. *A land capability classification for beaver*. Can. J. Zool. 55:1324-1335.

Soutiere, E.C. 1979. *Effects of timber harvesting on marten in Maine*. J. Wildl. Manage. 43(4):840-860.

Spencer, W.D., R.H. Barrett, and W.J. Zielinski. 1983. *Marten habitat preferences in the northern Sierra Nevada*. J. Wildl. Manage. 47(4):1181-1186.

Steventon, J.D. and J.T. Major. 1982. *Marten use of habitat in commercially clear-cut forest*. J.Wildl. Manage. 46(1):175-182.

Strickland, M.A., C.W. Douglas, M. Novak, and N. Hunzinger. 1982. *Fisher*. Pages 586-598 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Strickland, M.A., C.W. Douglas, M. Novak, and N. Hunzinger. 1982. *Marten*. Pages 599-612 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Thomas, J.W., R.G. Anderson, C. Maser, and E. Bull. 1979. *Snags*. Pages 60-71 **in** J.W. Thomas, ed. *Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington*. USDA For. Serv. Agric. Handbook 553. 512 pp.

Toweil, D.E. and J.E. Tabor. *River Otter*. Pg. 688-703 **in** J.A. Chapman and G.A. Feldhamer, eds. *Wild Mammals of North America: biology, management, and economics*. John Hopkins Univ. Press. Baltimore, M.D.

Trimble, G.R. and R.S. Sartz. 1957. *How far from a stream should a logging road be located*. J. For. 55:339-341.