MARTEN

(Martes americana)

Source: Smith (1993)

Prepared for Millar Western Forest Products'
Biodiversity Assessment Project

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1.1 Introduction

The Marten (*Martes americana*) is a member of the weasel family. Its morphological features are indicative of its life as a predator (Drew and Bissonette 1997). Its long thin body has few fat reserves and is covered with a short brownish pelage (Takats *et al.* 1995).

The Marten is found in forested habitats across Canada and the United States (Figure 1) and is thought to be a habitat specialist to some degree, associated with old coniferous forest ecosystems of complex structure (Raine 1983 Snyder and Bissonette 1987 Thompson 1994 Thompson and Colgan 1994 Thompson and Curran 1995 Paragi *et al.* 1996 Chapin *et al.* 1997).

1.2 Effects of Forest Management Activities

The availability of mature to old coniferous-dominated core areas could be threatened by forest management activities. Research by Thompson (1994) revealed that Marten density is 90 higher in uncut coniferous forests with several vertical layers of vegetation, mossy ground cover, and full canopy cover in winter than in logged deciduous stands with leaf litter as a forest floor covering and little winter canopy closure. While Marten are known to utilise logged habitat, the breeding and survival rates are much reduced in these areas (Thompson 1994). However, logged forests may be used intermittently as foraging habitat, as travel corridors, or as tempo-

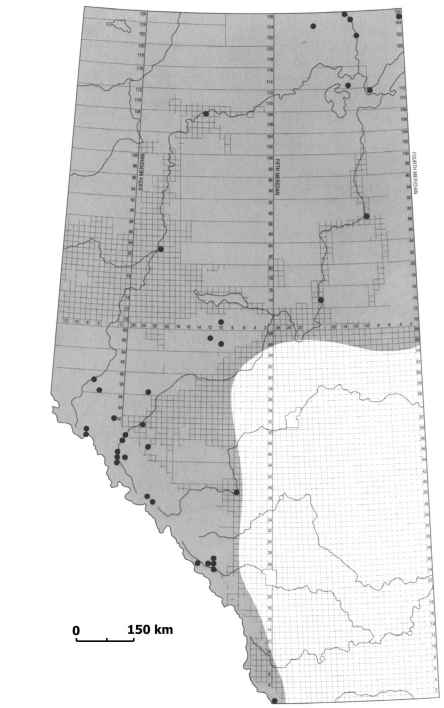

Figure 1. Estimated distribution of the Marten in Alberta (Smith 1993).

rary home ranges for young, dispersing individuals as long as complex structure is maintained (Todd pers. comm. 1999). Therefore, it is vital that forest managers be aware of Marten habitat requirements to ensure both its shelter and foraging needs are met through careful forest management planning.

2.0 HABITAT USE INFORMATION

2.1 Food Requirements

Marten Diet

Marten are considered opportunistic generalists with respect to foraging activities, although they may use some species as prey items more often than others (Weckworth and Hawley 1962 Buskirk and MacDonald 1984 Raine 1987 Thompson and Curran 1995 Paragi *et al.* 1996). Marten are known to rely strongly on Snowshoe Hare as a major prey item in some parts of its range (Ontario, Thompson and Colgan 1987 Thompson and Colgan 1994, western Northwest Territories, Poole and Graf 1996, western Newfoundland, Bateman 1986, and southeast Manitoba, Raine 1987). In other parts of its range, including Alberta, the Marten feeds primarily on microtine rodents (Cowan and MacKay 1950 Quick 1955 Weckworth and Hawley 1962 Soutiere 1979 Douglass *et al.* 1983 Slough *et al.* 1989 Nagorsen *et al.* 1989 Nagorsen *et al.* 1991). The suggestion that Marten are largely dependent on small mammals of the genus *Microtus* for food is supported by unpublished data of Todd (1991) which indicate that Marten population levels may oscillate with vole population sizes in three year cycles.

Along with microtine rodents and Snowshoe Hares, Marten will also consume Red Squirrels, mice, shrews, Ruffed Grouse and other birds, eggs, insects, fruits and berries, and carrion (Cowan and MacKay 1950 Quick 1955 Weckworth and Hawley 1962 Soutiere 1979 Douglass *et al.* 1983 Buskirk 1984 Buskirk and MacDonald 1984 Bateman 1986 Raine 1987 Nagorsen *et al.* 1989 Slough *et al.* 1989 Nagorsen *et al.* 1991 Bissonette and Broekhuizen 1995 Thompson 1994 Thompson and Colgan 1994 Takats *et al.* 1995 Thompson and Curran 1995 Paragi *et al.* 1996).

Fruits and berries may be an important component of the Marten's diet when available (Buskirk and MacDonald 1984) and may comprise up to 22 of its food during summer (Soutiere 1979). Although Marten generally avoid young clearcuts unless they are using them as travel corridors (discussed in the hiding cover section), they may take advantage of the soft mast-producing plants (particularly raspberries) that may be abundant in these areas (Soutiere 1979 Snyder and Bissonette 1987).

Foraging Habitat Requirements

As the small mammals, birds, and insects consumed by the Marten have variable habitat requirements, it can forage successfully in a variety of habitat types. It may be because of this fact that Marten home ranges tend to be mosaics, encompassing a wide range of habitat types.

Marten appear most comfortable in older coniferous-dominated stands (Thompson 1994). In fact, they have been found to hunt selectively in relict coniferous patches within logged ranges (Soutiere 1979 Snyder and Bissonette 1987 Thompson and Colgan 1994). They may be able to enter other habitat types to forage, however, as long as the necessary hiding cover is present to provide protection from predators (Snyder and Bissonette 1987 Thompson 1994 Thompson and Colgan 1994 Paragi *et al.* 1996 Chapin *et al.* 1997).

In winter, it is important that marten can enter the subnivean foraging environment through access points in the snow. Access points are provided by coarse woody debris, leaning trees, and stumps break through the snow surface (Corn and Raphael 1992 Sherburne and Bissonette 1994 Thompson 1994 Thompson and Colgan 1994 Thompson and Curran 1995 Paragi *et al.* 1996). Canopy closure > 30 helps to prevent snow hardening that may restrict Marten movement beneath the snow (Paragi *et al.*1996).

2.2 Cover Requirements

While mature to old coniferous or softwood-dominated forest is thought to provide optimal cover for the Marten (Raine 1983 Snyder and Bissonette 1987 Thompson 1994 Thompson and Colgan 1994 Thompson and Curran 1995 Paragi *et al.* 1996 Chapin *et al.* 1997), the animal may also be able to utilise other forest types such as clearcuts (Snyder and Bissonette 1987), second-growth logged stands (Thompson and Curran 1995), post-fire seres (Paragi *et al.* 1996), and stands with open overstorey (Chapin *et al.* 1997). The factors that ultimately control the animals' use of different habitat types are its ability to avoid predators and the capacity of the environment to provide thermal cover in winter.

Currently, it is believed that Marten active in the breeding population prefer to inhabit mature coniferous-dominated stands but may also use earlier successional seres as foraging or travelling habitat (Snyder and Bissonette 1987 Thompson and Curran 1995 Paragi *et al.* 1996 Chapin *et al.* 1997). Studies have shown, however, that young dispersing individuals may use recently clearcut or other sub-optimal habitats as home ranges (Snyder and Bissonette 1987 Paragi *et al.* 1996 Chapin *et al.* 1997). Although these individuals are thought not to be members of the breeding community (Thompson and Curran 1995), breeding may occur at a reduced rate in these suboptimal habitats (Thompson 1994).

Hiding Cover

It is thought that the Martens' association with old coniferous stands is due to the degree of closure of the canopy, the complex structure of the understorey vegetation, and the relative abundance of downed woody debris. These elements all work together to provide effective hiding cover for the animal (Thompson 1994 Thompson and Colgan 1994). However, if sufficient ground cover is present to effectively hide the Marten, other habitats including clearcuts, second-growth logged stands, post-fire seres, and stands with open canopies may provide appropriate shelter from predators (Snyder and Bissonette 1987 Bissonette and Broekhuizen 1995 Paragi *et al.* 1996 Chapin *et al.* 1997). The animals are thought to be able to avoid the attacks of avian predators by moving beneath downed woody debris or thick shrubby vegetation less than 3 m high (Snyder and Bissonette 1987 Paragi *et al.* 1996 Bissonette and Broekhuizen 1995 Chapin *et al.* 1997). Marten can climb trees to evade the advances of common terrestrial predators such as the coyote and wolf if one or more tall trees are present approximately every 25 m (Takats *et al.* 1995).

Chapin *et al.* (1997) and Todd (pers. comm. 1999) have mentioned that it may be the complex vertical and horizontal structure of understorey vegetation and downed woody debris, rather than the coniferous overstorey and stand age, that is important to Marten habitat suitability. It is the opinion of Stenhouse (pers. comm. 1999), however, that the balance between forest age and understorey characteristics is important to Marten. Radio telemetry studies support this claim. When Marten use younger stands, they move quickly, in direct paths to a patch of older coniferous-dominated forest, indicating that they do not feel comfortable within early successional seres even if suitable hiding cover is present.

Thermal Cover

While the Marten's body is well adapted for life as a predator (e.g. long, thin, minimal body fat, short pelage), it is not homeothermically efficient (Drew and Bissonette 1997). As laboratory tests have shown the Marten's minimum critical temperature to be 16 to 29° C, the animals are obligated to rest in suitable thermal cover (Drew and Bissonette 1997). In general, it is thought that spruce-dominated forests of at least 75 canopy closure best provide thermal cover. Mixedwood forests are also considered

appropriate as Marten habitat as long as more than 40 of the trees are coniferous, preferably spruce (Bissonette and Broekhuizen 1995 Takats *et al.* 1995).

Within these stands, Marten require access to the thermal cover of subnivean resting areas (Buskirk 1984 Buskirk *et al.* 1989 Corn and Raphael 1992 Schulz and Joyce 1992 Sherburne and Bissonette 1994 Paragi *et al.* 1996 Chapin *et al.* 1997 Drew and Bissonette 1997). Marten subnivean resting sites are often found in association with coarse woody debris. Not only does dead wood provide access to the subnivean environment, but woody material in an intermediate stage of decay has low thermal conductivity, improving the thermal properties of the resting site (Buskirk *et al.* 1989). In addition, the insulating properties of the snow allow the Marten to reduce energy loss. Snow can also act as cover for the animals as they hide from predators.

2.3 Reproduction Requirements

The Marten is a solitary animal that does not remain within family units for long periods of time (Paragi *et al.* 1996). While mating occurs in July and August, implantation is delayed and the young are born the following March or April, after 220 to 275 days of gestation (Takats *et al.* 1995).

The young Marten are born and raised in dens built in tree cavities, old stumps, rock piles, or squirrel middens (Buskirk 1984). While certain habitat areas are not selected specifically for the purpose of breeding, a female's reproductive success may be influenced by the quality of her home range (Paragi *et al.* 1996). This is thought to be a consequence of the vulnerability of young Marten to predation. Suitable canopy closure and understorey complexity are vital for their protection during this time (McCallum 1993 Paragi *et al.* 1996). Therefore, although Marten are occasionally found in less complex second-growth forests after logging, they are not thought to breed consistently in these areas (Thompson and Curran 1995).

2.4 Habitat Area Requirements

Although Marten are intrasexually territorial, they may share a range with a juvenile (Takats *et al.* 1995). Measured female home ranges vary from 59 to 2,056 ha while those of males are between 70 and 2,750 ha (Buskirk and MacDonald 1989). This large variation in home range size can be at least partially attributed to habitat quality (Bissonette and Broekhuizen 1995). In areas that are rather devoid of suitable forage, a male Marten holds a range of average size of 2,363 ha while a female may use 833 ha of forest. In more suitable stands, however, a male's range averages 628 ha while a female's is approximately 357 ha. During estrus, a female may extend her range to the size typical of males (Bissonette and Broekhuizen 1995). In the winter months, however, the proportion of the home range utilised by both males and females decreases, likely as an energy conservation measure (Bissonette and Broekhuizen 1995). Gordon Stenhouse (pers. comm. 1999) agrees that 700 ha is a reasonable starting point but asserts that field testing (of reproduction and recruitment) is required to ensure local applicability.

2.5 Landscape Configuration Requirements

Suitable Marten habitat should include both thermal and hiding cover as well as foraging areas. The home range should, therefore, appear as a mosaic of stands in different successional stages with attributes relating to feeding and sheltering Marten. It should include spruce-dominated stands (> 40 representation) with a high degree of canopy closure and shrub cover along with some recently cleared areas (3 to 15 years old) in which soft mast is available. Throughout all of its foraging and cover areas, the abundance, shape, configuration, and distribution of downed woody debris is important. This material provides access points to and supplies suitable thermal cover within the subnivean zone.

Marten are more vulnerable to predation as they venture into open areas. For this reason, the animals prefer to remain within 50 m of some suitable cover: habitat with ample coverage of large pieces of downed woody material and dense shrubby vegetation of height 1 to 3 m.

According to the research of Schulz and Joyce (1992), a suitable home range will contain at least 55 high quality Marten habitat.

3.0 MODEL

3.1 Envirogram

The elements that are thought to influence Marten habitat selection include conditions that enable escape from predators, the capacity of the environment to shelter it from cold, and its ability to successfully reproduce and raise young. Though the presence of food resources is also vital to the Marten, they are opportunistic generalists, consuming many different food items from various habitat types. The forest attributes influencing the animals' ability to survive and reproduce are summarised in the envirogram below (Figure 2).

3.2 Application Boundaries

Season: This model produces SI values for use year-round.

Habitat Area: Home range size used for home range smoothing is 700 ha.

Model Output: The model assigns a SI value for cover and hiding cover habitat suitability to each 25 m pixel of forested habitat.

3.3 Model Description

The HSM for Marten habitat follows the structure described in the envirogram (Figure 3). Thermal cover and denning sites are most readily found in mature to old coniferous forest with sufficient canopy closure and ample coverage of downed woody debris. The only variable included in the SI_{cover} equation is habitat type which approximates these three variables. Hiding cover of dense shrubby vegetation and small trees with some coverage of downed woody debris can offer protection from predation. Additionally, Marten may be able to move 50 m from hiding cover into open spaces. As Marten are able to utilise either shrubby vegetation or small trees as hiding cover, these two variables are compensatory. Downed woody debris cover enhances hiding cover habitat quality and is, therefore, included in the equation as a bonus function.

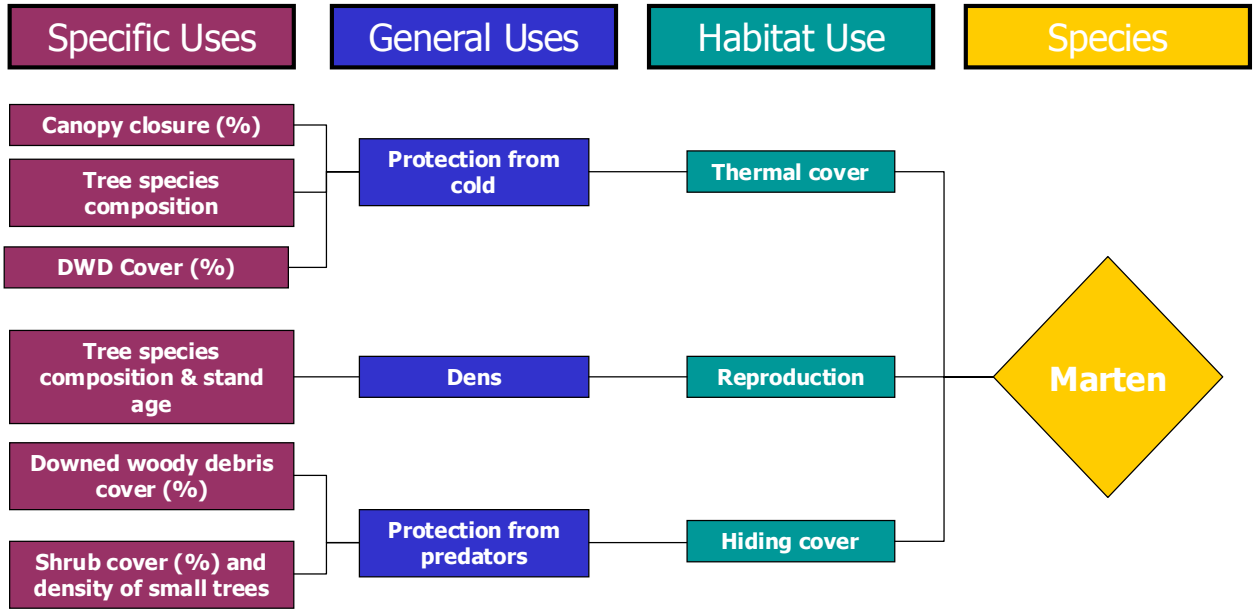

Figure 2. Envirogram of the Marten based on available habitat information for HSM development.

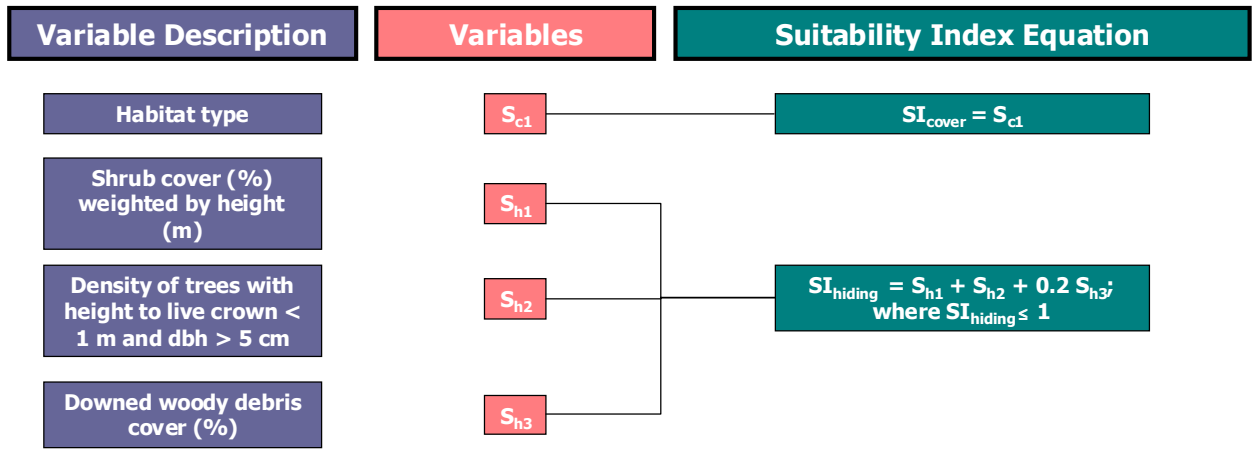

Figure 3. HSM structure for the Marten within Millar Western's FMA area.

3.4 Habitat Variable SIs

Cover

To assign cover suitability ratings to each habitat type (S_{c1}), the expected degree of canopy closure, tree species composition, and downed woody debris coverage by habitat type were all considered. Table 1 shows cover habitat suitability by habitat type.

Hiding Cover

SI_{hiding} indicates the potential of the stand to provide hiding cover based on its shrub cover weighted by height (S_{h1}), density of trees with low height to crown (S_{h2}), and downed woody debris cover (S_{h3}). Habitat suitability increases with shrub cover to a maximum at 50 cover (Figure 4) and with density of small trees to a maximum at 12,000 trees per ha (Figure 5). Suitability increases with downed woody debris cover to a maximum at 20 coverage (Figure 6).

Table 1. Marten cover habitat suitability by habitat type.

		Opening	Developing		Forest		Old
Broad	**Specific**	**Clearcut & Burns**	**Regenerating**	**Young**	**Immature**	**Mature**	**Old**
Hardwoods	Aspen					0.1	0.2
	Poplar					0.1	0.2
	White birch					0.1	0.2
Hardwood Mixed	Aspen-Pine				0.1	0.3	0.4
	Aspen-White spruce				0.2	0.4	0.6
	Aspen-Black spruce				0.1	0.3	0.4
	Poplar-Pine				0.1	0.3	0.4
	Poplar-White spruce				0.2	0.4	0.6
	Poplar-Black spruce				0.1	0.3	0.4
Softwood Mixed	Pine-Poplar				0.3	0.6	0.8
	Pine-Aspen				0.3	0.6	0.8
	White spruce-Poplar				0.4	0.8	1.0
	White spruce-Aspen				0.4	0.8	1.0
	Black spruce-Poplar				0.3	0.6	0.8
	Black spruce-Aspen				0.3	0.6	0.8
Conifers	Pine				0.5	0.7	0.9
	White spruce				0.5	1.0	1.0
	Black spruce				0.5	0.7	0.9
	Larch					0.1	0.2

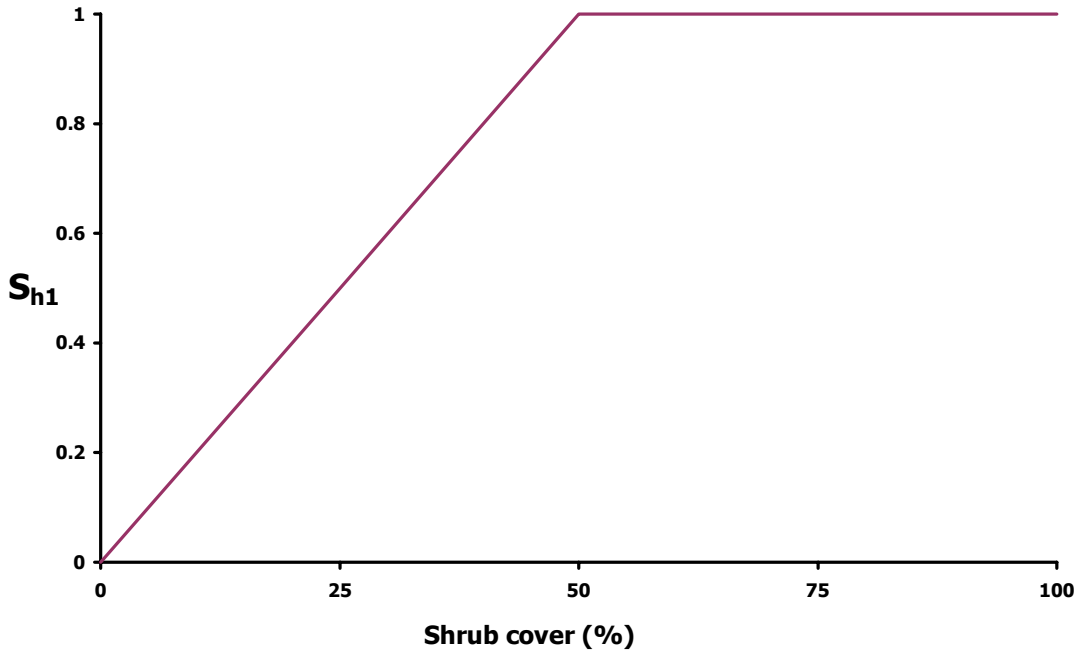

Figure 4. Marten hiding cover habitat suitability in relation to shrub cover within Millar Western's FMA area. Weighting: 0 - 25 cm = 0, 26 - 50 cm = 0.25, 51 cm - 1 m = 0.65, 1.1 - 3 m = 1, > 3 m = 0.2.

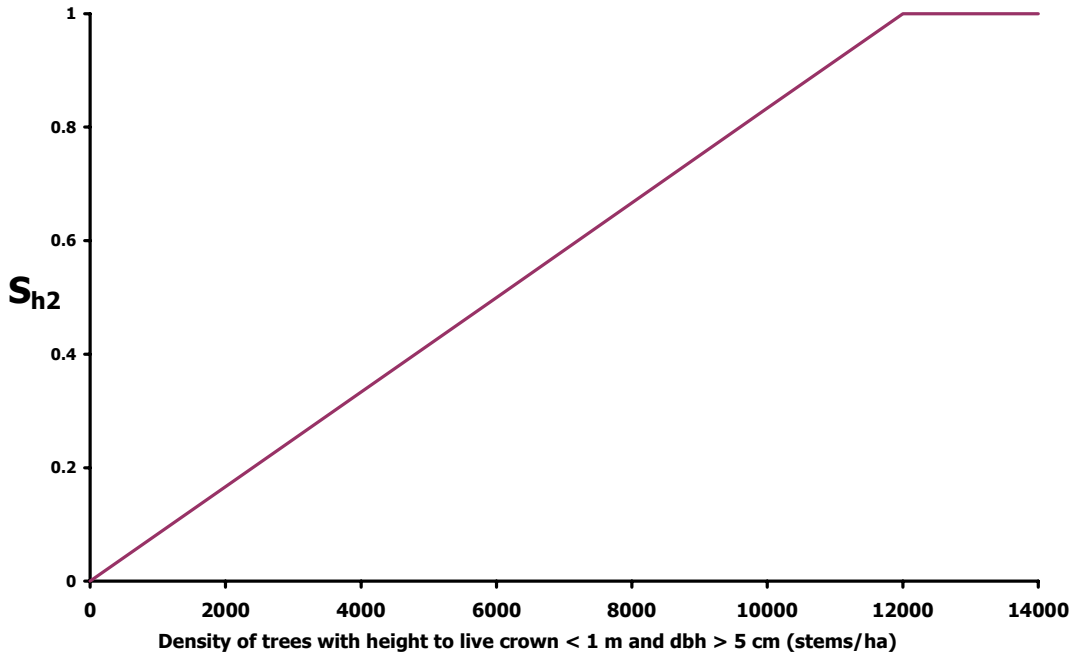

Figure 5. Marten hiding cover habitat suitability in relation to density of trees with height to live crown < 1 m and dbh > 5 cm within Millar Western's FMA area.

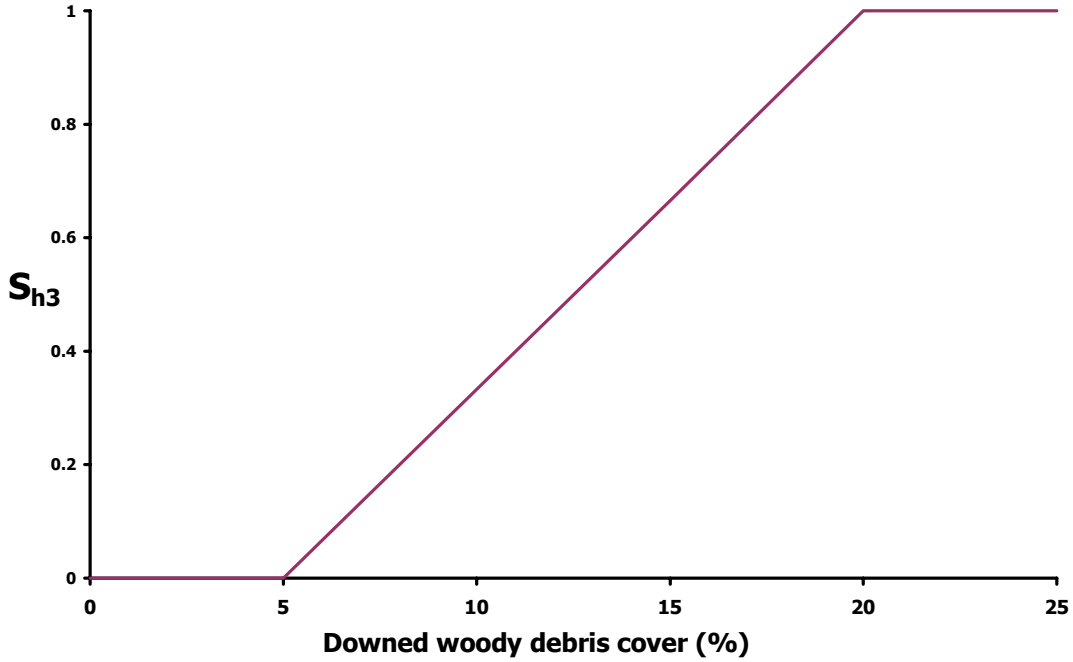

Figure 6. Marten hiding cover habitat suitability in relation to downed woody debris cover within Millar Western's FMA area.

3.5 Computation

Our goal is to create HSMs that allow the user to identify the potential impacts of proposed forest management strategies on cover and hiding cover habitats. Therefore, the outputs of the SI_{cover} and SI_{hiding} calculations are considered individually to display trends in habitat availability.

Cover Habitat Index

Using the simple SI_{cover} equation, $\mathbf{S_{c1}}$, the value of each pixel of forested habitat as cover is assessed.

Hiding Cover Habitat Index

The quality of each pixel of forested habitat as hiding cover is evaluated through use of the equation:

$$\mathbf{SI_{hiding} = S_{h1} + S_{h2} + 0.2S_{h3};}$$

$$\mathbf{where\ SI_{hiding} \leq 1.}$$

Adjustment of Hiding Cover SI

Marten are thought to be able to move up to 50 m into habitats lacking hiding cover. Therefore, poor hiding cover located within this distance of good hiding cover should be rated higher than it would on its own merit. To take this into account, an adjustment is made to the hiding cover SI. A circular window of radius 50 m moves over the grid representing Millar Western's FMA area with each pixel, in turn, acting as its centre. The maximum shelter rating within the circle is applied to the centre pixel as its SI_{hiding}:

$$\mathbf{Adjusted\ SI_{hiding} = Window\ Max\ (SI_{hiding})_{50m}}$$

Home Range Smoothing

Since an area of approximately 700 ha would be sufficient either as a male's home range or as a female's territory during estrus, we assess the quality of cover habitat within a circular window of radius 1,500 m, or 700 ha.

This window moves over the grid representing Millar Western's FMA area in such a way that its centres are located 1,500 m (one full radius) apart. Since Marten are thought to inhabit ranges in which ~50 of the stands represent suitable cover, the top 50 of the cover habitat suitability ratings within the circle are averaged and applied to the centre pixel. This approximates the value of a home range centred at that pixel as cover habitat.

Hiding cover values are not smoothed within the circle since the unsmoothed values indicate potential pathways of Marten movement between patches of suitable cover across the landscape. To smooth the values within the large home range area would cause the precise locations of potentially suitable travel corridors to be masked.

4.0 EXTERNAL REVISIONS

Arlen Todd, Wildlife Biologist with the Natural Resources Service (Fish and Wildlife Management Division), in Whitecourt, Alberta reviewed an early version of the Marten HSM and provided his comments on June 16, 1999. Based on his advice, the following changes were made to the document:

1) Arlen Todd was concerned about our decision to use the results of the Snowshoe Hare and Southern Red-backed Vole HSMs as a part of the SI_{food} for Marten. He provided numerous references showing that the relationship between Snowshoe Hare and Marten presence was not as strong as we had suggested. In addition, he stated that other small mammals, such as those of the genus Microtus, are as important to Marten as food items as the red-backed vole. Since these species have variable habitat requirements, it would be inaccurate to suggest that suitable Marten foraging habitat occurs only in suitable red-backed vole habitat. Therefore, we have removed these elements from the HSM.

2) The literature review had stated that breeding does not occur in logged habitats. Todd pointed out a reference stating that breeding does occur, though at a much reduced rate.

3) Though old stands generally provide the habitat structure required by Marten, it may be the structure that is important, not the age. Therefore, even logged habitats can provide suitable structure if this is considered in management planning.

Gordon Stenhouse of the Yellowhead Ecosystem Carnivore Working Group in Hinton, Alberta reviewed a draft of the Marten HSM and supplied comments on July 16, 1999. The following alterations were made in response to his comments:

1) Stenhouse pointed out several sections of the report that contained weak data or unsupported claims. These were either justified or removed in the next version of the report.

2) The rather detailed description of Marten use of Snowshoe Hares and Southern Red-backed Voles, was summarised into a brief overview of foraging habits. Since Marten are considered feeding generalists and the model did not include a suitability rating of foraging habitat, this in-depth discussion was considered unnecessary.

3) The description of habitats in which such soft-mast plants as raspberries are available may have given the impression that cleared areas are beneficial for Marten. This was not the intention of the discussion and wording was changed to ensure that the reader would understand this.

4) Stenhouse introduced data from BC that showed denning occurring in forestry slash piles located in a manner to provide connectivity to adjacent remaining stands. This concept was considered worth exploring since it is another tool that forest managers could use to improve conditions for Marten. As additional information on this topic becomes available, it should be incorporated into the HSM.

5) Stenhouse agreed that a home range size of 700 ha was a reasonable starting point. He mentioned, however, that field testing is essential since we will not know if this is the correct home range size without evaluating reproduction and recruitment.

6) Stenhouse suggested that more detailed discussion of the impacts of edge creation and forest fragmentation on Marten is necessary. Several additional references were added to the text.

5.0 LITERATURE CITED

Bateman, M.C. 1986. Winter habitat use, food habits, and home range size of the Marten, *Martes americana*, in western Newfoundland. Can. Field Nat. 100(1): 58-62.

Bissonette, J.A. and S. Broekhuizen. 1995. Martes populations as indicators of habitat spatial patterns: The need for a multiscale approach. In Turner, M.G and R.H. Gardner. Quantitative Methods in landscape ecology: The analysis and interpretation of landscape heterogeneity. Springer Verlag. New York. 536 p.

Buskirk, S.W. 1984. Seasonal use of resting sites by Marten in south-central Alaska. J. Wildl. Manage. 48(3): 950-953.

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 S.O. MacDonald. 1989. Analysis of variability in home-range size of the American Marten. J. Wildl. Manage. 53: 997-1004.

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(1): 191-196.

Chapin, T.G., D.J. Harrison, and D.M. Phillips. 1997. Seasonal habitat selection by Marten in an untrapped forest preserve. J. Wildl. Manage. 61(3): 707-717.

Corn, J.G. and M.G. Raphael. 1992. Habitat characteristics at Marten subnivean access sites. J. Wildl. Manage. 56(3): 442-448.

Cowan, I.M. and R.H. MacKay. 1950. Food habits of the Marten *(Martes americana*) in the Rocky Mountain Region of Canada. Can. Field Nat. 64: 100-104.

Drew, G.S. and J.A. Bissonette. 1997. Winter activity patterns of American Martens (*Martes americana*): rejection of the hypothesis of thermal-cost minimization. Can. J. Zool. 75: 812-816.

Douglass, R.J., L.G. Fisher, and M. Mair. 1983. Habitat selection and food habits of Marten, *Martes americana*, in the Northwest Territories. Can. Field Nat. 97(1): 71-74.

McCallum, I. 1993. Long term effects of timber management on Marten habitat potential in an Onatrio boreal forest. M. Sc. F. Thesis, Faculty of Forestry, Lakehead University, Thunder Bay, Ontario, 167 p.

Nagorsen, D.W., K.F. Morrison, and J.E. Forsberg. 1989. Winter diet of Vancouver Island Marten (*Martes americana*). Can. J. Zool. 67: 1394-1400.

Nagorsen, D.W., R.W. Campbell, and G.R. Giannico. 1991. Winter food habits of Marten, *Martes americana,* on the Queen Charlotte Islands. Can. Field Nat. 105(1): 55-59.

Paragi, T.F., W.N. Johnson, D.D. Katrik, and A.J. Magoun. 1996. Marten selection of postfire seres in the Alaskan taiga. Can. J. Zool. 74(12): 2226-2237.

Poole and Graf. 1996. Winter diet of Marten during a Snowshoe Hare decline. Can. J. Zool. 74: 456-466.

Quick, H.F. 1955. Food habits of Marten (*Martes americana*) in northern British Columbia. Can. Field Nat. 69: 144-147.

Raine, R.M. 1983. Winter habitat use and responses to snow cover of fisher (*Martes pennanti*) and Marten (*Martes americana*) in southeast Manitoba. Can. J. Zool. 61: 25-34.

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

Schulz, T. and L. Joyce. 1992. A spatial application of a Marten habitat model. Wildl. Soc. Bull. 20: 74-83.

Sherburne, S.S. and J.A. Bissonette. 1994. Marten subnivean access point use: response to subnivean prey levels. J. Wildl. Manage. 58(3): 400-405.

Slough, B.G., W.R. Archibald, S.S. Beare, and R.H. Jessup. 1989. Food habits of Martens, *Martes americana*, in the southcentral Yukon Territory. Can. Field Nat. 103(1): 18-22.

Smith, H.C. 1993. Alberta Mammals: An Atlas and Guide. Provincial Museum of Alberta, Edmonton.

Snyder, J.E. and J.A. Bissonette. 1987. Marten use of clear-cuttings 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(4): 850-860.

Stenhouse, G., Carnivore Biologist, Yellowhead Ecosystem Carnivore Working Group. 1999. Personal communication.

Takats, L., R. Stewart, M. Todd, R. Bonar, J. Beck, B. Beck, and R. Quinlan. 1995. Draft habitat suitability index model: Marten winter habitat. Foothills Model Forest, Hinton, AB.

Thompson, I.D. 1994. Marten populations in uncut and logged boreal forests in Ontario. J. Wildl. Manage. 58(2): 272-280.

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

Thompson, I.D. and P.W. Colgan. 1994. Marten activity in uncut and logged boreal forests in Ontario. J. Wildl. Manage. 58(2): 280-288.

Thompson, I.D. and W.J. Curran. 1995. Habitat suitability for Marten of second-growth balsam fir forests in Newfoundland. Can. J. Zool. 73(11): 2059-2064.

Todd, A.W., Wildlife Biologist, Alberta Natural Resources Service. 1999. Personal communication.

Todd, A.W. 1991. Ecology and Management of Fisher and Marten populations in Alberta. Unpublished paper given at Fisher and Marten Symposium. Larainie, Wyoming.

Weckworth, R.P. and V.D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26(1): 55-74.