Forest Management Guidelines for the Provision of Marten Habitat

VERSION 1.0

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Attention: Guidelines

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Summary of Forest Management Guidelines for the Provision of Marten Habitat

This is a summary of the guidelines that have been prepared to help planning teams and managers address the needs of marten in the preparation and implementation of forest management plans.

They are designed to maintain habitat of sufficient quality and quantity to support healthy populations of marten.

Marten habitat needs are addressed at 2 spatial scales - the landscape level, and the forest stand level.

The attached document consists of (i) an overview of marten ecology and habitat requirements, (ii) the implications of forest management on marten habitat, (iii) additional detail about the recommendations to manage habitat, (iv) an example application of the recommendations, and (v) a discussion of the anticipated evolution of the guidelines.

Recommended Guidelines

To meet current and future habitat needs of marten throughout the boreal forest of Ontario, the following practices are recommended:

Landscape Level

1. Maintain 10 - 20 percent of the forest, which has the capability to produce marten, in suitable conditions.

Suitable conditions are achieved where stands have the following characteristics:

- the composition of the overstorey is greater than 40 percent in spruce, fir, or cedar. Mixed composition is preferred over pure stands.
- the canopy closure of conifer is greater than 50 percent
- are found within preferred FEC site and vegetation types (those rated as “good” or “fair” in Appendix 1).
- are at least 15 m in height (approximately 80 years old). Uneven canopies are preferred.

2. Suitable marten habitat should be arranged in “core habitat areas” between 30 and 50 km^2 in size. A minimum of 75 percent of core habitat should be comprised of suitable stands.

3. Partial harvesting can occur in as much as 30 percent of the core habitat, provided it retains 50 percent of the original conifer basal area and crown closure of at least 50 percent.

4. Core areas should be connected by riparian reserves and other unharvested forest. While connections need not be continuous, gaps of open habitat more than 1 - 2 km across should be avoided.

Stand Level

5. Harvesting methods should be modified within the bounds of the Occupational Health and Safety Act, to retain at least 6 dead or declining trees per hectare, with at least 2 of those exceeding 30 cm dbh.

6. Silvicultural practices that retain logs, stumps, and other coarse woody debris on site should be encouraged.

Application of the Guidelines

These guidelines **must** be considered in the preparation and implementation of forest management plans in the Boreal Forest Region of Ontario.

In the area of transition between the boreal and the Great Lakes St. Lawrence forest, managers must make a choice to apply either the marten, or the pileated woodpecker guidelines. It is not required that both be applied. The choice of which guideline to apply should be based on an assessment of habitat capability and suitability for the management unit and in consideration of any ecoregional direction.

The complexity of natural systems precludes a rigid set of rules. Rather, the guidelines identify key principles and recommendations that must be adapted to fit local situations based on the professional judgement of experienced practitioners. However, any deviations from the guidelines must be recorded and rationalized in the forest management plan on the basis of compelling biological or socio-economic concerns.

Forest Management Guidelines for the Provision of Marten Habitat

Preface

These guidelines have been prepared to help planning teams develop and implement sound forest management practices that contribute to ensuring the long-term health of Ontario's forests. They comply with the Crown Forest Sustainability Act (CFSA; RSO 1994), as well as the requirements of the April 1994 Decision of the Environmental Assessment Board.

Using the Guidelines

The *Forest Operations and Silviculture Manual* (CFSA, Section 68), lists these guidelines as ones which **must be** considered during the preparation and implementation of forest management plans.

The considerable ecological variation associated with natural systems precludes a rigid set of rules to cover all situations facing forest planners and managers. Rather, the guidelines identify key principles and recommendations that must then be adapted to fit local situations based on the professional judgement of experienced practitioners. Any deviations from the guidelines must be recorded and rationalized in the forest management plan on the basis of compelling biological or socio-economic concerns.

Development of the Guidelines

These guidelines have been developed by combining current scientific evidence and expert opinion. A companion document is being prepared to provide additional detail on the existing scientific evidence for the recommendations contained in this manual. Also, spatial and non-spatial habitat supply models, and associated technical manuals are in development to assist in applying the guidelines. When improved tools are available, and as our understanding of the interactions between marten and their environment improves, revisions to the guidelines will occur. At a minimum, the guidelines will be revisited every 5 years.

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Forest Management Guidelines for the Provision of Marten Habitat

1.0 Introduction

The marten (*Martes americana*) was elevated to the status of a "provincially featured species" by the Environmental Assessment Board's ruling on timber management on Crown lands (April 1994). The Board directed that guidelines be prepared to manage for the habitat of marten in the boreal forest, and for the pileated woodpecker (*Dryocopus pileatus*) in the Great Lakes-St. Lawrence forest of central Ontario.

The provision of marten habitat will supply at least some of the habitat required by various other species that are also associated with mature and overmature forests, cavity trees, and coarse woody debris.

1.1 <u>Evolving Management Philosophy</u>

Historically, the Ministry of Natural Resources (MNR) attempted to manage habitat for some game species, and those species whose long-term survival was of concern (i.e. vulnerable, threatened and endangered species). In recent years, the appreciation of the connections among the components of natural systems, and the recognition of the intrinsic value of all species has grown. At the same time, it has become increasingly difficult to manage for the specific, often conflicting, habitat needs of an ever growing list of species. Thus, MNR's approach to resource management has been shifting to the maintenance of entire ecological systems and all their associated biological diversity. This perspective does not preclude management of habitat for individual species (such as marten), as long as it does not threaten the long-term well being of other species, or the functioning of the overall biological system.

This evolution in thinking about resource management has been reflected in, and encouraged by, a number of government policy initiatives. For example, Ontario's Policy Framework for Sustainable Forests and the 1994 Crown Forest Sustainability Act promote the long-term health of forest ecosystems. At the national level, Ontario has indicated support for the provisions of the 1995 Canadian Biodiversity Strategy.

These guidelines are expected to be applied in a way that contributes to the maintenance of ecological systems and biodiversity.

1.2 <u>Evolving Management Methods and Technology</u>

A key consideration in the maintenance of ecological systems is the need to manage at a number of spatial scales. Not only is it necessary to manage for particular habitat features at the forest stand level, but properties of landscapes (of which the forest stand is part) must also be managed.

Maintenance or creation of particular landscape characteristics (percent of forest types and age classes, forest patch size and distribution, etc.) will increase the likelihood that all the biological diversity associated with the landscape will be perpetuated. This multi-scaled perspective of habitat management requires that planning at the forest Management Unit (MU) level be closely linked to broader land use planning.

Th

d properties of both landscapes and forest stands that together are considered necessary to ensure perpetuation of marten populations.

In the past guidelines have been criticized for being too prescriptive, and for not being directed at achieving specific goals. In response to these criticisms, and to move towards more adaptive management, the marten guidelines reflect current understanding of the key habitat relationships that are being used and tested in various habitat suitability index (HSI) models. As well, one or more habitat models and associated technical manuals will ultimately support the application of the guidelines. Those managers who wish to use habitat supply modelling will find some assistance within these guidelines.

These guidelines consist of 5 major parts: (i) a brief overview of marten ecology and habitat requirements; (ii) a brief description of the implications of forest management for marten habitat; (iii) recommendations for providing marten habitat during forest management planning at the landscape level and within forest stands; (iv) an example of how to apply the guidelines in forest management planning; and (v) a discussion of anticipated improvements to the guidelines, and future directions for forest management.

A more detailed review of the scientific evidence supporting these guidelines is in preparation.

2.0 Marten Ecology and Habitat Use

2.1 General Description and Distribution

Marten are a medium sized member of the weasel family. They are between 500 and 680 mm in length and weigh between 500 and 1400 grams at maturity. Males are generally 20 - 40 percent larger than females but otherwise are similar in appearance. They range in colour from tan to dark chocolate brown and have an irregular cream to amber coloured throat patch.

Marten

Marten are well distributed across North American coniferous forests, ranging from Alaska to Newfoundland, and from the tree line to the southern extent of coniferous forest in most regions (Strickland and Douglas 1987). Habitat change associated with human settlement and agricultural development along with over trapping in some areas has resulted in a reduction of the marten's original range along its southern borders (Thompson 1991, Buskirk and Ruggiero 1994).

2.2 Life History and Development

Marten are a long-lived species with a relatively low reproductive rate and slow physical development. Marten mate in late June through early August and young are born in March or April (Strickland and Douglas 1987). Female marten typically mate for the first time at 15 months of age and have their first litter at 2 years. Only one litter is produced each year. Litter size ranges from 1-5 with a mean of 2.85 (Strickland and Douglas 1987). Litter size may be age dependent, peaking at 6 years of age and declining to near zero by 12 years (Mead 1994). Young marten develop slowly by mammalian standards and are weaned at 42 days (Mead 1994). Both the age at which reproductive maturity is reached, and the annual reproductive output for marten are lower than expected for an animal of its body size (Buskirk and Ruggiero 1994).

Although marten are relatively long-lived, with some marten reaching 14+ years in the wild, the mean age of 6,448 trapped marten from central Ontario was less than 1 year (Strickland and Douglas 1987). In an uncut boreal forest, mortality of marten in a trapped population was estimated at 34.5 percent, of which the majority of deaths occurred by trapping (28.1 percent of total mortality). However, in cutover boreal forest, trapping accounted for the deaths of all marten, for that portion of the population within the cutover (Thompson 1994). This rate of mortality in trapped populations is similar to that found in an accessible logged area in Maine where trapping accounted for 90 percent of all documented mortalities (Hodgman *et al*. 1994). Males are two to three times more susceptible to trapping than females (Strickland and Douglas 1987), likely due to their larger foraging areas where they encounter more traps (Yeager 1950). Other sources of mortality include starvation, and predation by other forest carnivores. Females and immature animals are more susceptible to starvation because of the increased energy demands of reproduction, and for younger animals, the poorer quality of habitat to which they have access (Hawley and Newby 1957).

2.3 Food Habits and Energetics

Marten are opportunistic feeders and their diet includes a wide variety of animal and plant materials (Strickland and Douglas 1987). Red-backed voles *(Clethrionomys gapperi*) and meadow voles (*Microtus pennsylvanicus*) are the principle items in the diet along with snowshoe hare (*Lepus americanus*) (Buskirk and MacDonald 1984, Thompson 1986, Martin 1994) Red-backed voles, although a staple in the diet of marten, are usually only taken in proportion to their availability (Weckwerth and Hawley 1962, Buskirk & MacDonald 1984). The larger prey items (meadow voles and hare) are preferred and are especially important in the marten's winter diet (Raine 1987, Thompson and Colgan 1994). Hare increases in importance in the diet of marten as the winter progresses (Thompson and Colgan 1990).

Marten remain active throughout the winter. They do not store large energy reserves as fat prior to winter, nor is their long slender body shape conducive to energy conservation. Marten are estimated to require approximately 80 Kcal/day at rest during winter, roughly equivalent to the energy obtained from 3 voles (Buskirk 1983). In Ontario, Thompson (1986) reported that 85 percent of the caloric intake of marten in winter was comprised of hare when hare were abundant. Raine (1981) in Manitoba reported that hare made up 53 percent of marten diets in winter. Access to larger prey may allow marten to remain inactive in sheltered resting sites for longer periods of time, conserving energy and avoiding extremely low temperatures (Thompson 1986, Buskirk 1983).

The ability to capture sufficient prey during the winter months is critical to marten survival and reproduction. Marten embryos (blastocysts) remain in a suspended state throughout the winter. Active gestation does not begin until spring (Jonkel and Weckwerth 1963), when those females that have come through the winter in good shape begin active gestation. Reduced reproductive rates were observed in marten during prey declines in northern Ontario (Thompson and Colgan 1987). Marten densities were observed to fluctuate by as much as 85 percent during that same prey decline (Thompson and Colgan 1987). Similar reductions in population density were associated with prey reductions in Montana (Weckwerth and Hawley 1962).

During summer months, marten are most active at night when their principle prey is active, and therefore most easily detected (Buskirk 1983). However, during winter, marten switch to being most active during the warmest part of the day, even though this does not coincide with the activity patterns of their prey (Buskirk 1983, Thompson and Colgan 1994). Marten spend the coldest periods in resting sites, often beneath the snow (Steventon 1979, Raine 1981). Temperatures of less than - 15^{o} C were associated with reduced marten activity in northern Ontario (Thompson and Colgan 1994).

2.4 Population Density and Home Range

Marten occur at low densities and occupy large home ranges. Marten densities estimated in Algonquin Park ranged between 1.2 - 1.9 / km^2 with densities of resident adults estimated at 0.6 marten / km^2 (Francis and Stephenson 1972). Thompson and Colgan (1987) estimated marten densities (adults and juveniles combined) as high as 2.4 / km^2 in uncut forest during the fall when prey was abundant, and as low as 0.4 / km^2 in cutovers during a spring when prey were not abundant. In Maine, adult marten densities were estimated to be 1.2 / km^2 in unharvested forest, and 0.4 / km^2 in clearcut areas (Soutiere 1979). Archibald and Jessup (1984) estimated fall densities in the Yukon to be 0.6 adults / km^2. Expected densities for a carnivore of equal body size to that of marten are approximately ten times higher than those reported for marten (Buskirk and Ruggiero 1994).

Home ranges of male marten are 2 - 3 times larger than those of females and usually overlap several female home ranges. Home ranges estimated through mark-recapture studies in Algonquin Park were 3.6 km^2 for males and 1.1 km^2 for females (Francis and Stephenson 1972). A number of radiotelemetry studies estimated home range sizes between 2.0 and 15.0 km^2 for males and 0.8 and 8.4 km^2 for females (Strickland and Douglas 1987). Thompson and Colgan (1987) reported telemetry-based home ranges of 3.4 and 1.0 km^2 for males and females respectively in uncut boreal forest in Ontario. Home ranges for marten are 3-4 times larger than what would be expected based on body size (Buskirk and Ruggiero 1994).

2.5 Habitat Relationships

In general terms, marten in the boreal forest are inhabitants of conifer dominated forests and associated vegetation types found nearby. In most studies, marten have been found to prefer mesic (moist) coniferous forest in the latter stages of succession, especially those with complex physical structure near the ground. Marten require a number of key habitat components including maternal den sites where the young are raised, winter dens and resting sites, abundant prey, and protection from the elements and predators.

2.5.1 Maternal Dens

Maternal den sites are usually located in cavities in dead and living trees, or fallen logs (Spencer 1981, Martin and Barrett 1983, Hargis and McCullough 1984, Wynne and Sherburne 1984). Large structures are required to provide sufficient space for raising young. Hollow cedar logs and standing stems larger than 40 cm diameter at breast height (dbh) were favoured in Maine (Wynne and Sherburne 1984).

2.5.2 Resting Sites and Dens

Marten use of resting sites differs between seasons. In summer, marten rest in the canopies of large conifer trees, usually in mature conifer forest (Steventon and Major 1982, Wynne and Sherburne 1984). Large diameter cavity trees are important summer resting sites in western North America, but are less important in eastern North America, perhaps due to their reduced availability. Although marten forage widely, they return to familiar resting sites within their territories (Simon 1980).

In winter, marten use resting sites and dens that are well insulated beneath the snow. Thirty of 31 winter den sites in Maine were beneath the snow in natural cavities formed around large decayed stumps (Steventon and Major 1982). All dens encountered by Thompson (1986) in northern Ontario were beneath the snow. In Manitoba, Raine (1981) noted winter den sites associated with the seed caches (middens) of red squirrels beneath the snow. Although marten may forage in a wide variety of conditions during winter, requirements for resting sites are more specific. When snow cover is continuous the vast majority of resting sites were associated with large logs, stumps and dead or declining trees (Lofroth and Steventon 1990).

Winter den sites are often associated with large stumps, decayed logs, and squirrel middens.

2.5.3 Foraging Habitat and Coarse Woody Debris

Thompson and Colgan (1987) suggest that the rate at which marten capture prey is a dominant factor influencing habitat choice. During winter months mice and voles continue to be active beneath the snow and provide a major component of the marten's diet. In order to hunt in these "subnivean" spaces, marten search out the natural hollows and air spaces in the snowpack which form around leaning trees, stumps, logs and other low physical structures commonly referred to as coarse woody debris (CWD). Steventon and Major (1982) and Sherburne and Bissonette (1994) suggest that the abundance of CWD may influence marten hunting success and therefore habitat suitability. Marten use of subnivean access sites in and around coarse woody debris has been described in most winter habitat studies. However, Thompson and Colgan (1994) believe that the important role of larger prey items such as hare decreases the importance of CWD in northeastern boreal forests. Snowshoe hare are usually caught on the surface or in slight depressions in the snow.

Abundant coarse woody debris provides access to small mammal prey during the winter

In summer, coarse woody debris continues to play an important role as habitat for mice and voles. Large logs in intermediate stages of decay and rotten stumps are critical components of the habitat for red-backed voles and other small mammals. The spaces beneath and within the logs are used as travel routes by small mammals. Hummocks, stumps and logs are prime locations for nesting. (Gunderson 1959, Raphael 1988).

2.5.4 Canopy Closure

Overhead canopy cover by conifers is a crucial component of marten habitat in the boreal forest. Snow depths beneath coniferous canopies are lower than in either open areas or deciduous stands, and temperature regimes are also moderated by the overhead canopy.

Intermediate levels of canopy closure between 40 and 70 percent seem to be preferred. Canopy closure less than 30 percent is avoided during winter (Koehler *et al*. 1975, Spencer *et al*. 1983). Snyder and Bissonette (1979) reported better live trapping success where the canopy closure of spruce and fir was greater than 50 percent. Marten in Alaska prefer spruce stands where overhead cover exceeds 70 percent (Buskirk 1984).

Intermediate canopy closure is often associated with late successional conditions, where individual tree mortality has created canopy gaps as well as significant coarse woody debris. Small canopy gaps may also provide more diverse understorey conditions that are favoured by small mammal populations (Hunter 1990), and snowshoe hare (Koehler 1990).

2.5.5 Forest Vegetation Types

Overwhelmingly, studies of marten habitat use have reported a preference for mesic or moist conifer and conifer-dominated mixedwood forest types (Buskirk and Powell 1994). Francis and Stephenson (1972) and Taylor and Abrey (1982) found marten to prefer mixed forests over pure conifer conditions in central Ontario, similar to the findings of Soutiere (1979) in Maine. de Vos (1952) noted heavy use of cedar swamps, and a preference for white spruce over black spruce or jack pine-spruce mixes in northeastern Ontario. Balsam fir and black spruce forests are used in Newfoundland (Snyder and Bissonette 1987) and black and white spruce dominated forests are the main habitat types used by marten in Alaska (Buskirk and MacDonald 1984).

Mature and overmature stands of fir and spruce are preferred habitat for marten.

Use of late successional conifer forests is higher in winter than summer (Campbell 1979, Soutiere 1979, Steventon and Major 1982, Buskirk *et al*. 1989). Avoidance of deep snow (Koehler and Hornocker 1977), cold winter temperatures (Buskirk *et al.* 1989) and predators are apparent reasons for heavier winter use of coniferous stands (Buskirk and Powell 1994).

Juveniles are found in a wider range of conditions than adults (Burnett 1981, Buskirk *et al.* 1989). Young animals are likely excluded from the best habitats by adults, and suffer higher mortality rates as a result.

2.6 Forest Ecosystem Classificiation and Marten

The Forest Ecosystem Classification (FEC) systems used in boreal Ontario (Sims *et al.*1990, McCarthy *et al*. 1995) integrate a number of factors that may influence marten habitat choice, and therefore provide some opportunity to characterize habitats. FEC classifications integrate both overstorey and understorey composition as well as soil features including texture, moisture and drainage regimes, and the form and amount of humus. FEC does not however, explicitly characterize structural components of forest stands.

D'Eon and Watt (1994) hypothesized marten use of FEC types in northeastern Ontario, and those predictions were subsequently field tested (Bowman *et al.* in press). Racey *et al.* (1989) also used FEC as a basis for predicting marten use of forest types in northwestern Ontario. Appendix 1 summarizes habitat relationships of marten based on FEC types used in the boreal forest of Ontario.

2.7 Habitat Suitability Index Models and Marten

Habitat suitability index (HSI) models have been developed in a number of jurisdictions to combine the various habitat requirements of marten into a single habitat rating. Allen (1982) developed the first suitability model for marten. This model was used to rate winter habitat, which was assumed to be most limiting. Allen (1982) used 4 variables to define suitability:

V1: Percent tree canopy closure where stands with less than 25 percent canopy closure are assumed to have no habitat value in winter, and stands with 50 percent or greater canopy closure were optimal.

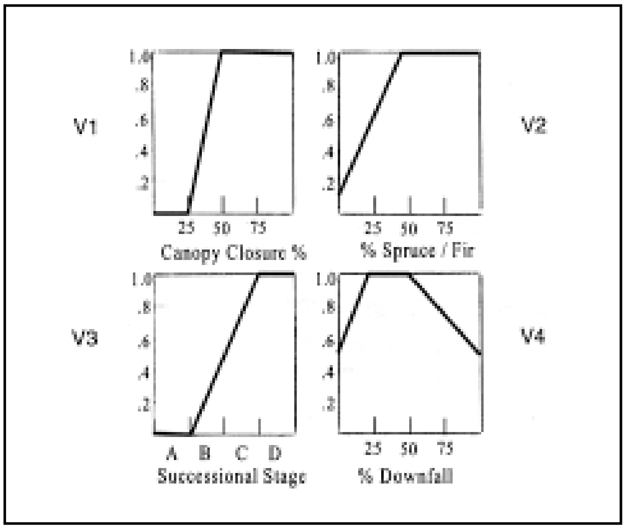
V2: Percent of overstorey comprised of spruce or fir where stands with 40 percent or greater spruce or fir in the overstorey were considered optimal and stands with no spruce or fir continued to have very low value.

V3: Successional stage of the stand - seedling/sapling development stages (A) were assumed to have no winter habitat value; polewood / sapling stands (B) had low value; young stands (C) had moderate value; and mature and overmature stands (D) had optimal value as winter habitat.

V4: Percent cover of downfall (CWD) where 25-50 percent cover by woody material larger than 7.6 cm in diameter was considered optimal.

Allen (1982) combined the four variables to obtain a final result, as follows:

$$HSI = (V1 * V2 * V3 * V4)^{1/2}$$



Allen's (1982) four variables used to rate marten habitat suitability.

Most other HSI models for marten are adaptations of Allen's original. In Central Ontario, Naylor *et al.* (1994) modified Allen's (1982) model to accommodate the use of Ontario's Forest Resource Inventory (FRI). Stand height was substituted for successional stage, percent spruce or fir was expanded to provide for weighted rankings of 8 different conifer species, and CWD was ranked by FRI working groups to provide an estimate of the availability of coarse woody debris. The rating for stand height was doubly weighted to acknowledge the perceived importance of this variable to marten habitat.

Preliminary testing of the Central Ontario model with trapline harvest data has been undertaken with encouraging results (Naylor *et al.* 1994).

Bowman *et al.* (in press) investigated winter habitat use near Timmins, Ontario and found that the best predictors of marten track occurrence and abundance were, in order of importance: percent composition of spruce and fir, stand height, the abundance of coarse woody debris and canopy closure. These studies confirm the basic structure of Allen's (1982) model.

3.0 Implications of Forest Management Activities

The available evidence suggests that marten are dependent on mature and overmature conifer dominated forests in Ontario. Thus there is a potential competition for stands - to either maintain them as marten habitat, or to harvest them for industrial purposes.

Fifty years of fire suppression in Ontario has apparently contributed to the development of a forest dominated by older aged stands (Ward and Tithecott 1993). Marten populations have increased over that time despite increased trapping (Strickland and Douglas 1987). As this older forest continues to age and succumbs to disease, blowdown, fire and insects, marten populations are expected to decline. The "normalization" of forest age class structures to meet industrial demands for wood fibre in boreal Ontario will necessarily add to the anticipated decline.

Forest industry requirements for wood promote rotation ages that fall below the age at which most stands begin to exhibit the structural characteristics required by marten. Intensive silviculture practices may further reduce the availability of structural features used by marten, and further simplify the species composition of conifer dominated mixedwood stands preferred by marten (Thompson 1991).

3.1 Clearcutting

The effects of clearcutting on marten habitat suitability and use are both immediate and long lasting. Densities of marten in new clearcuts are very low and stay low for up to forty years (Thompson and Harestad 1994, Soutiere 1979, Steventon and Major 1982, Snyder and Bissonette 1987). Home ranges are 3-4 times larger in areas that have been clearcut, and mortality in clearcuts is markedly higher than in uncut forests (Thompson 1994).

Where abundant coarse woody debris remains following a stand replacing disturbance such as fire or clearcutting, the negative impacts on marten may be partially mediated (Buskirk and Ruggiero 1994). The amount of CWD remaining may depend on the logging system being used, where full tree systems may leave less CWD than either tree length or shortwood systems.

Clearcutting in spruce dominated boreal forests results in marked changes in the small mammal community. Red-backed voles are replaced as the dominant small mammal by less preferred prey (e.g. deer mice and shrews) in upland habitats (Sims and Buckner 1973, Martell and Radvanyi 1977, Martell 1983) and by meadow voles in lowland spruce where grasses and sedges colonize recent cutovers. Snowshoe hare usually do not colonize cutover habitats for up to seven years, and peak use normally does not occur until after 20 years (Litvaitis *et al.* 1985).

Although in some cutovers, meadow voles can become quite common, they remain largely inaccessible to marten if subnivean access sites are not abundant. In many clearcuts, coarse woody debris is uncommon, having been trampled, windrowed, removed from the site, or burned in prescribed fires. Meadow voles and hares are also noted for their population fluctuations between years, making their availability as prey unpredictable from year to year. In a severe winter in northern Ontario, meadow voles were absent from a recent lowland spruce cutover until June (Courtin unpubl.).

Marten that do forage in cutovers in winter experience higher mortality rates due to predation and trapping (Thompson 1994).

3.2 Partial Harvesting

Partial harvesting of forest stands provides some opportunity to maintain marten populations in harvested forests. Diameter limit cuts in Maine that left 40 percent of the original spruce-fir basal area did not reduce marten densities (Soutiere 1979). Campbell (1979) reported that harvesting up to 57 percent of the harvestable trees had little impact on habitat quality. Partial harvests that leave 40 - 50 percent of the canopy or 50 percent of the basal area of forest stands should continue to provide suitable marten habitat (Spencer *et al.* 1983, Lofroth and Steventon 1990).

Partially harvested stands usually develop more varied structural conditions which provide habitat for a diverse prey base for marten. The replacement of red-backed voles as the dominant species in the small mammal community that was observed in clearcut forests has not been observed in partial harvests in mixedwoods (Martell 1983), nor in diameter limit cutting in lowland black spruce forests (Courtin and Beckerton 1996).

3.3 Silvicultural Interventions

Clearcut and intensive renewal treatments designed to maximize wood production, do so at the expense of diverse structural conditions within a stand (Thompson 1991). In turn, these treatments might contribute to lower prey densities and lower densities of predators including marten. Mechanical site preparation, for example, has been implicated in the elimination of red-backed voles from cutover sites (Martell 1983).

3.4 Landscape Composition

Forest landscape composition will continue to change as a result of the combined forces of natural succession and forest management activities. The area in older age classes preferred by marten will decrease. The availability of spruce/fir communities on the landscape is also expected to change.

Current age-class distributions across much of Ontario's boreal forest reflect the history of fire suppression. The percentage of older age stands will decrease markedly over the next 40 years.

As forest stands are harvested, burned or otherwise disturbed, there is a natural tendency for aspen and birch to colonize these open sites, especially in mixedwood forests. A reduced proportion of spruce on regenerating sites has been observed across boreal Ontario (Hearnden *et al.* 1992). This reduction in potential marten habitat may be partially alleviated by the increasing incidence of balsam fir.

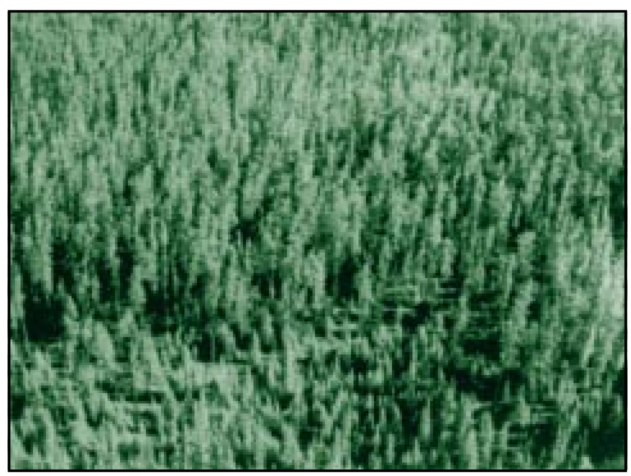
The combined impact of increased younger aged forests and reduced spruce composition will have serious implications for the quantity and quality of marten habitat.

Soutiere (1979) believed that in order to maintain a residual population of marten within a commercially clearcut forest, 25 percent of that forest should remain in mature and overmature conditions.

3.5 Landscape Configuration

Understanding of the impacts of landscape configuration and pattern on marten is limited. Nevertheless, it is believed that continued fragmentation of the mature conifer forest will have negative impacts on marten populations.

As forests become more fragmented, the populations of many species fluctuate more markedly (Wiens 1985). The combination of delayed sexual maturity, low reproductive output, and marked reductions in marten pregnancy rates during years of low prey availability are indicative of the susceptibility of marten populations to similar fluctuations.



Marten require large tracts of mature conifer dominated forests.

The large home ranges, and corresponding low densities that marten exhibit provide further evidence that large areas of suitable habitat are required to sustain their populations.

Marten appear to avoid travelling through large expanses of open habitat and rarely venture more than 500 - 1000 m from uncut forest areas (Steventon 1979, Soutiere 1979, Steventon and Major 1982, Snyder and Bissonette 1987). Small populations of marten that are isolated from each other by large clearcut areas are at increased risk of local extinction. Should a random natural event deplete one of these isolated marten populations there would be a lower probability of recolonization.

4.0 Recommended Forest Management Guidelines

The recommendations that follow are designed to maintain healthy populations of marten. They recognize that an increasing amount of forest area will be maintained in younger age-classed stands, but ensure that networks of core habitat are maintained across forest landscapes. Further, if core habitat areas are to serve their intended purpose, marten harvest should be monitored and quotas adjusted where necessary to ensure that populations in core habitat areas are not undermined.

4.1 <u>Landscape Composition</u>

The key to maintaining healthy marten populations in managed forests is to ensure that large areas of quality marten habitat are maintained across the landscape.

Determining just how much older forest is required to ensure healthy marten populations, requires sophisticated analytical modelling and knowledge of detailed population parameters, both of which are not presently available. In the absence of analytical results, a decision must be based on current understanding of natural disturbance regimes, their variation, and the forest conditions they produce. Van Wagner (1978) hypothesized that under natural fire regimes approximately 1/3 of the forest area, on average, would be in mature and overmature conditions. However, the extreme variation experienced in some natural systems might result in the loss of all suitable marten habitat during some time periods. In a managed forest where a continuous supply of many benefits is desired, and where natural events such as fire and insects are also disturbing the forest, these extreme levels of natural variation should be avoided. A conservative level of suitable habitat must be established that is large enough to avoid the risk of losing marten habitat over large areas of the boreal forest.

Maintain 10 - 20 percent of the forest, which has the capability to produce marten, in suitable conditions.

Capable forest types are those that, at maturity, support a spruce, fir, or cedar dominated or mixed forest condition. These stands can be identified from current FRI stand descriptions, or based on FEC site and vegetation types as rated in Appendix 1.

Suitable conditions are achieved where stands have the following characteristics:

- ***the species composition of the overstorey is greater than 40 percent spruce, fir, or cedar with mixed composition being preferred over pure stands.***
- ***the canopy closure of conifers is greater than 50 percent.***
- ***are found within preferred FEC site types and vegetation types for northeastern and northwestern Ontario. They are those rated as “Good” or “Fair” in Appendix 1.***

- ***are at least 15 m in height (approximately 80 years old). Uneven canopies are preferred.***

4.2 Landscape Structure

Suitable marten habitat should be arranged in "core habitat areas" between 30 and 50 km^2 in size. A minimum of 75 percent of core habitat areas should be comprised of suitable stands.

Stands which are suitable for marten habitat should be maintained in aggregations of sufficient size to support 25 or more adult marten. Sub-populations of this size should be able to persist for 40 - 50 years when the surrounding habitat should once again be capable of supporting adult reproduction. Core area requirements have been developed based on conservative estimates of marten density between 0.6 - 0.8 adult marten / km^2 in good to moderate habitat conditions.

A variety of other habitat types, including hardwood dominated forests, wetlands, meadows, and small patch cuts add to the diversity of local landscapes and increase the diversity and abundance of prey within the core habitat area.

Partial harvesting can occur in as much as 30 percent of the core habitat area, provided it retains 50 percent of the original conifer basal area and canopy closure of at least 50 percent.

Partial harvesting promotes structurally diverse stands and provides some opportunity to harvest wood from core areas.

Core areas should be connected by riparian reserves and other unharvested forest. While connections need not be continuous, gaps of open habitat more than 1 - 2 km in width should be avoided.

Core areas form the basis for recolonizing the surrounding cutover forest and should be well distributed across the landscape. Wherever possible, they should be interconnected to promote continued genetic interchange and minimize the effects of natural population declines within individual core areas.

Younger stands are unlikely to provide the structurally diverse conditions, snags, and coarse woody debris preferred by marten. Stands must have reached a stage where mortality of larger trees has commenced.

4.3 Stand Level

It is recommended that harvesting practices be modified within the bounds of the Occupational Health and Safety Act, to promote the retention of at least 6 dead or declining trees per hectare, with at least 2 of these exceeding 30 cm dbh.

Dead and declining trees play an important role in marten reproduction and in the habitat requirements of their prey. Continued efforts to conserve dead and declining trees in managed forests are required in the face of shorter rotations, mechanized harvesting, and rigorous utilization standards.

Further details on the management of cavity trees, and otherwise dead or declining trees, can be found in the guidelines for pileatedwoodpeckers (Naylor *et al.* 1996) and in a separate technical note for boreal forests (Watt 1996).

Silvicultural practices that retain logs, stumps and other coarse woody debris on site are encouraged.

The role of coarse woody debris in almost all aspects of marten ecology warrants special consideration of this element in management practices. Harvesting systems that leave slash at the stump, rather than at roadside, and site preparation techniques that minimize slash removal and alignment are preferred options.

5.0 Application of the Guidelines

It is mandatory that the marten guidelines be applied in boreal forest conditions in Ontario. In the area of transition between the boreal and Great Lakes St. Lawrence forest, managers must make a choice between applying the marten or the pileated woodpecker guidelines. In this situation, although managers may choose to apply both guidelines, it is only mandatory to apply one or the other, not both. The choice of which guideline to apply should be based on an assessment of the habitat capability and suitability for the management unit and in consideration of any ecoregional direction.

The following illustrates the necessary steps that a management team needs to follow to ensure reasonable consideration of the guidelines and to perpetuate healthy marten populations.

Step 1 . The first step in applying the guidelines is to set preliminary objectives for marten populations and habitat within the planning unit. The context for setting these objectives is found within existing land use plans, regional and provincial policy initiatives, and more specifically the results of an eco-regional analysis of habitat supply for marten.

Step 2 . The planning team should then determine the total area within the planning unit that is capable of providing suitable habitat for marten at some time during the planning horizon. This determination of production capability for marten is a critical step in formulating management alternatives, and may also provide rationale to revisit and alter the objectives decided upon in Step 1.

Step 3 . At this point, the team can begin the iterative process of developing and testing forest management alternatives to determine their effects on sustainability. The planning team should conduct analyses to determine the impacts of each alternative on the availability of suitable marten habitat, the sustainable flow of fibre and other forest products, and the sustainability of other forest values.

If the Strategic Forest Management Model (SFMM) is being used the model can be constrained to find solutions that maintain at least 10 - 20 percent of the capable forest types in suitable conditions for marten (i.e. >80 years). A number of model runs should be conducted to determine the impacts on all objectives of maintaining varying proportions between 10 and 20 percent of those forest types in suitable age classes for marten habitat.

Step 4 . Once the planning team has decided on the habitat supply scenario, they must determine the location and spatial arrangement of core habitat areas for marten for each 20 year period within a 100 year planning horizon. Special consideration should be given to the connections between core areas when they are being allocated. The use of riparian reserves, younger stands, and areas scheduled for partial harvesting should be considered as potential corridors.

Step 5 . Any core area where operations are proposed in the next 5 year period must be evaluated and planned in detail.

The planning team should ensure that stands within the core habitat are indeed suitable, and that in total, they comprise approximately 75 percent of the core area. This detailed analysis provides the opportunity to adjust core area boundaries to accommodate as many objectives as possible.

Any proposed harvest treatments scheduled for the core area must be laid out and identified as part of an Area of Concern (AOC), with an appropriate prescription.

Step 6 . Silvicultural ground rules should be modified within the bounds of the Occupational Health and Safety Act (RSO 1990), to reflect the requirements to retain standing dead trees, live residual trees, and coarse woody debris.

Appendix 2 contains an example of how to apply the guidelines.

6.0 Future Directions

This first version of the marten guidelines will be revised when improved scientific understanding and/or new methods are developed to more accurately forecast changes in habitat quantity and quality. Future versions of the guidelines will also be consistent with, and complimentary to MNR's proposed ecological land use plans.

6.1 Habitat Supply Forecasting

The need to consider long time frames and large geographic areas in applying these guidelines highlights the need for habitat supply modelling.

Eco-regional analyses of habitat supply will provide a context for forest management unit level decisions. Forecasts of habitat supply will be used to guide decisions for minimizing potential adverse effects on the future quantity and quality of habitat.

Preliminary estimates of habitat suitability (D'Eon and Watt 1994) have been linked to the Strategic Forest Management Model (SFMM) and non-spatial estimates of habitat availability can be forecasted at the eco-regional and forest management unit level.

However, information about the spatial arrangement and distribution of various habitats, which non-spatial models cannot provide, is required to understand the implications for wildlife populations.

Naylor *et al.* (1994) have developed an HSI model for marten in central Ontario, and have linked that model to a forest simulator to project marten habitat suitability under differing management strategies. This model provides spatial estimates of habitat availability at the coarse resolution of individual traplines or mapsheets.

Prototype models have been developed to provide stand level spatial resolution. McCallum (1993) linked an HSI model to a spatial forest simulator and generated spatially explicit forecasts of marten habitat quality. The model is still under development.

Ultimately it will be necessary to translate forecasts of habitat change into forecasts of population change. Reliable forecasts of population change are difficult because there is not necessarily a one-to-one correspondence between habitat change and population change.

A population viability assessment (PVA) model is being investigated for use in Ontario. In combination with a spatial forest simulator this model would allow managers to spatially assess the viability (likelihood of persistence) and the abundance of marten populations across managed forest landscapes.

A number of knowledge gaps limit our ability to use these more sophisticated modelling techniques. Emergent properties of landscapes which influence marten habitat use are not completely understood. PVA models that require estimates of population parameters such as age specific mortality rates, reproductive rates, and dispersal success have not been tested across Ontario. Finally, the impacts of individual silvicultural treatments on components of marten habitat are only qualitatively understood.

Improved scientific understanding of habitat and population interactions, and improved methods for applying that knowledge through spatial models will be incorporated into future versions of these guidelines. These improvements will provide a more realistic portrayal of the expected effects of habitat change on the status of marten populations.

6.2 Ecological Land Use Planning

The future vision of land use planning in Ontario consists of ecological land use plans for large, ecologically based planning areas, accompanied by operational planning for smaller areas and management units.

Ecological land use planning will:
(i) integrate direction from relevant provincial policies, (ii) establish broad objectives and management standards for the key natural resources within the planning area, and (iii) allocate land and natural resources among competing uses. These ecological plans will provide a clear basis for operational planning at the local forest management unit level.

Ecological land use plans will provide a context to ensure that local operational planning decisions will contribute to sustainable resource use and the conservation of biodiversity.

An important component of ecological land use plans will be to establish objectives for the desired future forest condition. These objectives will be based, at least in part on the landscape and stand conditions expected under natural disturbance regimes. Future versions of these guidelines will reflect this change.

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Literature Cited

Allen, A.W. 1982. Habitat suitability index models: marten. US Fish Wildl. Serv. FWS/OBS-82/10.11. 9 p.

Archibald, W.R. and R.H. Jessup. 1984. Population dynamics of the pine marten (*Martes americana*) in the Yukon Territory. p. 81-97. *in* Olsen, R., R. Hastings, F. Geddes. comps., eds. Northern ecology and resource management. Edmonton, Alberta. University of Alberta Press.

Bowman, J.C., J.F. Robitaille and W.R. Watt. In press. Forest Ecosystem Classification: a tool for managing marten habitat? (accepted For Chron.)

Burnett, G.W. 1981. Movements and habitat use of American marten in Glacier National Park, Montana. University of Montana. MSc Thesis. 130 p.

Buskirk, S.W. 1983. The ecology of marten in south-central Alaska. Fairbanks Alaska. Univ. Alaska. PhD Thesis. 131 p.

Buskirk, S.W. 1984. Seasonal use of resting sites by marten in south central Alaska. J. Wildl. Manage. 48: 950-953.

Buskirk, S.W., S.C. Forrest, M.G. Raphael and H.J. Harlow. 1989. Winter resting site ecology of marten in the Central Rocky Mountains. J. Wildl. Manage. 53: 191-196.

Buskirk, S.W. and S.O. MacDonald. 1984. Seasonal food habits of marten in south-central Alaska. Can. J. Zool. 62: 944-950.

Buskirk, S.W. and L.F. Ruggiero. 1994. American marten. p. 7-37. *in* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, W.J. Zielinski Tech. eds. The scientific basis for conserving forest carnivores; American marten, fisher, lynx, and wolverine in the western United States. USDA For. Serv. Gen Tech. Rep. RM-254.

Buskirk, S.W. and Powell, R.A. 1994. Habitat ecology of fishers and American martens. p. 283-296. *in* Buskirk, S.W., A.S. Harestad and M.G. Raphael. comps., eds. Martens, sables and fishers: biology and conservation. Ithica, N.Y. Cornell University Press.

Campbell, T.M. 1979. Short-term effects of timber harvests on pine marten ecology. Fort Collins, CO. Colorado State University. MSc Thesis. 71 p.

Courtin, G.M. and Beckerton, J. 1996. Does the practice of careful cutting maintain biodiversity? presented at the National Model Forest Network Meeting. Cochrane, Ontario. Feb. 1996.

D'Eon, R.G. and W.R. Watt. 1994. A forest habitat suitability matrix for northeastern Ontario. OMNR Northeast Science & Technology. Tech. Manual TM004. 83 p.

de Vos, A. 1952. Ecology and management of fisher and marten in Ontario. Toronto, Ont. Ontario Dept Lands. For. 90 p.

Francis, G.R. and A.B. Stephenson. 1972. Marten ranges and food habits in Algonquin Park, Ontario. Ont. Min. Nat. Res. Rpt. No. 91.

Gunderson, H.L. 1959. Red-backed vole habitat studies in central Minnesota. J. Mammal. 40: 405-412.

Hargis. C.D. and D.R. McCullough. 1984 Winter diet and habitat selection of marten in Yosemite National Park. J. Wildl. Manage. 48: 140-146.

Hawley, V.D. and F.E. Newby. 1957. Marten home ranges and population fluctuations in Montana. J. Mammal. 38: 174-184.

Hearnden, K.W., S.V. Millson, and W.C. Wilson. 1992. A report on the status of forest regeneration. The Ontario Independent Forest Audit Committee. Queen's Printer, Toronto. 117 p.

Hodgman, T.P , D.J. Harrison, D.D. Katnik, K.D. Elowe. 1994. Survival in an intensively trapped marten population in Maine. J. Wildl. Manage. 58: 593-600.

Hunter, M.L., Jr. 1990. Wildlife, forests and forestry. Englewood Cliffs, N.J. Prentice Hall. 370 p.

Jonkel, C.J. and R.P. Weckwerth. 1963. Sexual maturity and implantation of blastocysts in the wild pine marten. J. Wildl. Manage. 27: 93-98.

Koehler, G.M. 1990. Demographic and habitat characteristics of lynx and snowshoe hares in north-central Washington. Can. J. Zool. 68: 845-851.

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

Koehler, G.M., W.R. Moore and A.R. Taylor. 1975. Preserving the pine marten: management guidelines for western forests. Western Wildlands 2: 31-36.

Litvaitis, J.A., J.A. Sherburne and J.A. Bissonette. 1985. Influence of understorey characteristics on snowshoe hare habitat use and density. J. Wildl. Manage. 49: 866-873.

Lofroth, E.C. and J.D. Steventon. 1990. Managing for marten winter habitat in interior forests of British Columbia. p. 67-75. *in* Chambers, A. ed. Symposium proceedings, Wildlife forestry symposium: a workshop on resource integration for wildlife and forest managers. Prince George, B.C. Forestry Canada.

Martell, A.M. 1983. Changes in small mammal communities after logging in north-central Ontario. Can. J. Zool. 61: 970-980.

Martell, A.M. and A. Radvanyi. 1977. Changes in small mammal communities after clearcutting of northern black spruce forest. Can. Field Nat. 91: 41-46.

Martin, S.K. 1994. Feeding ecology of American martens and fishers . p. 297-315 *in* Buskirk, S.W., A.S. Harestad and M.G. Raphael. comps., eds. Martens, sables and fishers: biology and conservation. Ithica, N.Y. Cornell University Press.

Martin, S.K. and R.H. Barrett. 1983. The importance of snags to pine marten habitat in the northern Sierra Nevada. p. 114-116. *in* Davis, J.W., G.A. Goodwin, R.A. Ockenfels. Tech. coords. Proceedings of the symposium on snag habitat management. USDA For. Serv. Gen. Tech. Rep. RM-99.

McCallum, R.I. 1993. Long term effects of timber management on marten (*Martes americana*). Habitat Potential in an Ontario Boreal Forest, MSc. Thesis. Lakehead University. 190 p.

McCarthy, T.G., R.W. Arnup, J. Nieppola, B.G. Merchant, K. Taylor, and W.J. Parton. 1995. Field guide to forest ecosystems of northeastern Ontario. OMNR, Northeast Science & Technology. Field Guide FG001.

Mead, R.A. 1994. Reproduction in martens and fishers. p. 404-422. *in* Buskirk, S.W., A.S. Harestad and M.G. Raphael. comps., eds. Martens, sables and fishers: biology and conservation. Ithica, N.Y. Cornell University Press.

Naylor, B., J.Baker, D.Hogg, J.McNicol, and W.R. Watt. 1996. Forest management guidelines for the provision of pileated woodpecker habitat. OMNR. (in press)

Naylor, B., T. Bellhouse, S. Christilaw and P. Weilandt. 1994. Development and validation of a habitat suitability index model for the American marten in central Ontario. OMNR Central Region Science and Technology. Tech. Rep No. 29. 13 p.

Racey, G.D., T.S. Whitfield, and R.A. Sims. 1989. Northwestern Ontario forest ecosystem interpretations. Thunder Bay, Ont. OMNR Tech. Rep. No. 46. 990 p.

Raine, R.M. 1981. Winter food habits, responses to snow cover, and movements of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba. Winnipeg, Manitoba. University of Manitoba. MSc Thesis. 144 p.

Raine, R.M. 1987. Winter food habits and foraging behaviour of fishers (*Martes pennanti*) and martens (*Martes americana*) in southeastern Manitoba. Can. J. Zool. 65: 745-747.

Raphael, M.G. 1988. Habitat associations of small mammals in a subalpine forest, southeastern Wyoming. p. 359-367. *in* Szaro, R.C., K.E. Severson, and D.R. Patton. eds. Symposium Proceedings: management of amphibians, reptiles and small mammals in North America. USDA For. Serv. Gen. Tech. Rep. RM-166.

Sherburne, S.S. and J.A. Bissonette. 1994. Marten subnivean access point use: response to subnivean prey levels. J. Wildl. Manage. 58: 400-405.

Simon, T.L. 1980. An ecological study of the marten in the Tahoe National Forest, California Sacremento, CA. California State University. MSc Thesis. 143 p.

Sims, R.A., W.D. Towill, K.A. Baldwin, and G.M. Wickware. 1989. Field guide to ecosystem classification for northwestern Ontario. Toronto, Ont. OMNR. 191 p.

Sims, H.P. and C.H. Buckner. 1973. The effect of clearcutting and burning of *Pinus banksiana* forests on the populations of small mammals in southeastern Manitoba. Am. Midl. Nat. 90: 228-231.

Snyder, J.E. and J.A. Bissonette. 1987. Marten use of clearcuttings and residual forest stands in western Newfoundland. Can. J. Zool. 65: 169-174.

Soutiere, E.C. 1979. Effects of timber harvesting on marten in Maine. J. Wildl. Manage. 43: 850-860.

Spencer, W.D. 1981. Pine marten habitat preferences at Sagehen Creek, California. MS Thesis. Univ. California, Berkely. C.A.

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

Steventon, J.D. 1979. Influence of timber harvesting upon winter habitat use by marten. Orono ME. School of Wildlife Management, University of Maine at Orono, M.A. Thesis. 24 p.

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

Strickland, M.A. and C.W. Douglas. 1987. Marten. p. 531-546 *in* Novak, M., J.A. Baker, M.E. Obb
ard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ont. Trappers. Assoc. North Bay Ont.

Taylor, M.E. and N. Abrey. 1982. Marten (*Martes americana*) movements and habitat use in Algonquin Provincial Park, Ontario. Can. Field Nat. 96: 439-447.

Thompson, I.D. 1986. Diet choice, hunting behaviour, activity patterns, and ecological energetics of marten in natural and logged areas. Kingston, Ont. Queens University PhD Diss. 179 p.

Thompson, I.D. 1991. Could marten become the spotted owl of eastern Canada? For. Chron. 67: 136-140.

Thompson, I.D. 1994. Marten populations in uncut and logged boreal forests in Ontario. J. Wildl. Manage. 58: 272-280.

Thompson, I.D. and P.W. Colgan. 1987. Numerical responses of martens to a food shortage in northcentral Ontario. J. Wildl. Manage. 51: 824-835.

Thompson, I.D. and P.W. Colgan. 1990. Prey choice by marten during a decline in prey abundance. Oecologia 83: 443-451.

Thompson, I.D. and P.W. Colgan. 1994. Marten activity in uncut and logged boreal forests in Ontario. J. Wildl. Manage. 58: 280-288.

Thompson, I.D. and A.S. Harestad. 1994. Effects of logging on American martens with models for habitat management. p. 3355-367. *in* Buskirk, S.W., A.S. Harestad and M.G. Raphael. comps., eds. Martens, sables and fishers: biology and conservation. Ithica, N.Y. Cornell University Press.

Van Wagner, C.E. 1978. Age-class distributions and the forest fire cycle. Can. J. For. Res. 8: 220-227.

Ward, P.C. and A.G. Tithecott. 1993. The impact of fire management on the boreal landscape of Ontario. OMNR. AFFMB Publication No. 305. 12 p.

Watt, W.R. 1996. Managing for snags in boreal forests of northeastern Ontario. Northeast Science and Technology Technical Manual (in press)

Weckwerth, R.P. and V.D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26: 55-74.

Wiens, J.A. 1985. Vertebrate responses to environmental patchiness in arid and semi-arid ecosystems. p. 169-193 *in* Pickett, S.T.A. and P.S. White. eds. The ecology of natural disturbance and patch dynamics. San Diego, CA. Academic Press

Wynne, K.M. and J.A. Sherburne. 1984. Summer home range use by adult marten in northwestern Maine. Can. J. Zool. 62: 941-943.

Yeager, L.E. 1950. Implications of some harvest and habitat factors on pine marten management. Trans. N.A. Wildl. Conf. 15: 319-334.

Appendix 1. Forest ecosystem classification interpretations for marten habitat suitability for northeastern and northwestern Ontario.

Suitability	NW Ontario Vegetation Types	NE Ontario Site Types	NE Ontario Vegetation Types
Good	6, 7, 14, 15, 16, 19, 20, 21, 24, 25, 31	5A, 5B, 6A, 6B, 8, 9, 13	6, 7, 8, 9, 19, 20 21
Fair	1, 4, 8, 9, 10, 11, 22, 32, 33, 34	3A, 3B, 4, 6C, 11, 12	12, 13, 14, 18, 22
Poor	2, 3, 5, 12, 13, 17, 18, 23, 26, 27, 28, 29, 30, 35, 36, 37, 38	1,2A, 2B, 7A, 7B, 10, 14	1, 2, 3, 4, 5, 10, 11, 15, 16, 17, 23, 24, 25, 26

Appendix 2. Applying the Guidelines: An Example Forest

The example forest is situated in the transitional forest between the clay belt and the Chapleau Plains area in northeastern Ontario. This area has historically produced high marten densities and harvests, and contributes to the livelihood of 10 registered trappers.

The forest Management Unit (MU) has a history of logging dating back at least 25 years and supports a number of forest industries, most notably a lumber mill and an oriented strand board mill. Mill demands for wood exceed local supply, and wood supply for the Region has been described as tight but manageable.

The total forested area of the example FMU is 400,000 ha. However, only 285,000 ha is considered to have the "capability" to develop the mesic conifer dominated forest conditions used by marten. The remaining 115,000 ha of forested land is comprised of jack pine sand flats, upland dominated by relatively pure aspen communities, and scattered black spruce bogs. None of these conditions are likely to develop into a mesic conifer-dominated condition without a high level of management intervention.

The Strategic Forest Management Model (SFMM) was used to evaluate the implications, and determine the sustainability, of maintaining suitable marten habitat on the landscape throughout the planning horizon at three levels: (i) a minimum of 28,500 ha of suitable habitat (10 percent of capable habitat), (ii) 42,750 ha of suitable habitat (15 percent level), and (iii) 57,000 ha of suitable habitat (20 percent level).

The results of SFMM analyses indicated that maintaining an even flow of more than 28,500 ha of suitable marten habitat, had serious wood supply implications, and that wood supply deficits in the 40 - 60 year time period were unacceptable. A follow up analysis was conducted to determine what mix of habitat levels might be sustained given the socio-economic concerns identified.

The planning team was able to identify the following option which provided more than minimal amounts of habitat in most time periods, and met the other plan objectives, including the wood fibre demands:

Years 0 - 20	57,000 ha (20 percent)
Years 21 - 40	42,750 ha (15 percent)
Years 41 - 60	28,500 ha (10 percent)
Years 61 - 80	42,750 ha (15 percent)
Years 81 +	57,000 ha (20 percent)

Having identified the time period specific objectives for suitable marten habitat, the planning team is faced with the difficult task of identifying where and how the area targets will be apportioned to core habitat areas.

A thematic map of the management unit should be created, depicting the location of all "capable habitat" conditions, and identifying the current age of the stands in 20 year age classes. The planning team can use this map to identify specific geographic areas where potential exists to establish core habitat areas in each 20 year planning period. The selection of specific core areas should include consideration for multiple values wherever possible. For example, core habitat areas for marten could also satisfy some of the late winter habitat requirements of moose. Selection of areas in proximity to high quality moose summer/ fall habitat, known aquatic feeding areas and calving sites should be considered.

Riparian reserves could also contribute to core habitat areas in many locations.

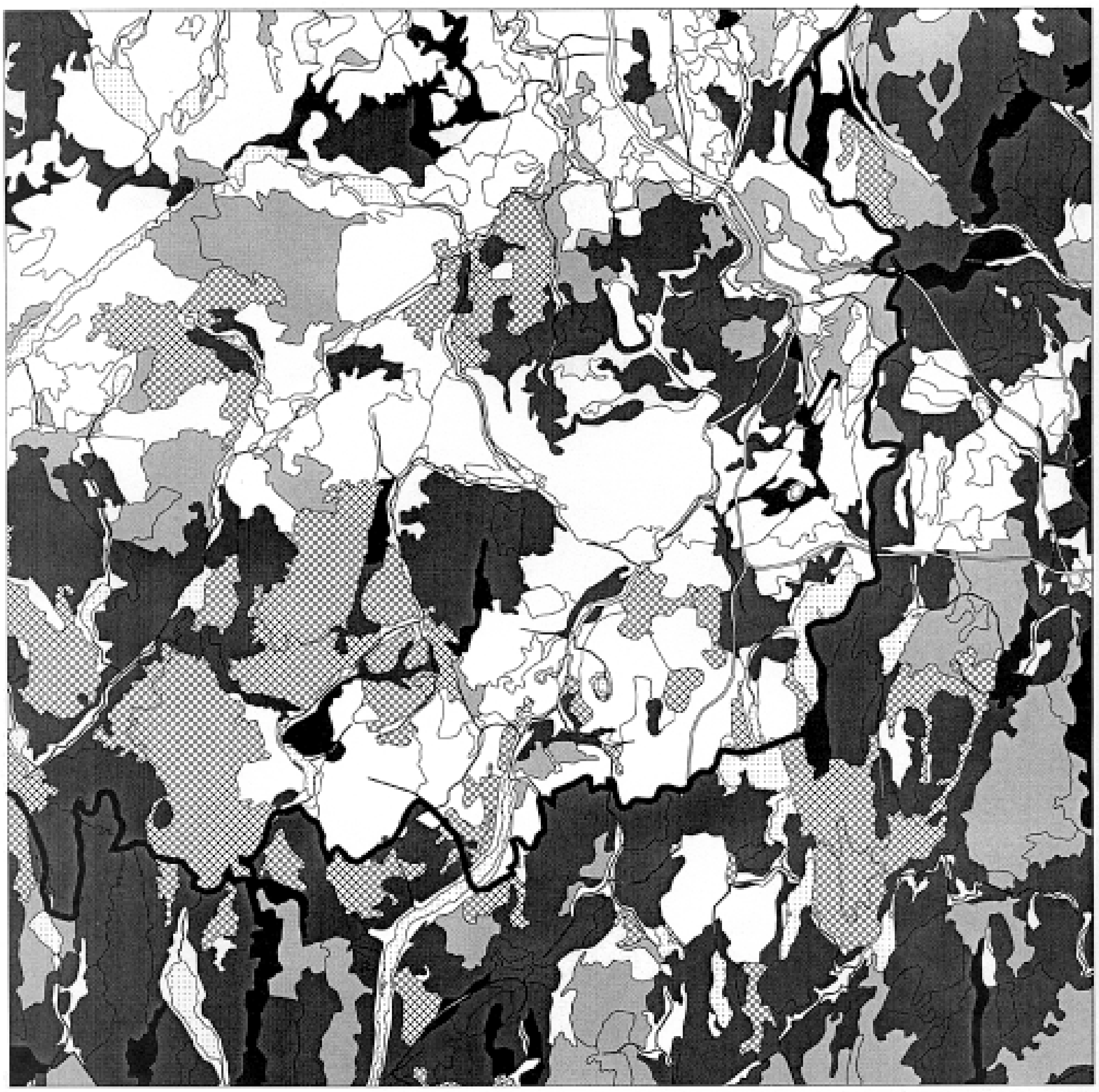
In the case of the 41 - 60 year time period, the planning team would look for between 6 and 10 potential core area sites of 3,000 to 5,000 ha each. Stands that were currently between 40 and 80 years of age would form the bulk of these potential core areas. In 40 years, those stands would be between 80 and 120 years of age and suitable for marten.

Once the planning team has identified the locations of present and core habitat areas, the planning team concentrates on developing detailed area prescriptions for any proposed operations within core habitat areas that might be affected in the next 5 year planning period. The accompanying map illustrates one such core habitat area where operations are proposed.

The core habitat area covers 3,437 ha in the southeast corner of the base map. The area falls along the slope of an esker where mixed coniferous -deciduous forest proliferates. FEC types (5b, 8,9,12) are abundant on the lower slopes and make up the bulk of the core habitat areas. Many of the FRI working group designations are to species other than spruce, fir, or cedar, but FRI attributes confirm that 40 percent of the species composition within those stands is either spruce, fir or cedar.

The age of most stands within the core habitat area fall between 80 and 90 years, and the planning team has identified that the area will contribute to marten habitat requirements for the next two 20-year planning periods. Within the core habitat area, 24 percent is comprised of mature jack pine and aspen communities that are unsuitable. Those areas have been proposed for harvest within the immediate 5 year operating plan. In both cases, group seed tree harvests are proposed to facilitate regeneration and provide future cavity trees. In addition, partial harvesting of 120 ha of spruce-pine and spruce-aspen stands is proposed adjacent to the pine and aspen clear cuts. The partial harvesting will be designed to remove 30 percent of the basal area, concentrating on merchantable jack pine and aspen stems.

Regeneration of the clear cuts will follow the existing silvicultural ground rules, and the partial harvest blocks will receive no further treatment until the spruce component is harvested, sometime after 40 years.



Marten Core Habitat Area - Little Nighthawk Lake

1:51000 (approx.)

Suitable (120+)	Capable (40-80)	Incapable Harvestable
Suitable (80-120)	Capable (0-40)	Incapable Unharvestable
Boundary	Water	