

CANADA LYNX

(Lynx canadensis)



Source: Smith (1993)

**Prepared for Millar Western Forest Products'
Biodiversity Assessment Project**

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1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES

1.1 Introduction

The Canada Lynx (*Lynx canadensis*) is a secretive member of the boreal forest animal community (Parker *et al.* 1983; Quinn and Parker 1987; Dwyer *et al.* 1989; Koehler and Brittell 1990; Koehler and Aubry 1994; Poole *et al.* 1996; Slough and Mowat 1996, Figure 1). As a medium-sized, reddish to gray-brown coloured felid with dense fur, the lynx is similar in appearance to the bobcat (*Lynx rufus*, Quinn and Parker 1987; Dwyer *et al.* 1989). A Canada Lynx can be distinguished from its relative, however, by the long tufts of fur on its ears and the black tip on its tail. In addition, its legs are longer and its feet are nearly double the size of a bobcat (Koehler and Brittell 1990).

1.2 Effects of Forest Management Activities

Lynx are most commonly found to inhabit areas that support a mosaic of stands in different successional stages. In general, early successional habitat with thick understorey contains abundant Snowshoe Hares for use as prey, while overmature coniferous forests or other stands with abundant deadfall tend to offer suitable characteristics for denning. Prior to human intervention, it is thought that small-scale natural disturbance agents, such as light burns, disease, insect infestation, and wind, created this mosaic. Recently affected areas supplied foraging habitat while unaffected forests developed into overmature

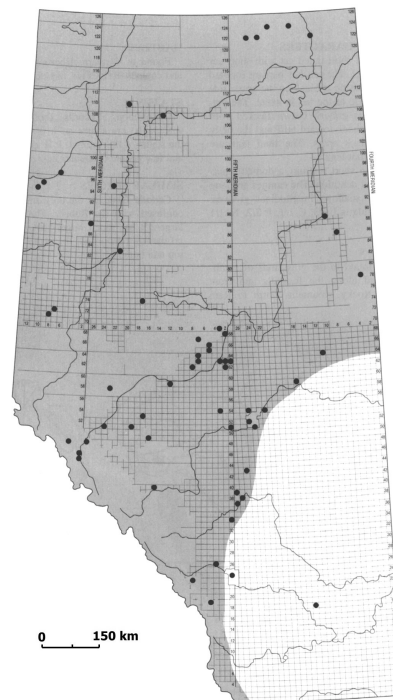


Figure 1. Estimated distribution of the Canada Lynx within Alberta (Smith 1993).



stands suitable for denning. Burned forests can also provide suitable denning conditions since deadfall is abundant within them. Therefore, suppression of these disturbance agents for the protection of human habitation and timber resources could have a negative impact on the availability of suitable habitat for lynx populations (Parker *et al.* 1983; Koehler and Brittell 1990; Poole *et al.* 1996).

Forest managers should strive to provide a temporal and spatial array of young and mature forest stands through careful planning of timber harvest layouts (Quinn and Parker 1987). It is thought that strip or block-cutting can produce the mosaic of open shrubby and closed dense forest habitats required for both foraging and denning activities (Quinn and Parker 1987).

Through personal observation and research, Poole (pers. comm. 1999) pointed out that lynx are able to survive within forests of a single type as long as conditions offering both foraging and denning opportunities are present. If both shrubby understorey supporting hares and overmature forest characteristics necessary for denning exist in the same area, the habitat could be considered suitable for lynx. In particular, it is essential that female lynx have access to downed woody debris (*i.e.*, blowdown or deadfall) that acts as a den (Koehler and Brittell 1990; Poole pers. comm. 1999; Todd pers. comm. 1999). Therefore, intensive forestry activities that involve salvage of downed material from a burned site may be detrimental to the reproductive process of the lynx, at least in the immediate vicinity of the burn (Todd pers. comm. 1999). Similarly, since planted and tended boreal stands tend to have less structural complexity than naturally regenerating sites, they may be used less frequently by both hares and lynx (Thompson 1988).



2.0 HABITAT USE INFORMATION

2.1 Food Requirements

Although Canada Lynx feed primarily on Snowshoe Hares, they will also consume mice, voles, Red Squirrels, flying squirrels, Ruffed Grouse, and occasionally deer, caribou fawns, and Moose calves (Nellis and Keith 1968; Nellis *et al.* 1972; Brand *et al.* 1976; Todd 1985; Quinn and Parker 1987; Koehler and Aubry 1994). When hare populations are large, they may supply up to 90% of a lynx' kills (Brand and Keith 1979). During periods of cyclic low hare abundance, alternative prey resources may become an important component of its diet (Poole pers. comm. 1999).

Because of their dependence on Snowshoe Hares, the population size of Canada Lynx is strongly correlated with the population fluctuations of this primary prey species (Nellis *et al.* 1972; Brand *et al.* 1976; Brand and Keith 1979; Parker *et al.* 1983; Ward and Krebs 1985; Todd 1985; Quinn and Parker 1987; Koehler and Brittell 1990; Murray *et al.* 1994; Poole 1994; Mowat *et al.* 1996; Slough and Mowat 1996; O'Donoghue *et al.* 1997; Poole 1997). Indeed, lynx will exist in high densities only at times when Snowshoe Hares are abundant (Quinn and Parker 1987; Koehler and Brittell 1990). Thus, it is easily understood that the habitat conditions promoting dense Snowshoe Hare populations are also optimal as Canada Lynx foraging habitat. It is important to point out, however, that the maintenance of appropriate Snowshoe Hare habitat will not avoid the occurrence of population cycles.

Snowshoe Hare Habitat

The Snowshoe Hare depends on its surroundings to provide suitable foraging habitat and hiding cover conditions. It will consume a variety of plant species and though it may prefer some species to others, it generally selects food items based on availability and accessibility. Optimal foraging habitat is provided by:

- ◆ Stands with plentiful shrubby vegetation (Bookhout 1965; Meslow and Keith 1971; Telfer 1972; Bider 1974; Keith 1974a; Wolff 1978; Parker 1984; Ranvanyi 1987; Gilbert 1990); and
- ◆ Stands with preferable species composition, especially willow, aspen, birch, rose, and white spruce (Meslow and Keith 1968; Bider 1974; Keith 1974b; Walski and Maritz 1977; Wolff 1978; Sinclair *et al.* 1982; Litvaitis *et al.* 1985; Parker 1986; Smith *et al.* 1988).

Hiding cover is provided by coniferous, particularly spruce-dominated stands, with suitable understorey (Adams 1959; Brocke 1975; Dolbeer and Clark 1975; Wolff 1980; Lloyd-Smith and Piene 1981; Buehler and Keith 1982; Parker 1984; Litvaitis *et al.* 1985; Fuller and Heisey 1986; Parker 1986; Halpin and Bissonette 1988; MacCracken *et al.* 1988; Barta *et al.* 1989; Koehler 1990). In addition, dense shrub thickets may provide appropriate hiding cover (Rogowitz 1988), particularly during summer (Hodges pers. comm. 1999). In general, sufficient protection from predators is provided by stands with:

- ◆ At least 50 to 60% coniferous trees in the overstorey (Keith 1974a; Conroy *et al.* 1979; Keith *et al.* 1984; Radvanyi 1987); and
- ◆ Dense shrubby understorey (< 3 m high) or abundant downed woody debris (Meslow and Keith 1968; Wolff 1980; Wolfe *et al.* 1982; Litvaitis *et al.* 1985; Sievert and Keith 1985; Parker 1986; MacCracken *et al.* 1988; Koehler and Brittell 1990; Koehler 1990).

Canada Lynx' Use of Developing Stands

The habitat selected by both lynx and Snowshoe Hare will change with the population cycle. When Snowshoe Hares are abundant, they will use a greater proportion of the landscape as cover habitat, but as the population size dwindles, only certain pockets of optimal habitat will be used by the remaining hares (Brand *et al.* 1976; Wolff 1980; Fuller and Heisey



1986). Lynx respond to this behaviour by greatly expanding or abandoning the home range held during the population peak and foraging preferentially around these patches of dense habitat with relatively high hare activity (Brand *et al.* 1976; Ward and Krebs 1985; Poole 1995; Slough and Mowat 1996).

Lynx feel most comfortable in overmature stands or in younger stands with high structural complexity (as discussed further below). As noted previously, however, their primary prey species tends to prefer early successional habitats (< 20 years of age, Koehler and Brittell 1990; Poole *et al.* 1996). In fact, observations reveal that lynx are reluctant to move more than 100 m into young stands (Koehler and Brittell 1990; Koehler and Aubry 1994). Therefore, to provide the cats with the necessary security while hunting, forest of suitable cover characteristics must exist adjacent to Snowshoe Hare habitat so lynx have the opportunity to move quickly into the young stand and back into the cover of the mature forest (Koehler and Brittell 1990; Poole *et al.* 1996; Poole pers. comm. 1999; Todd pers. comm. 1999). While very little information is currently available on the area requirements of lynx, a HSI model constructed by Boyle and Fendley (1987) for bobcats suggests that the cat's home range should contain at least 40% prey habitat.

2.2 Cover Requirements

Although lynx generally prefer older forest stands as habitat (Koehler and Brittell 1990), Poole (pers. comm. 1999) suggested that they are not restricted to old forest and can be found in stands as young as 20 years of age provided it is highly complex structurally. In Alberta, mixedwood stands may be particularly desirable as cover (Koehler and Aubry 1994). Research by Poole *et al.* (1996) has shown that most lynx activity occurs within stands of canopy closure > 50%.

Common understanding of lynx habitat requirements suggests that the animal prefers to remain within forest of suitable cover con-

dition while it hunts. Observation of the lynx in Washington has shown that it is reluctant to stray further than 100 m from this habitat (Koehler and Brittell 1990; Koehler and Aubry 1994). Poole (pers. comm. 1999) agrees with this assessment, adding that this edge environment is a valuable part of lynx habitat since it also forms an important component of hare habitat.

Todd (pers. comm. 1999) suggested that fairly large trees are required as a security feature for the animals as they can climb them to escape predation by wolves. In addition, Todd mentioned that forest cover provides the shelter necessary to moderate temperatures, particularly by providing shade from summer heat.

2.3 Reproduction Requirements

In Alberta, the breeding season of the lynx occurs between April and May (Nellis *et al.* 1972). A female's age at first breeding is dependent partly on her physical condition and the abundance of food resources in the vicinity and partly on the availability of appropriate denning sites (Quinn and Parker 1987). The gestation period is nine weeks and kittens remain with the mother for almost a full year, dispersing as she prepares to breed again the following spring (Quinn and Parker 1987; Poole 1994; Poole 1995; Mowat *et al.* 1996).

The availability of food resources influences the ovulation rate, pregnancy rate, and litter size of lynx (Brand and Keith 1979; Slough and Mowat 1996). Though adults continue to reproduce during the first year of a hare decline, all recruitment stops by two years into the decline, and remains low or non-existent for three to four years (Poole 1994; Mowat *et al.* 1996). In addition, as starvation takes its toll, the survival rate of kittens is much reduced (Poole 1994). As hares become more plentiful, lynx recruitment increases again.

It is thought that overmature forest must be positioned proximate to early successional habitat for denning habitat requirements to



be fulfilled (Koehler and Brittell 1990; Koehler and Aubry 1994). The research of Poole (pers. comm. 1999) revealed, however, that stand age is not a limiting requirement. Instead, even a dense regenerating stand can provide denning habitat if a suitable quantity of deadfall is present. In fact, the most important feature of denning habitat is thought to be the presence of significant quantities of downed woody debris and leaning logs. It was suggested that appropriate denning sites would contain at least 1 log per metre of forest, inclined so that it is not lying directly on the ground (Koehler and Brittell 1990). This was the only numerical estimate that was known to us at the time of writing. We do not believe, however, that it accurately reflects the properties of suitable denning habitat since optimal sites are 'jumbles of deadfall and blowdown of fairly large diameter' (Todd pers. comm. 1999).

The denning site must be at least 1 ha in size to be useful to the female and must be proximate to good foraging habitat (Koehler and Aubry 1994). As females may need to move their kittens in search of better foraging sites or away from disturbance, several suitable denning areas should be connected by travel corridors of sufficient cover within the home range (Koehler and Brittell 1990). As suggested by the research on female and kitten movements by Mowat *et al.* (1996), good denning sites should be within approximately 500 m of each other. While the literature does not give an indication of the number of denning sites that should be available for a female's use, it does mention that a greater number of potential dens is better as females are given the opportunity to move kittens from disturbance and predators, thus decreasing the mortality rate of the young (Koehler and Aubry 1994). These denning sites should be scattered throughout the home range (Mowat *et al.* 1999).

2.4 Habitat Area Requirements

The secretive nature of the lynx makes it difficult to carry out a census of its population density. Studies in Alberta have found that population density ranges from zero to ten lynx per 10,000 ha (Brand *et al.* 1976). Although females do not appear to be territorial and may overlap home ranges with other females, the home range of a male lynx is generally exclusive (Poole 1995).

Studies of lynx home ranges have shown that the animals tend to maintain the same territories for several consecutive years during periods of high hare abundance. Dispersal may occur for two reasons: innate dispersal, which involves spontaneous movement of young individuals and environmental dispersal, in response to unfavourable environmental conditions (Poole 1997). Near the end of their first year, kittens disperse from their mothers in response to the innate desire to establish their own home ranges and may often move many kilometres away (Poole 1995; Mowat *et al.* 1996). Adult dispersal of up to 1,100 km may occur during periods of Snowshoe Hare decline and early in the period of low hare population size (Ward and Krebs 1985; Slough and Mowat 1996; O'Donoghue *et al.* 1997; Poole 1997). In addition, the home range size of adult lynx may increase after the hare crash. A study by Ward and Krebs (1985) has shown that with hare declines of 14.7 to 0.2 hares per ha, territories expanded from 1,320 to 3,920 ha, and some lynx appeared to be nomadic.

To accommodate the lynx at any time during its population cycle, a territory of 3,000 ha has been declared suitable for lynx habitat. This estimate receives support from the research of Brand *et al.* (1976) that found the average lynx home range to be 2,800 ha.



2.5 Landscape Configuration Requirements

Lynx habitat must contain both foraging and denning cover and it is essential that corridors of suitable cover for lynx travel connect these two habitat types. Therefore, optimal lynx habitat will be a mosaic of different forest types including a range of successional stages between the developing stands required by Snowshoe Hares and the mature forests needed by lynx for denning and cover.

Forest edge is an important asset to a lynx' environment as it requires direct access to early successional stands for foraging but is reluctant to move more than 100 m into these spaces.

2.6 Sensitivity to Human Disturbance

Lynx are vulnerable to over-exploitation by humans. Because of the importance of lynx pelts to the fur industry (Parker *et al.* 1983; Todd 1985; Quinn and Parker 1987; Koehler and Brittell 1990; Poole 1994; Mowat *et al.* 1996), populations can become locally extinct due to the intensity of trapping activities. This occurs particularly in areas where a group of lynx is not connected with the rest of the continental population (such as in Newfoundland, Cape Breton Island, and Nova Scotia, Parker *et al.* 1983) or at times when the population is already undergoing declines related to food shortage (Poole 1994).

Roads through lynx habitat increase the vulnerability of the animal to trappers as well as to accidental death. Year-round, lynx will travel within 15 m of a well-used road to take advantage of the abundant vegetation resources that have attracted hares to the area. The animals are able to successfully utilise this resource only if suitable cover exists on both sides of the roadway (Todd 1985; Koehler and Aubry 1994).

Aside from mortality by trapping, lynx do not appear to be sensitive to human activity. In

fact, the animals have been known to inhabit forest-farmland mosaic present in Rochester, Alberta and do not show significant alarm when encountered by a human in the forest or passed from above by a noisy aircraft (Todd 1985). Poole (pers. comm. 1999) added that lynx appear to become bolder and less wary of humans during periods of low prey abundance.



3.0 MODEL

3.1 Envirogram

To provide the lynx with suitable habitat, conditions must be satisfied for the elements of food resources, protection from predators and extreme environmental conditions, as well as denning requirements. Shown in the envirogram below are the forest attributes that influence the lynx' ability to obtain food and shelter (Figure 2).

Since the primary prey species of the lynx is the Snowshoe Hare, the quality of portions of the lynx' home range as hare habitat is an important consideration in assessing the suitability of the forest for foraging. During population lows, hares are most reliably found within good cover habitat. Suitable cover conditions are provided by mixedwood stands > 20 years of age with canopy closure > 50%. While denning, the female lynx is rather specific in its habitat choice and relies on stands with ample downed woody debris.

3.2 Application Boundaries

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

Habitat Area: Home range size is thought to be ~ 3,000 ha. No home range smoothing is required by this HSM, however.

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

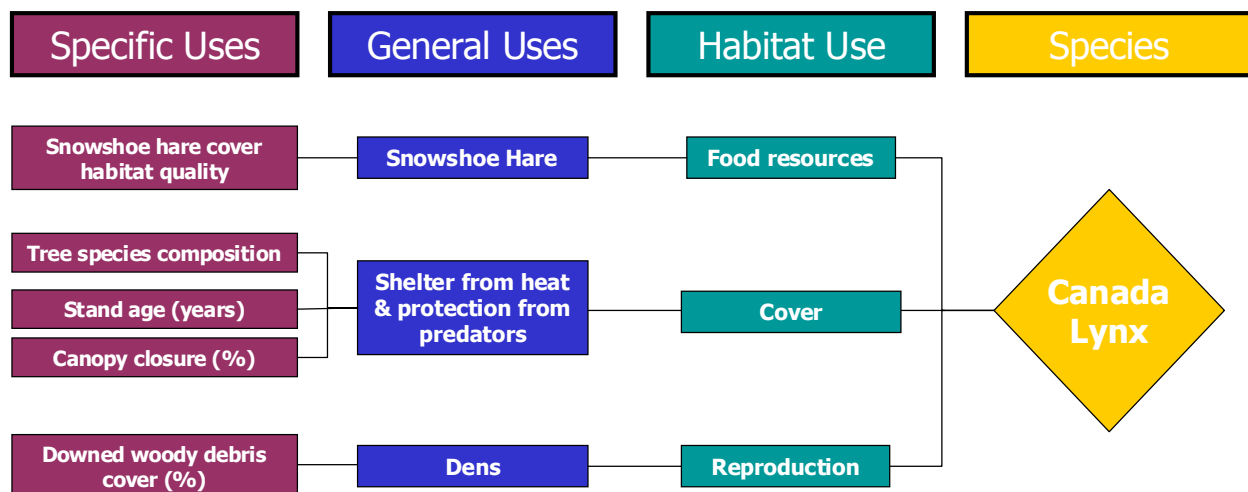


Figure 2. Envirogram of the Canada Lynx based on available habitat information for HSM development.

3.3 Model Description

The HSM for Canada Lynx habitat follows the structure described in the envirogram (Figure 3). As all elements are critical components of year-round habitat, no compensation is allowed between them.

The SI_{food} considers only the quality of the stand as Snowshoe Hare cover habitat. During population lows, hares are most likely to be found in patches of good quality cover habitat since the potential for survival is highest in these locations. Since Canada Lynx rely on Snowshoe Hares as their primary prey species, they tend to concentrate their foraging activities around these areas.

The SI_{cover} accounts for the requirements of the lynx that relate to protection from predators and extreme environmental conditions. Suitable shelter consists of mixedwood stands > 20 years of age with a relatively closed canopy. Since both of these forest features must be present to render a stand appropriate as lynx cover, there is no compensation allowed between them.

The SI_{denning} takes into account the specific requirements of the female lynx and its young during the denning season. The only variable included is habitat type. We believe that the appropriate coverage of inclined downed

woody debris will be more readily available in some habitat types than others. In addition, suitable denning conditions are thought to be available in stands recently affected by high intensity fires. Denning suitability decreases with logging activity since both the current downed woody debris coverage and the potential for future downed woody debris and leaning tree recruitment decrease.

3.4 Habitat Variable SIs

Food

Suitable foraging habitat is provided by stands possessing the same characteristics as Snowshoe Hare cover habitat. Therefore, from the Snowshoe Hare HSM, the output of the final SI_{cover} equation is reclassified as the S_{f1} variable for the lynx HSM.

Cover

Suitable cover is composed of stands older than > 20 years of age (S_{c1}). Mixedwood stands may be preferred although pure hardwood or softwood may also be used. In addition, lynx are thought to require significant canopy closure (S_{c2}). Cover suitability ratings by habitat type are shown in Table 1. Figure 4 shows the importance of canopy closure to cover. Suitability is maximised at canopy closure > 75%.

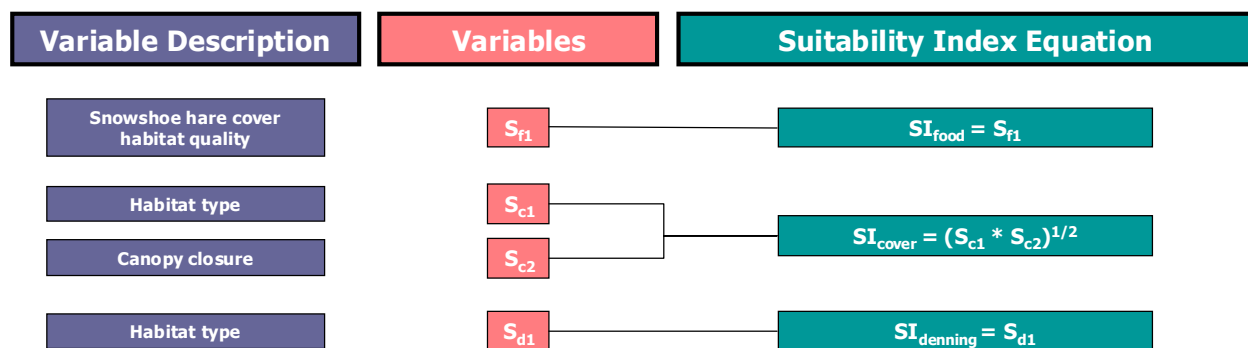


Figure 3. HSM structure for the Canada Lynx within Millar Western's FMA area.



Canada Lynx HSM

Table 1. Canada Lynx cover habitat suitability, by habitat type.

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

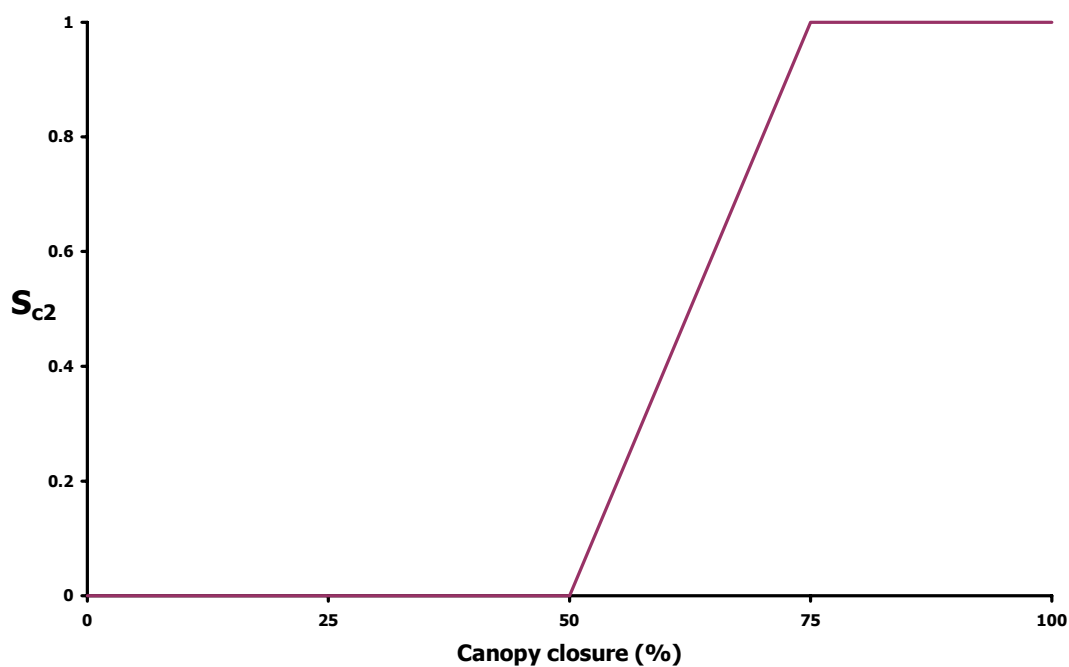


Figure 4. Lynx cover suitability in relation to canopy closure within Millar Western's FMA area.



Denning

The only variable that contributes to the suitability of a stand for denning is the density of downed woody debris. Since it is not simply the coverage of downed woody debris that is important to the lynx but the relative position and inclination of the pieces of wood, we cannot use the SHE variable, downed woody debris cover, as a proxy for denning habitat suitability. Instead, we intend to predict the habitat types (S_{d1}) in which denning habitat would be expected to be available (Table 2).

Stands managed under the crop planning system or those that have been modified by thinning or timber harvesting receive reduced denning habitat suitability ratings. In fact, the suitability ratings applied to each stand as a function of its habitat type (Table 2) are reduced by half following thinning or harvesting.

Proximity

Foraging habitat is most valuable when within 100 m of suitable cover habitat. Similarly, cover is most suitable when within this specified distance of food. Denning sites are most valuable when within 500 m of good foraging habitat.

3.5 Computation

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

Foraging Habitat Index

The value of each forested pixel as Snowshoe Hare cover habitat is assessed using the HSM developed by KBM Forestry Consultants (2000). The SI_{cover} values applied to each pixel of forested habitat by the Snowshoe Hare HSM are renamed S_{f1} for Canada Lynx.

$$SI_{food} = S_{f1}$$

Cover Habitat Index

To ensure that the lynx are able to move between feeding and denning sites, the model assesses the quality of travel cover. Each pixel of forested habitat within Millar Western's FMA area is evaluated for its effectiveness in providing cover using the equation:

$$SI_{cover} = (S_{c1} * S_{c2})^{1/2}$$

Table 2. Canada Lynx denning habitat suitability, by habitat type.

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



Denning Habitat Index

The quality of a stand as denning habitat depends on the forest floor coverage, inclination, and relative positioning of downed woody debris (predicted by habitat type). The denning equation is simply:

$$SI_{\text{denning}} = S_{d1}$$

A forest with the characteristics necessary to provide a denning site must be at least 1 ha in size to be useful to the female and kittens. To take this into account, a circular window of radius 75 m (1.7 ha) moves over the grid representing Millar Western's FMA area with each pixel, in turn, acting as its centre. The denning habitat values derived above for each pixel within the window are averaged. The average value is recorded as the SI_{denning} of the pixel at the centre of the window.

Adjustment of SIs Based on Proximity of Food, Cover, and Denning Resources

As lynx are reluctant to move more than 100 m into habitat of unsuitable cover to forage and require foraging opportunities within 500 m of their dens, an adjustment of the SI_{food} , SI_{cover} , and SI_{denning} values is necessary. The edge habitat between good foraging and cover habitats is more valuable to lynx than forest distant from either of these resources. As well, denning habitat is more valuable if it is proximate to food resources. To take this into account, the following calculations are carried out:

$$\text{Adjusted } SI_{\text{food}} = [SI_{\text{food}} * \text{Window} / (\text{Max } (SI_{\text{cover}})_{100m})]^{1/2}$$

$$\text{Adjusted } SI_{\text{cover}} = [SI_{\text{cover}} * \text{Window} / (\text{Max } (SI_{\text{food}})_{100m})]^{1/2}$$

$$\text{Adjusted } SI_{\text{denning}} = [SI_{\text{denning}} * \text{Window} / (\text{Max } (SI_{\text{food}})_{500m})]^{1/2}$$

Home Range Smoothing

We do not smooth the suitability ratings for foraging, cover, or denning habitats within the home range window since this action would cause the precise locations of potential habitats to be masked. Since lynx are thought to abandon or alter their home range at different times during the hare population cycle, it is preferable to understand changes in the provision of habitats with forest succession and disturbance, instead of developing an estimate of suitability for each potential home range.



4.0 EXTERNAL REVISION

Arlen Todd, wildlife biologist with Alberta Environment, Fisheries and Wildlife Management Division, in Whitecourt, Alberta reviewed a draft copy of the HSM for lynx on April 27, 1999. We made the following changes from the original document based on his advice:

- 1) Todd suggested that the variable, downed woody debris cover, does not adequately reflect the optimal features of dens. Unfortunately, the accessible data do not provide information on the relative position and size of pieces of downed woody debris.
- 2) Though the original document eluded to the fact that kitten survival changes with the Snowshoe Hare cycle, it was suggested that the effect of food availability on conception rate should also be stated.
- 3) Additional information on sensitivity of lynx to human disturbance was presented by Todd and included in the literature review.
- 4) The original document stated that the minimum requirement of lynx cover habitat is forest of at least two m height with relatively closed canopy. As Todd presented concern that the large trees required by lynx as escape routes from predators would not be present in this sort of environment, the minimum acceptable cover conditions were altered accordingly.
- 5) Todd suggested some references that would make the document more 'Alberta-specific'. These were included into the literature review.

Kim Poole, Wildlife Research Biologist with the Fish and Wildlife Division of Timberland Consultants in Nelson, British Columbia reviewed a draft copy of the HSM for lynx on May 17, 1999. We made the following changes from that document based on his advice:

- 1) Poole suggested that too much emphasis had been placed on literature written on studies done in the western United States. Additional references and comments of

personal communication were added to lessen the dependence on these references.

- 2) Poole was concerned with the fact that this is a static model for lynx habitat preference. He stated that though it may accurately predict lynx habitat use for eight of ten years, it will not be successful for the two years influenced by hare decline. He recommended that a model be created that will take into account these deterministic fluctuations. It will not be possible to take this recommendation into account as the model will produce output in ten year time steps – the same length of time required to complete one 'Snowshoe Hare cycle'. Therefore, the model will produce output at approximately the same point in the Snowshoe Hare cycle every ten years. The changes in lynx habitat use that occur between these ten years steps will not be observed. Because lynx are most vulnerable during Snowshoe Hare population lows, we have chosen to produce a model that concentrates on preferred habitat features, during this portion of the cycle.
- 3) Though most research shows that a mosaic of opening and closed forest habitats are required to satisfy lynx life requisites, Poole's observation and research showed that the animals are able to survive within single habitat types as long as both Snowshoe Hares and downed woody debris (for denning) exist.

Gordon Stenhouse, carnivore biologist with the Yellowhead Ecosystem Carnivore Working Group in Hinton, Alberta provided comments on a draft version of the HSM for Canada Lynx on July 12, 1999. He did not recommend changes to the document which had already been through several internal and external reviews but did point out weaker sections of the model, recommending that additional references be sought to strengthen them. Therefore, no substantial alterations were made based on his advice.



5.0 LITERATURE CITED

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