

WOODLAND CARIBOU

(Rangifer tarandus caribou)



Source: Smith (1993)

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

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Table of Contents

1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES .	1
1.1 Introduction	1
1.2 Effects of Forest Management Activities	2
2.0 HABITAT USE INFORMATION	3
2.1 Food Requirements	3
2.2 Cover Requirements	3
2.3 Reproduction Requirements	4
2.4 Habitat Area Requirements	4
2.5 Landscape Configuration Requirements	5
2.6 Sensitivity to Human Disturbance	5
3.0 MODEL	6
3.1 Envirogram	6
3.2 Application Boundaries	6
3.3 Model Description	9
3.4 Habitat Variable SIs	11
3.5 Computation	16
4.0 EXTERNAL REVISION	18
5.0 LITERATURE CITED	20

List of Figures

Figure 1.	Present and historic Woodland Caribou distribution in Alberta (AE 1999).	1
Figure 2.	Envirogram of Woodland Caribou summer habitat based on available information for HSM development.	7
Figure 3.	Envirogram of Woodland Caribou winter habitat based on available information for HSM development.	7
Figure 4.	Envirogram of Woodland Caribou reproductive habitat based on available information for HSM development.	8
Figure 5.	HSM structure for Woodland Caribou summer habitat in Millar Western's FMA area.	9
Figure 6.	HSM structure for Woodland Caribou winter habitat in Millar Western's FMA area.	10
Figure 7.	HSM structure for Woodland Caribou reproduction habitat in Millar Western's FMA area.	10
Figure 8.	Woodland Caribou foraging habitat suitability in relation to lichen cover within Millar Western's FMA area.	11
Figure 9.	Woodland Caribou foraging habitat suitability in relation to shrub cover within Millar Western's FMA area. Weighting: 0 - 3 m = 1, > 3 m = 0.2.	12
Figure 10.	Woodland Caribou foraging habitat suitability in relation to sedge cover within Millar Western's FMA area.	12
Figure 11.	Woodland Caribou foraging habitat suitability in relation to forb cover within Millar Western's FMA area.	13
Figure 12.	Woodland Caribou foraging habitat suitability in relation to arboreal lichen cover within Millar Western's FMA area.	13
Figure 13.	Woodland Caribou cover habitat suitability in relation to developmental stage within Millar Western's FMA area.	14
Figure 14.	Woodland Caribou cover habitat suitability in relation to tree species composition within Millar Western's FMA area.	14
Figure 15.	Woodland Caribou cover habitat suitability in relation to tree species composition within Millar Western's FMA area.	15
Figure 16.	Woodland Caribou hiding cover suitability in relation to proximity to road within Millar Western's FMA area.	15



1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES

1.1 Introduction

In Alberta, the caribou (*Rangifer tarandus caribou*) occurs at low densities and has been identified as a vulnerable species (Bradshaw *et al.* 1995; Rettie and Messier 1998). The need for increased attention to caribou was made clear when census results in 1990 revealed that caribou populations had declined by 50 to 75% since 1970 (Edmonds 1988; Van Tighem 1990).

The historical range of the caribou extended south and east from Alaska through the Great Lakes region to New England (Servheen and Lyon 1989). Presently, however, it has been drastically reduced in the United States with all caribou existing north of the Canadian border except for one herd that continues to inhabit the Selkirk Mountains of Idaho (Figure 1, Servheen and Lyon 1989). As this reduction in range has occurred gradually since European settlement, it has been attributed to human activity (Edmonds 1988; Bradshaw *et al.* 1995; Rettie and Messier 1998).

In west-central Alberta, there are nine recognized caribou ranges: Calahoo, Narraway, Lingrell, Redrock/Prairie Creek, A la Pêche, Little Smoky, North Jasper, South Jasper/White Goat, and North Banff/Siffleur (Brown and Hobson 1998). Of these groups, all but one are referred to as Mountain Caribou as they use, for at least part of the year, mountainous terrain. The Little Smoky herd is the only group that behaves as Woodland Caribou utilising fens, muskegs, and coniferous stands within the boreal forest. Until recently, it was thought that caribou did not exist within Millar Western's FMA area. Summer use of the most westerly portions of the FMA area has now been confirmed, however (Smith pers. comm. 1999). As the Little Smoky herd's range is located only 100 km west of Whitecourt, it can be assumed that any caribou inhabiting Millar Western's FMA area will behave, and select habitat, as Woodland Caribou.



Figure 1. Present and historic Woodland Caribou distribution in Alberta (AE 1999).



The habitat requirements of caribou in Alberta have not yet been quantified to a great extent (Smith pers. comm. 1999). In particular, a recent report prepared for the Research Subcommittee of the West-central Alberta Caribou Standing Committee has stated that three questions are in need of answer: What do caribou need in terms of habitat requirements? How do caribou respond to human activity and changing landscapes? How are caribou populations changing over time (Brown and Hobson 1998)? At the present time, numerous research projects are underway in an effort to learn more about this species. This HSM will, therefore, require continual adjustment as new information becomes available.

1.2 Effects of Forest Management Activities

When timber harvesting occurs within caribou wintering areas, the capability of the stand to intercept incoming snow is reduced. Therefore, clearcutting of a stand eliminates its interception capability. Although caribou are tolerant of deep snow, they may choose to forage where snow is shallower and may avoid snow with a crusted surface that does not support their weight in order to conserve energy. Therefore, the true value of winter forest cover is its capability to intercept snow and temper the freeze/thaw cycles that lead to snow hardening. In addition, the productivity of lichens, the caribou's major winter food source, is thought to be negatively impacted by timber harvesting (Cumming 1992). Smith *et al.* (1998) found that caribou appear to avoid clearcuts and tend to move away from harvested areas.



2.0 HABITAT USE INFORMATION

2.1 Food Requirements

With respect to its feeding habits, the caribou is considered a 'grazer'. Its foraging requirements differ with the seasons.

During spring and summer, the Woodland Caribou feeds on nutritious forbs, leaves of deciduous shrubs, sedges, lichens, and fungi (Duquette 1985; Thomas *et al.* 1996; Rettie *et al.* 1997). These materials are readily available at this time and caribou are not normally required to travel long distances in search of suitable foods (Edmonds 1988; Stuart-Smith *et al.* 1997).

During winter, the caribou's metabolic rate is reduced to only 75% of the summer rate and food energy is used more for body weight maintenance than for growth (Duquette 1985). The animal, therefore, seeks high carbohydrate, low protein foods composed predominantly of arboreal and terrestrial lichens with supplements of sedges (Duquette 1985; Thomas *et al.* 1996). It is predominantly the 'reindeer lichens' of the genus *Cladina* that are consumed by the caribou (Cumming 1992).

Though lichens have the ability to grow under a range of environmental conditions, they are poor competitors and are quickly replaced by mosses and vascular plants in nutrient-rich, moist environments (Harris 1996). They are, therefore, most abundant in older coniferous stands (80 to 120 years old, Brown and Hobson 1998), with less than 50% canopy closure and thin mineral soils (Duquette 1985). Slope and aspect are also related to lichen density as *Cladina* spp. are able to reach their greatest abundance on dry, upper slopes and south-facing exposures (Harris 1996).

The caribou is well adapted for snow. The animal must dig through accumulated snow to access its food resources using an action termed 'cratering' (Cumming 1992). It is able to smell lichens and can crater successfully

through 100 cm of snow. Where snow depth is excessive, however, caribou will quickly turn to arboreal lichens (Smith pers. comm. 1999). Therefore, foraging habitat includes areas of high terrestrial and arboreal lichen productivity as well as shrub and herbaceous vegetation availability. Since energy conservation is best achieved when less cratering is required to reach lichens, forest stands that provide effective snow interception are beneficial (Smith pers. comm. 1999).

2.2 Cover Requirements

Hiding Cover

The caribou uses a strategy different than other cervids for predator evasion. Elk, moose, and deer in west-central Alberta prefer to hide within dense forest cover, whereas the caribou tend to disperse at low densities over the range. Though the hunting success of the caribou's major predator, the wolf, is reduced by this method, caribou populations are still strongly influenced by predation (Brown and Hobson 1998). In fact, wolves have been associated with up to 22% of annual adult mortality of the Little Smoky herd during a period when recruitment rate was 15% (Edmonds 1988).

Forest Cover

Caribou in west-central Alberta have been known to successfully feed and move through snow of significant depth (Smith pers. comm. 1999) and it is uncommon for them to become stressed by cold temperatures (Brown pers. comm. 1999). Therefore, the animals do not generally select habitat for thermal regulation. Instead, they will choose home ranges based on food supply. As previously mentioned, in mature coniferous stands (spruce or pine) with less than 50% canopy closure, abundant lichens are available (Duquette 1985; Brown and Hobson 1998).



Though muskeg environments may also be used, forested areas are preferred when snow is sufficiently deep or crusted to influence the caribou in open areas (Brown and Hobson 1998).

The Little Smoky caribou herd is known to use similar cover habitat types year-round. In summer, the animals may seek shelter from heat, provided by the shady conditions of coniferous stands (Smith pers. comm. 1999). In winter, these stands also temper the snow pack. In early winter, before snow depth and hardness begins to impact the caribou, they may preferentially use muskeg habitats.

Studies in west-central Alberta have revealed that mixed-coniferous stands of spruce and/or pine and muskeg environments are used in the following proportions in all seasons:

- ◆ Mixed-coniferous (spruce and pine) = 16 to 40% of observations;
- ◆ Relatively pure pine stands = 19 to 51% of observations; and
- ◆ Muskeg habitat = 13 to 31% of observations.

2.3 Reproduction Requirements

The fall migration of the caribou occurs in mid-September, just prior to the breeding season. In west-central Alberta, the rut occurs from mid-September to mid-October and is most often associated with open muskeg environments (Edmonds 1988).

Between mid-April and mid-May, pregnant female caribou begin their journey from the wintering range to a selected calving site that is often within 100 m of muskeg (Edmonds 1988; Smith pers. comm. 1999). Calving sites are usually located in isolation from other caribou (Boonstra and Sinclair 1984; Edmonds 1988). The attraction to open muskeg areas is probably related to the caribou's heightened ability to perceive incoming predators (Edmonds 1988). Muskeg with open water is particularly desirable as the caribou and its

calves are offered the opportunity to quickly escape from predators (Duquette 1985; Edmonds 1988).

The cow and its calves may remain within the calving site for several weeks (Duquette 1985). As the nutritional requirement of the mother and calves is high during this time, the calving site should be located close to a plentiful supply of lichens (Servheen and Lyon 1989). Like most ungulates, caribou time their calving efforts with the onset of green-up so that protein-rich herbaceous and shrubby vegetation is available for consumption during lactation. In spring, these food items first become available near muskeg, well sites or cutlines, and on south-facing slopes (Smith pers. comm. 1999). Calving sites are generally located near or within the summer range (Duquette 1985; Edmonds 1988).

2.4 Habitat Area Requirements

The total range of the Little Smoky Herd, inhabiting the forests along the Little Smoky River just west of the Millar Western FMA area, is 2,800 km² (Alberta Natural Resources Service unpubl. data). This estimate includes both summer and winter habitat for a herd of approximately 60 to 100 individuals. The winter and summer ranges of Woodland Caribou tend to overlap significantly with their centres generally less than 12 km apart (Brown and Hobson 1998). Mean winter and summer range sizes for individual radio-collared caribou in the Little Smoky herd are 168 km² and 24 km² (N = 17) respectively (Alberta Natural Resources Service unpubl. data). These individual home ranges overlap to form seasonal herd ranges (Darby and Pruitt 1984; Edmonds 1988).



2.5 Landscape Configuration Requirements

A review of west-central Alberta's caribou research has shown that the Woodland Caribou uses spruce and/or pine forests and treed muskegs as foraging and cover habitats throughout the year. Though dense coniferous forests may be more important in years with significant snowfall, open muskegs may be preferentially, but not exclusively, used during milder portions of the winter. In west-central Alberta, mature coniferous forest is the most commonly used habitat in late winter regardless of snow conditions (Alberta Natural Resources Service unpubl. data). Thus, both open muskeg and mature coniferous forest should be available within the home range, giving the animals the opportunity to inhabit the type appropriate to the current environmental conditions.

During the calving season, caribou in the Little Smoky herd often choose calving sites within or in proximity to (< 100 m) muskeg habitat, although dispersal to isolated locations within a variety of habitat types also appears to be a calving strategy (Alberta Natural Resources Service unpubl. data).

Functional habitat will include both appropriate seasonal ranges and suitable paths of travel between them. During winter, the caribou prefers to follow the easiest path of travel and often moves along frozen rivers, lakes, or wetlands (Darby and Pruitt 1984; Duquette 1985). Caribou generally have strong fidelity to their traditional travel routes between summer and winter ranges. Typical distances between summer and winter ranges are less than 12 km for Woodland Caribou of the Little Smoky herd (Brown and Hobson 1998).

2.6 Sensitivity to Human Disturbance

When experiencing perpetual disturbance by human activity, the caribou may avoid or abandon optimal or traditional habitats in favour of less suitable ones and may even reduce the home range size of the herd (Bradshaw *et al.* 1997). Noise disturbance has been found to disrupt the feeding behaviour of the caribou. Though it may return in time to the previously occupied location, it has been observed to be driven away by loud sounds (Bradshaw *et al.* 1997). Research has shown that caribou home ranges, particularly the calving grounds are at maximum distance from roads and human population centres (Cumming 1992).

Road and railway accidents are important causes of mortality and can severely impact a population that is already of low density (Cumming 1992). Hunting of caribou is no longer permitted in Alberta but poaching may have serious impacts on small isolated herds (Cumming 1992).



3.0 MODEL

3.1 Envirogram

It will be necessary to create three separate models for Woodland Caribou since the animals require significantly different habitat elements during the spring/summer (called summer below), rutting/calving (called reproduction), and severe winter seasons (called winter below).

Three elements have been identified as critical components of Woodland Caribou habitat during all seasons – the ability to obtain appropriate food resources; to minimise disturbance by human activity; and to find suitable cover from inclement environmental conditions (Figures 2 to 4). The forest features important to the animals' success in achieving these endeavours are shown in the envirograms below.

Summer Habitat

During summer, caribou take advantage of ample lichen, herbaceous vegetation, and shrub resources as forage. Additionally, caribou may benefit from the option of moving into coniferous forests with a relatively closed canopy for shelter from environmental conditions. Habitat suitability is also influenced by proximity to roads (Figure 2).

Winter Habitat

During winter, plentiful lichens and ground vegetation are necessary. Since forbs and deciduous shrubs are not as readily available in late fall and early winter, the caribou feed more heavily on lichens with supplements of sedges. Cover requirements are similar year-round (variables are identical to those shown above (Figure 3).

Reproductive Habitat

While calving, female caribou prefer to locate themselves in proximity to muskeg habitat surrounded by ample food resources.

3.2 Application Boundaries

Season: Three separate models have been created for Woodland Caribou habitat – summer, winter, and reproduction.

Habitat Area: Home range size used for home range smoothing is 2,400 ha for summer habitat and 16,800 ha for winter habitat.

Model Output: The model assigns seasonal SI values to each 25 m pixel of forested habitat.

Woodland Caribou HSM

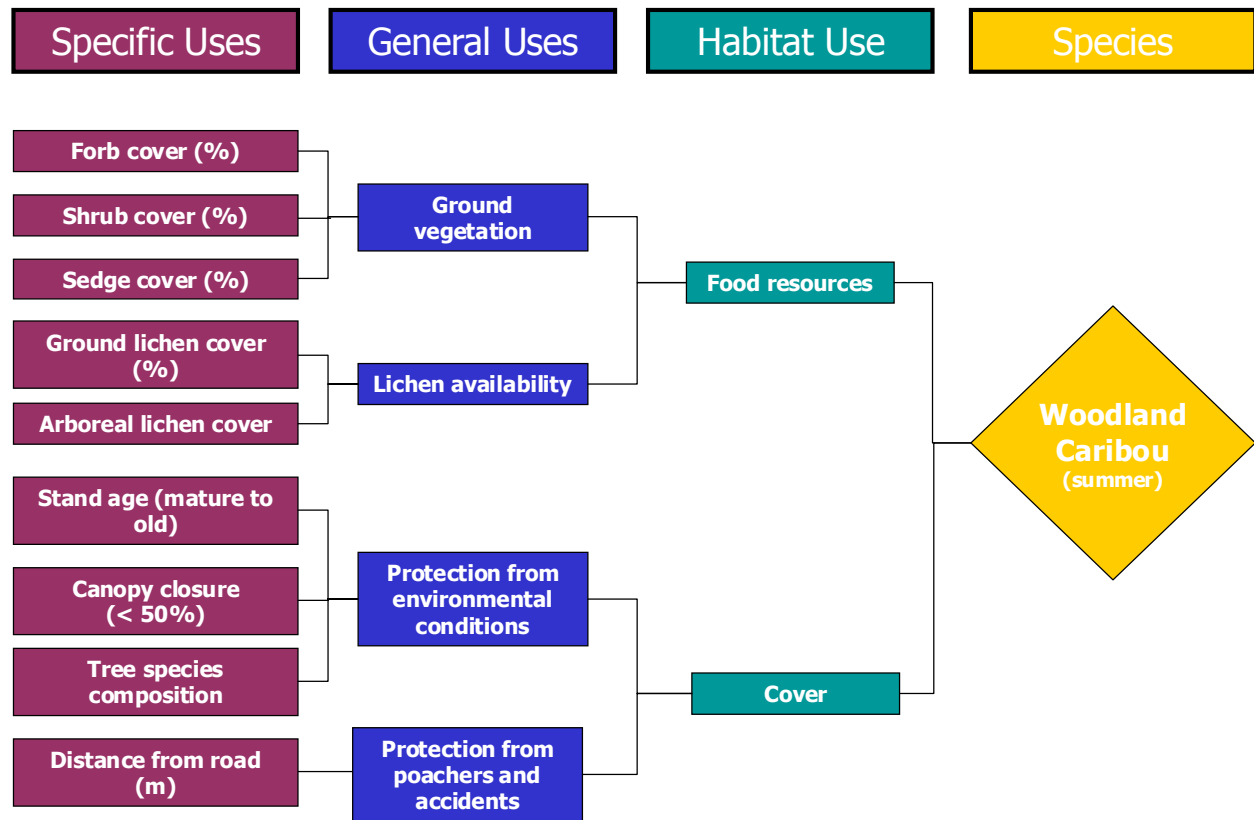


Figure 2. Envirogram of Woodland Caribou *summer habitat* based on available information for HSM development.

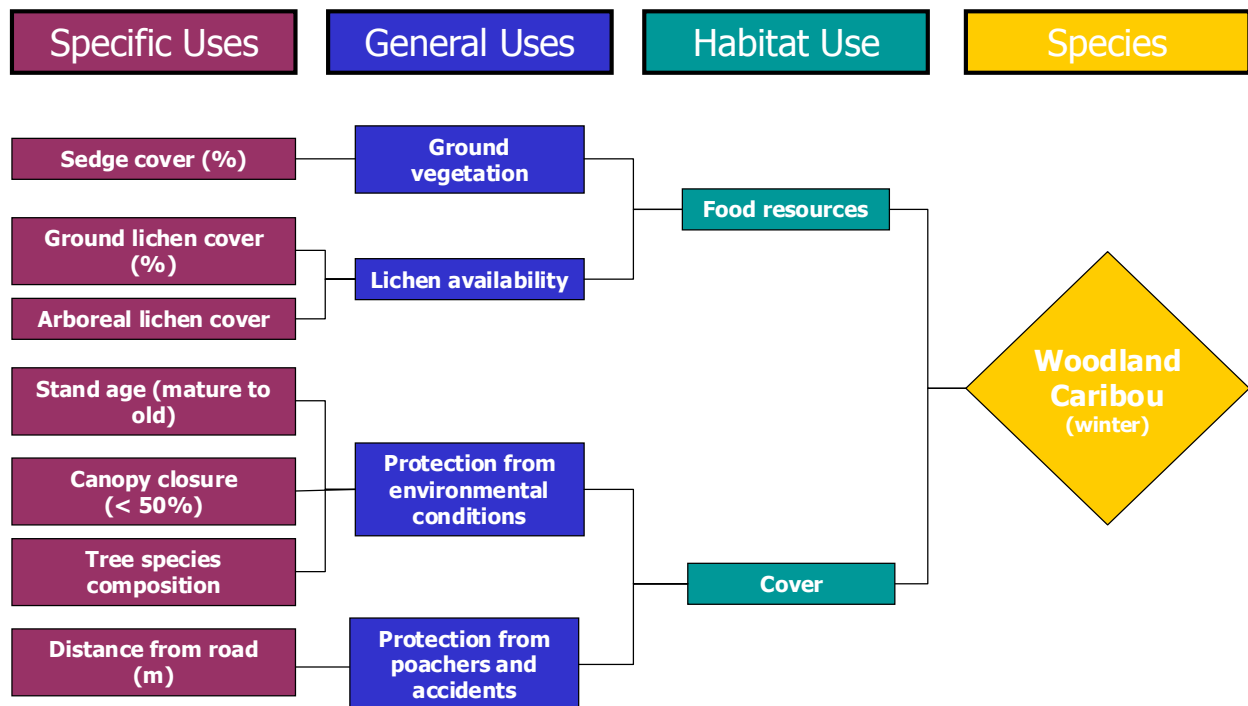


Figure 3. Envirogram of Woodland Caribou *winter habitat* based on available information for HSM development.

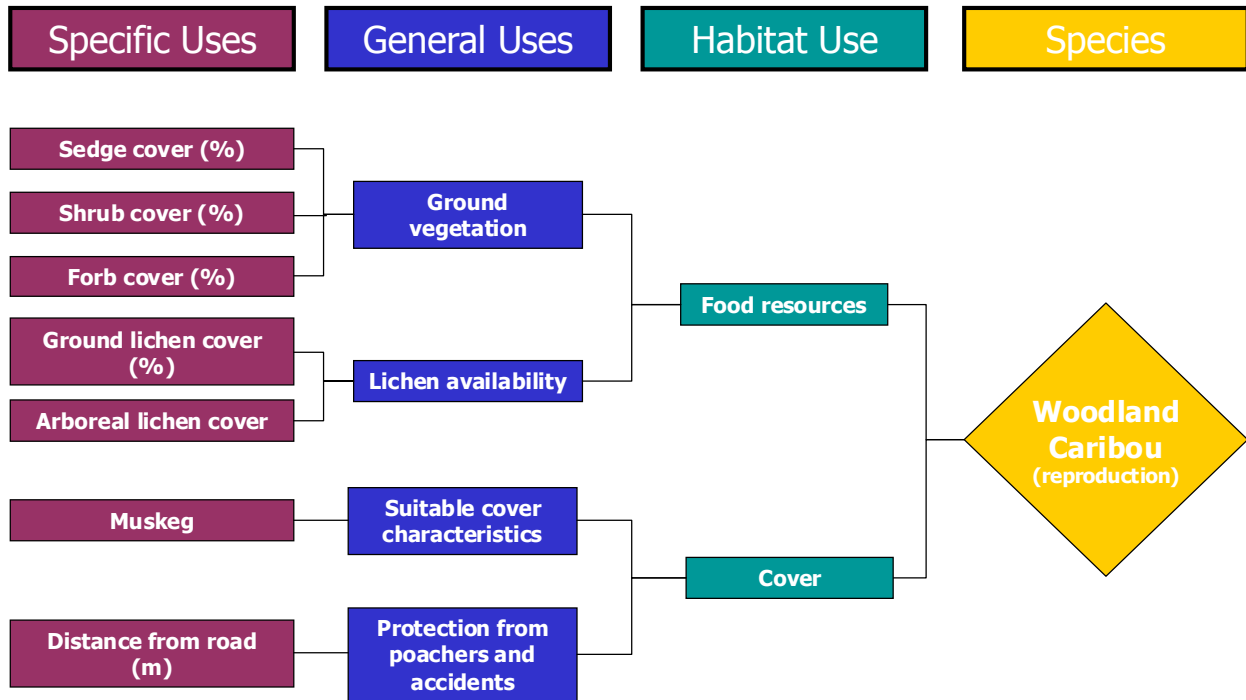


Figure 4. Envirogram of Woodland Caribou *reproductive habitat* based on available information for HSM development.



Woodland Caribou HSM

3.3 Model Description

The HSMs for Woodland Caribou seasonal habitats follow the structures described in the envirograms (Figures 5 to 7). As each element is critical and needed at the same time, no compensation is allowed between the seasonal elements. Distance from roads is used as a part of the cover habitat suitability equations for all seasons.

Summer Habitat

The SI_{food} during summer, $SI_{\text{food}(\text{summer})}$, consists of the variables lichen, forb, shrub, and sedge cover. SI_{cover} is the same in both summer and winter. It includes the variables stand age, tree species composition, and canopy closure. Suitability is reduced with proximity to roads (Figure 5).

Winter Habitat

SI_{food} for winter consists of variables indicating the percentage of forest floor covered with lichens, the coverage of arboreal lichens, and sedge cover (Figure 6).

Reproductive Habitat

SI_{food} for the calving season is identical to that of summer habitat. $SI_{\text{cover}(\text{reproduction})}$ includes the variables of presence of muskeg and distance from roads (Figure 7).

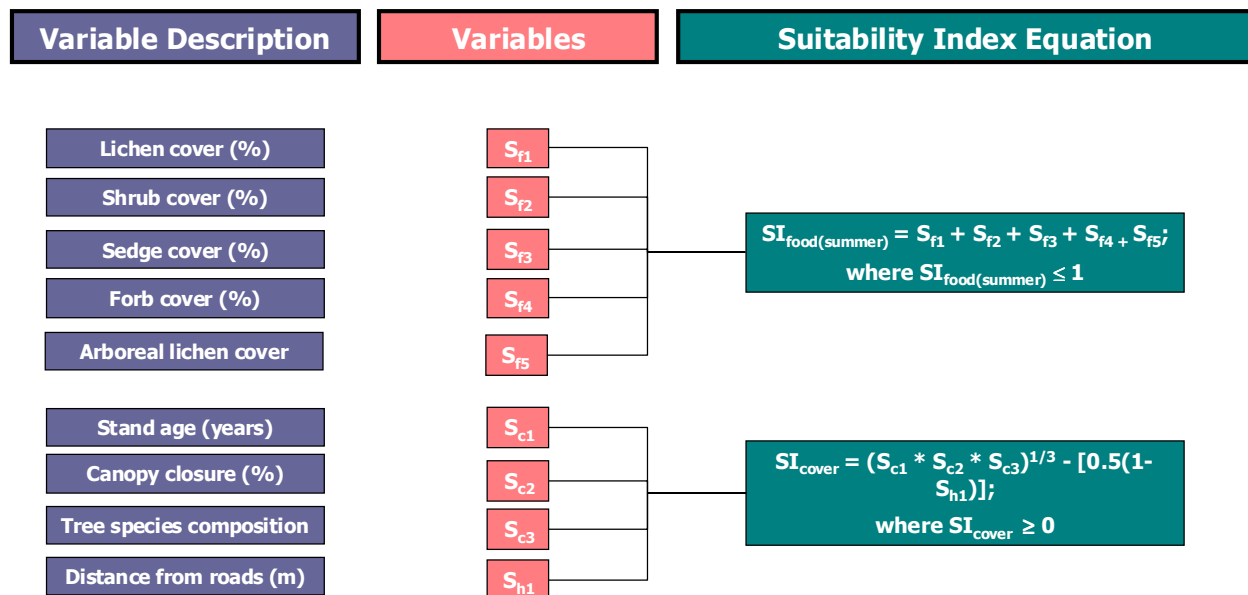


Figure 5. HSM structure for Woodland Caribou *summer habitat* in Millar Western's FMA area.

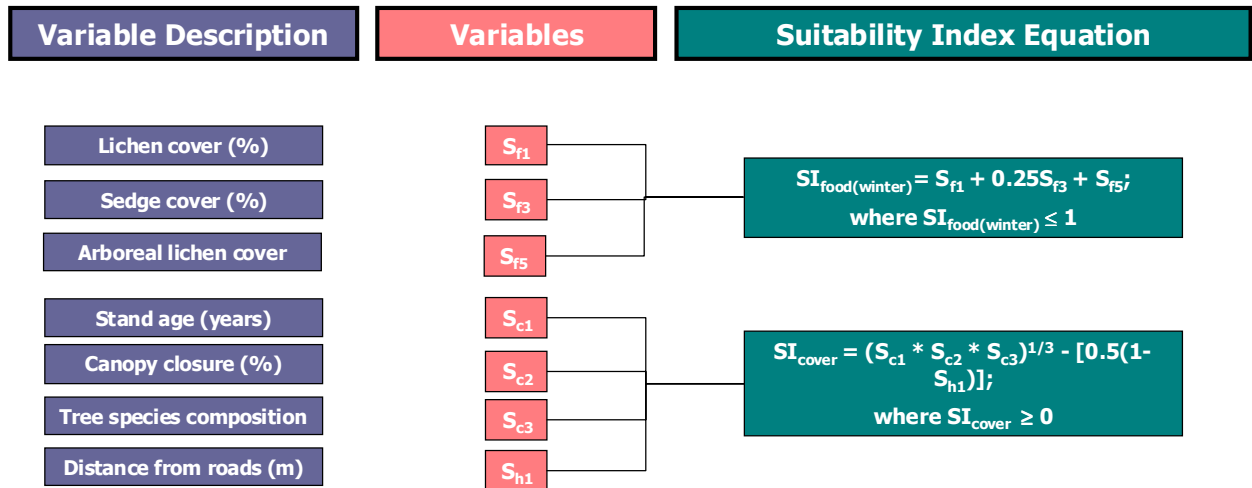


Figure 6. HSM structure for Woodland Caribou *winter habitat* in Millar Western’s FMA area.

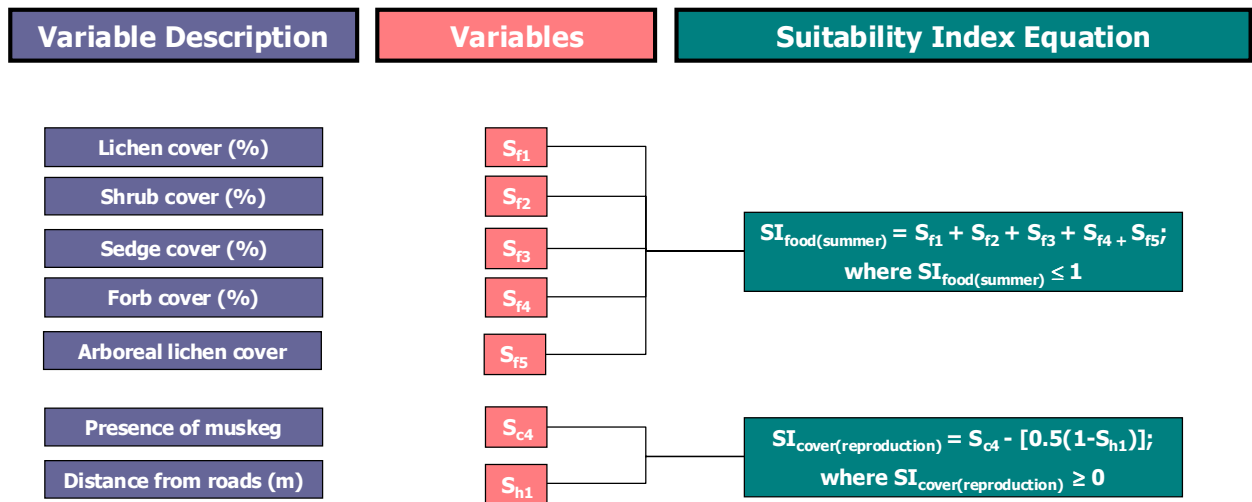


Figure 7. HSM structure for Woodland Caribou *reproduction habitat* in Millar Western’s FMA area.

3.4 Habitat Variable SIs

Food

Foods used by the Woodland Caribou throughout the year include ground lichens (S_{f1}), shrubs (S_{f2}), sedges (S_{f3}), forbs (S_{f4}), and arboreal lichens (S_{f5}). Suitability increases linearly with greater representation of all of these vegetation types. Maximum suitability is reached at 10% for ground lichens (Figure 8), 25% for shrubs (Figure 9), 10% for sedges (Figure 10), and 15% for forbs (Figure 11). In addition, a stand that has been given an arboreal lichen cover rating of high is considered optimal caribou foraging habitat (Figure 12).

Cover

Preferred forest cover is provided by stands of mature to old age (S_{c1} , Figure 13). Canopy closure of 20 to 50% promotes optimal lichen growth (S_{c2} , Figure 14). Figure 15 shows that optimal cover is provided by relatively pure pine or spruce stands (S_{c3}). Cover for the calving season is provided by muskeg environments. For variable S_{c4} , all pixels representing muskeg habitat receive a suitability rating of 1 while all others are rated 0. Cover habitat suitability is optimal at distances greater than 500 m from roads (S_{h1} , Figure 16).

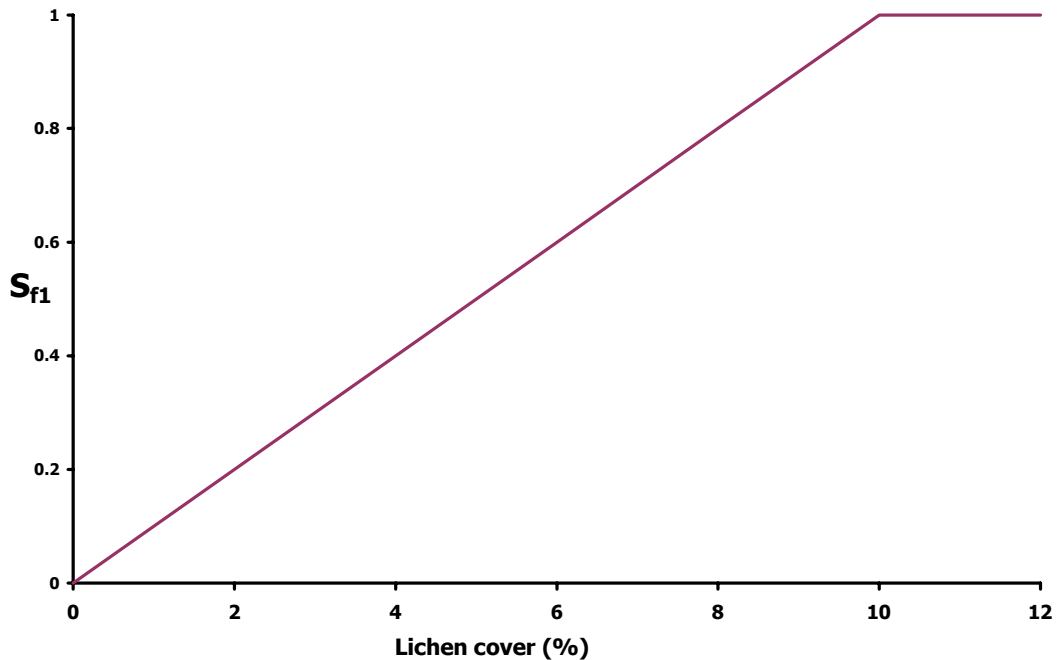


Figure 8. Woodland Caribou foraging habitat suitability in relation to lichen cover within Millar Western’s FMA area.

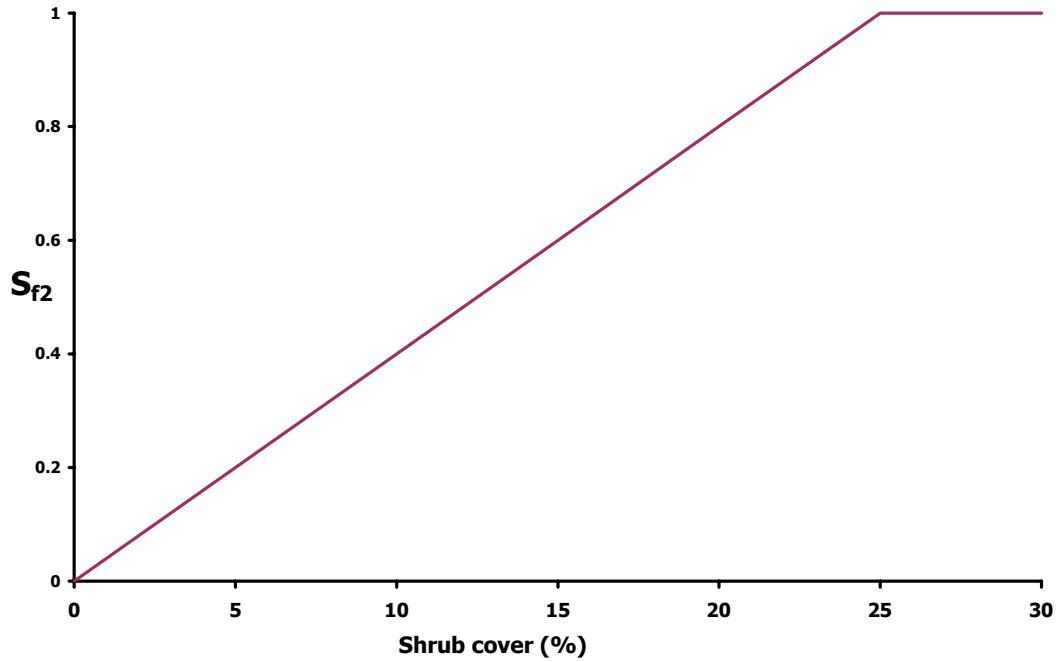


Figure 9. Woodland Caribou foraging habitat suitability in relation to shrub cover within Millar Western's FMA area. Weighting: 0 - 3 m = 1, > 3 m = 0.2.

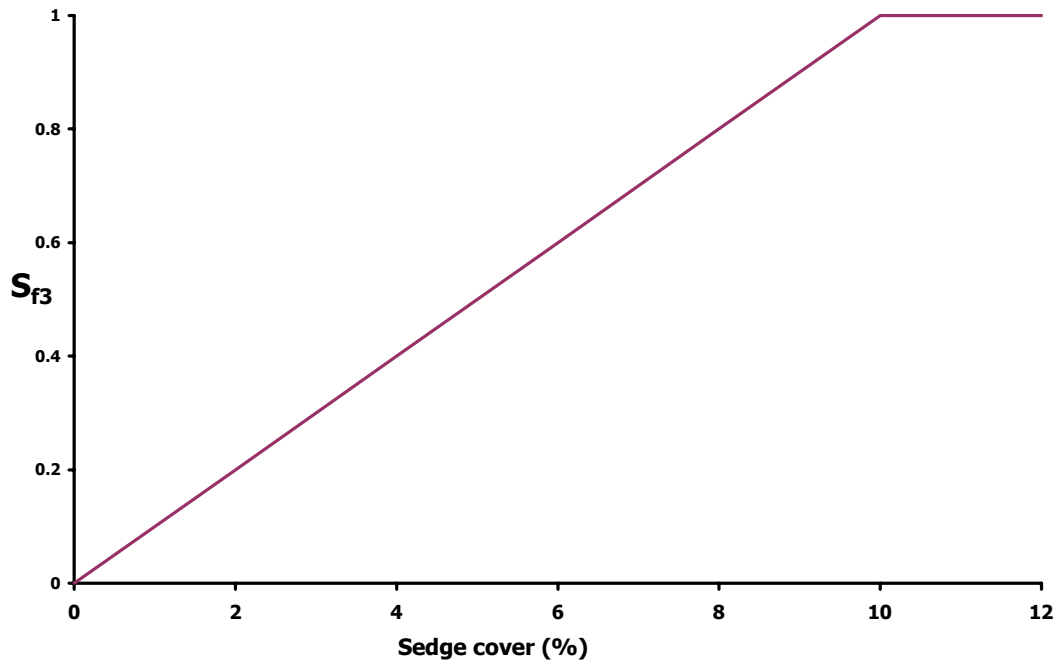


Figure 10. Woodland Caribou foraging habitat suitability in relation to sedge cover within Millar Western's FMA area.

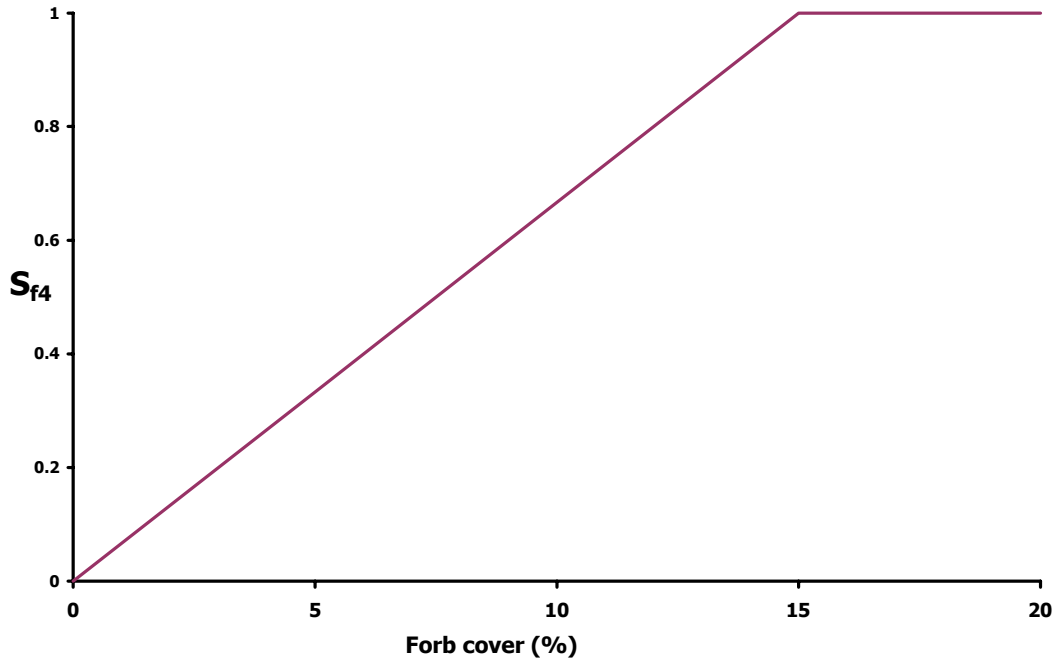


Figure 11. Woodland Caribou foraging habitat suitability in relation to forb cover within Millar Western’s FMA area.

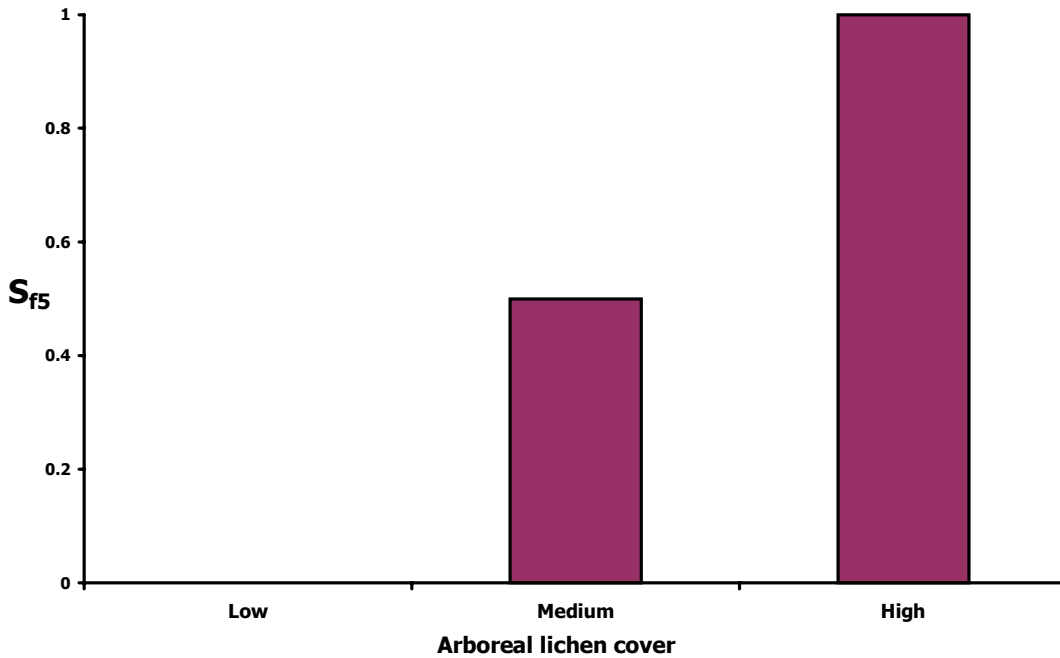


Figure 12. Woodland Caribou foraging habitat suitability in relation to arboreal lichen cover within Millar Western’s FMA area.

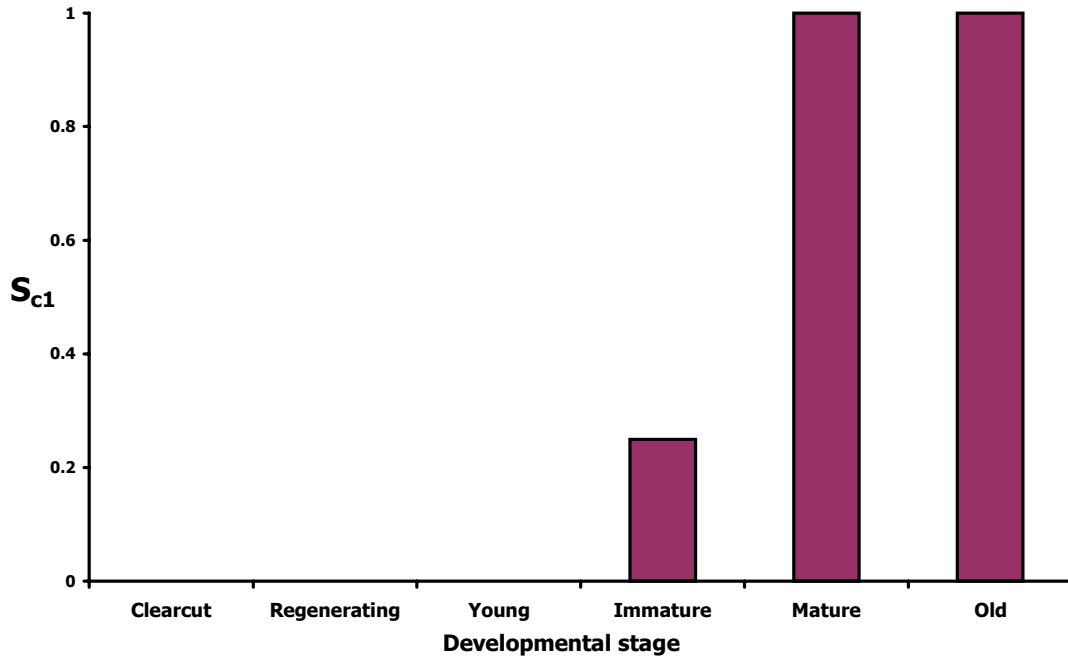


Figure 13. Woodland Caribou cover habitat suitability in relation to developmental stage within Millar Western’s FMA area.

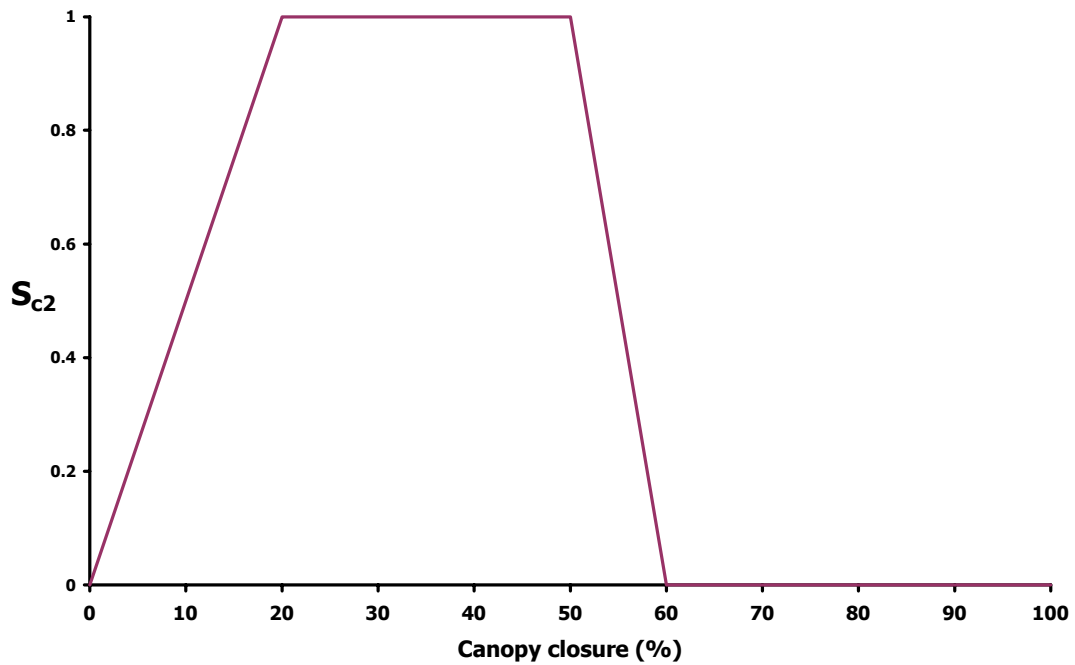


Figure 14. Woodland Caribou cover habitat suitability in relation to tree species composition within Millar Western’s FMA area.

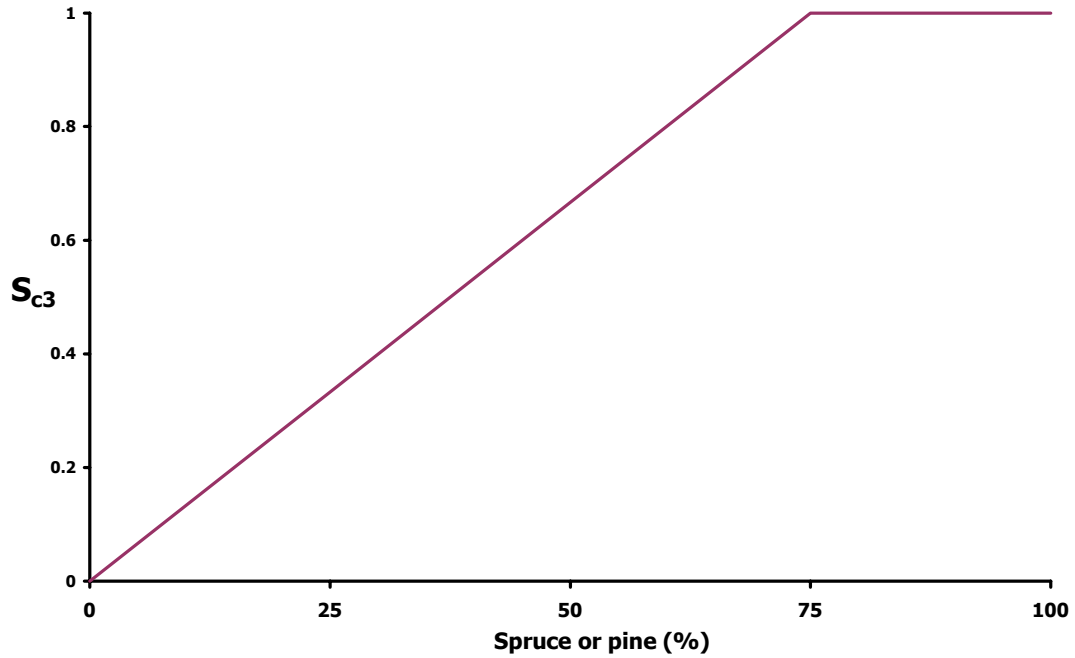


Figure 15. Woodland Caribou cover habitat suitability in relation to tree species composition within Millar Western’s FMA area.

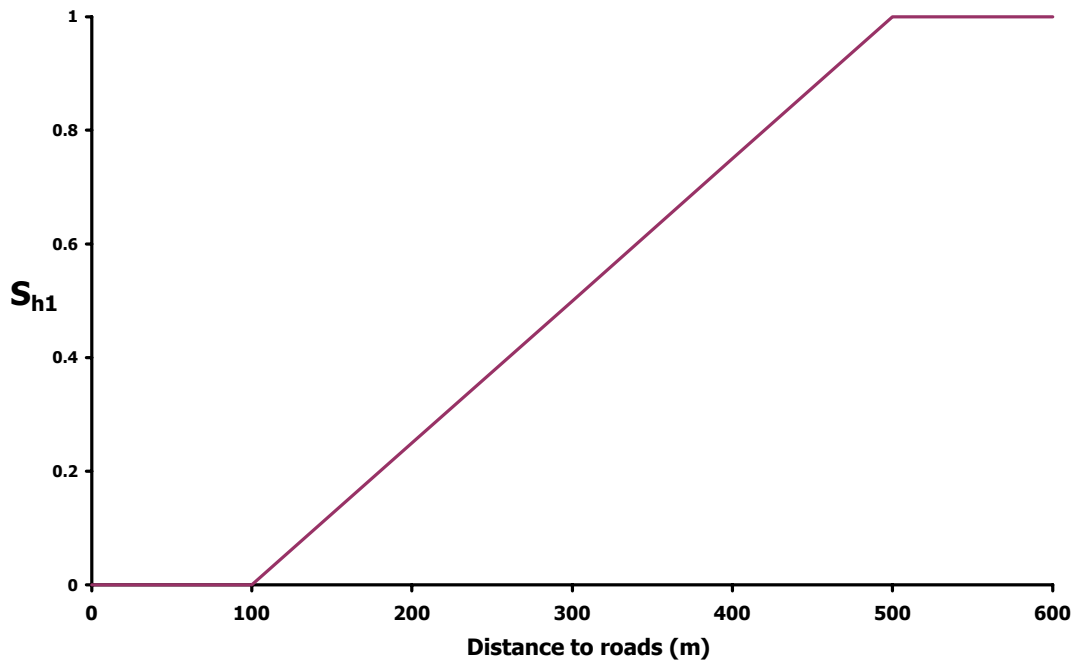


Figure 16. Woodland Caribou hiding cover suitability in relation to proximity to road within Millar Western’s FMA area.



3.5 Computation

Our goal is to create HSMs that allow the user to identify the potential impacts of proposed forest management strategies on caribou habitat. The Woodland Caribou has different habitat requirements during each season. For this reason, three HSMs have been developed – summer, winter, and reproduction. The results of the SIs for these seasons are displayed separately.

Prior to the assessment of the quality of a potential home range as seasonal habitat, the seasonal SIs for food and cover are evaluated for each pixel using the following equations. Cover habitat suitability is reduced by proximity to roads. To take this into account, all roads are buffered to a distance of 500 m. The suitability ratings of all pixels within the buffer are reduced according to the distance-dependent relationship shown in Figure 16. All pixels outside of the buffer are given a suitability rating of 1 for this variable.

$$SI_{\text{food}(\text{summer})} = S_{f1} + S_{f2} + S_{f3} + S_{f4} + S_{f5} ;$$

$$\text{where } SI_{\text{food}(\text{summer})} \leq 1.$$

$$SI_{\text{food}(\text{winter})} = S_{f1} + 0.25S_{f3} + S_{f5} ;$$

$$\text{where } SI_{\text{food}(\text{winter})} \leq 1.$$

$$SI_{\text{cover}} = (S_{c1} * S_{c2} * S_{c3})^{1/3} - [0.5(1 - S_{h1})];$$

$$\text{where } SI_{\text{cover}} \geq 0.$$

$$SI_{\text{cover}(\text{reproduction})} = S_{c4} - [0.5(1 - S_{h1})];$$

$$\text{where } SI_{\text{reproduction}} \geq 0.$$

Caribou are thought to select both summer and winter habitat based on food supply. Therefore, the cover equation can be considered a modifier of foraging habitat suitability. To take this into account, the summer and winter food equations are combined with the cover equation in such a way that stands offering suitable foraging opportunities are considered slightly less suitable if they lack the desired cover characteristics.

$$\text{Adjusted } SI_{\text{food}(\text{summer})} = SI_{\text{food}(\text{summer})} - [0.2(1 - SI_{\text{cover}})];$$

$$\text{where Adjusted } SI_{\text{food}(\text{summer})} \geq 0.$$

$$\text{Adjusted } SI_{\text{food}(\text{winter})} = SI_{\text{food}(\text{winter})} - [0.2(1 - SI_{\text{cover}})];$$

$$\text{where Adjusted } SI_{\text{food}(\text{winter})} \geq 0.$$

Female caribou with calves are most secure within 100 m of muskeg habitat. Therefore, the suitability rating of food resources within this distance of muskeg should be improved over that of more distant pixels. Similarly, the quality of cover habitat is enhanced by proximity to food resources. This can be accounted for using the following equations:

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

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

Summer

To assess the quality of each potential home range as caribou summer habitat, the adjusted $SI_{\text{food}(\text{summer})}$ ratings are averaged within a circular window of radius 2,775 m (2,419 ha). The average values are applied to the centre pixel as its SI rating. The circle then moves over 2,775 m (one full radius) and the averages are again taken and applied to the centre pixel.



Woodland Caribou HSM

Winter

The suitability of a potential range as winter habitat is assessed using the adjusted $SI_{\text{food(winter)}}$ calculation. Food suitability ratings are averaged within a circular window of radius 7,300 m (16,742 ha) and average values are applied to the centre pixel. The window moves in such a way that its centres are located 7,300 m (one full radius) apart. This moving circle need not be centred at the same point as the summer range since migration from summer to mild winter range is a common behaviour of the caribou.

Reproduction

The suitability ratings for foraging and cover habitats for the reproductive season are not smoothed. Female caribou may elect to migrate long distances to utilise a preferred calving site. Smoothing reproduction suitability ratings would cause the precise locations of the potential calving sites to be lost.



4.0 EXTERNAL REVISION

On June 16, 1999, Christoff Rohner, post-doctorate fellow working at the University of Alberta on Woodland Caribou research, provided a review of an early draft version of the caribou HSM. The following alteration was made based on his advice:

- 1) Rohner did not believe that rock outcrops or barren lands were important components of the Woodland Caribou predator evasion strategy in west-central Alberta. This portion of the model was, therefore, removed. Subsequently, all other reviewers provided the same comment.

Arlen Todd, wildlife biologist with Alberta Environment, Fisheries and Wildlife Management Division in Whitecourt, Alberta provided his thoughts on the Woodland Caribou HSM on June 23, 1999.

- 1) Along with editorial comments, Todd stated that we had under-estimated the capability of the caribou to function in snow.
- 2) Though mentioned in the literature review that caribou use pure spruce stands, the model considered only pure pine, spruce/pine mixedwoods, and treed muskeg as appropriate forest cover habitats. This oversight was corrected.

On June 24, 1999, the comments of Kent Brown, caribou researcher in Alberta, were sent via email to KBM. The following summarises his comments:

- 1) We had indicated in the review that caribou may group together to lessen predation pressure. Brown has informed us that the caribou in that area do not perform this behaviour.
- 2) The Selkirk caribou in Idaho are the most researched of all North American caribou. We had incorporated some habitat selection data from this research into the model for caribou of west-central Alberta. Brown pointed out that the ecology of these two

herds is very different and this comparison is not appropriate. This idea was confirmed by the next reviewers, Kirby Smith and Jan Ficht (nee Edmonds).

- 3) Though the literature review stated that lichens are most productive in forests with canopy closure less than 50%, the sign was reversed and for modelling purposes, they were said to be most productive in relatively closed canopy forests. This error was corrected.
- 4) Brown stated that the lower critical temperature of a caribou is -30 to -35 °C. Therefore, they are not seriously influenced by temperature in Alberta.

Kirby Smith and Jan Ficht (nee Edmonds) of the Alberta Natural Resources Service in Edson, Alberta reviewed a version of the caribou HSM and provided comments on June 30, 1999. Through these comments, the following changes were made:

- 1) These two researchers stated that compared to other members of the deer family, caribou are well adapted to snow. Although they prefer to move through shallower and less crusted snow, they are not completely restricted by the presence of deep snow. In addition, caribou can smell lichens and crater through up to 100 cm of snow. Where ground lichens are unavailable, they will turn to arboreal lichens.
- 2) We had written that caribou would seek muskeg environments for predator avoidance since their abilities to detect incoming predators are heightened in open environments. Ficht and Smith stated that more importantly, caribou in west-central Alberta disperse into very low density population structures. This allows them to best avoid wolf predation.



Woodland Caribou HSM

- 3) The importance of the food items readily available during green-up in small clearings, muskegs, south-facing slopes, etc. was understated.
- 4) Updated home range size estimates from the unpublished data of Alberta Natural Resources Service were provided by Ficht and Smith.
- 5) Though it had been previously suggested that caribou will move into 'late winter cover' only during severe winter conditions, the unpublished data of the Natural Resources Service indicate that mature coniferous forest is the most commonly used habitat regardless of winter snow conditions.



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