SPRUCE GROUSE

(Dendragapus canadensis franklinii)

Source: Salt and Salt (1976)

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 Spruce Grouse (*Dendragapus canadensis franklinii*), a member of the Order *Galliformes* and the Family *Tetraonidae*, breeds and winters in the boreal forests of Canada and Alaska (Ouellet 1995, Figure 1). The southern edge of its range parallels the transition zone between the deciduous and coniferous biomes (Schroeder and Boag 1991). The subspecies found in Alberta, *D. c. franklinii*, is a year-round resident. It is relatively common and its populations are considered healthy (Alberta Wildlife Management Branch 1991).

1.2 Effects of Forest Management Activities

As a species reliant on dense coniferous forest, timber harvesting activities that can alter tree species composition can be detrimental to the Spruce Grouse (Gauthier and Guillemette Consultants Inc. 1991). For example, the density of males decreased from 2.5 to 0.9 individuals per km^2 following harvesting operations in the boreal forest of Abitibi-Témiskamingue, Québec (Turcotte *et al*. 1994). In Alberta, the "…destruction of coniferous woods has forced it to retreat further north…" (Semenchuk 1992). Conversely, the research of Schroeder and Boag (1991) revealed that in Alberta, Spruce Grouse may actually be attracted to young lodgepole pine stands, suggesting that its habitat may improve following burning or timber harvesting.

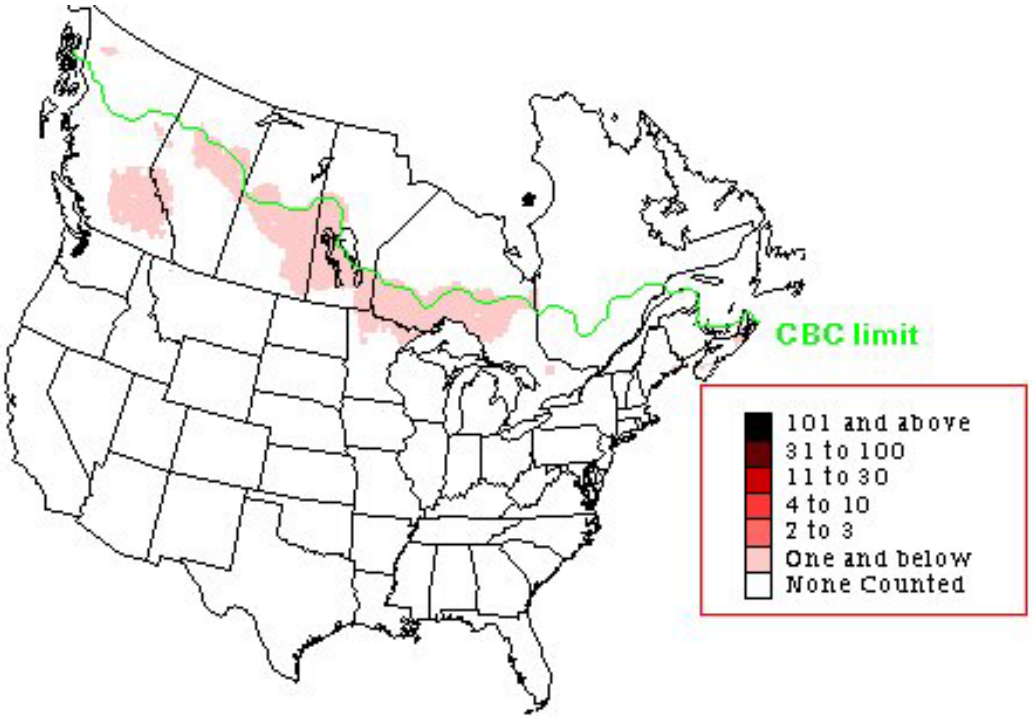

Figure 1. Breeding distribution of the Spruce Grouse in North America, BBS data (Gough *et al.* 1998).

2.0 HABITAT USE INFORMATION

2.1 Food Requirements

The diet of the Spruce Grouse changes seasonally (Ehrlich *et al*. 1989). In early to mid-summer, it is an omnivorous ground forager, feeding on berries (mostly *Vaccinium* spp., Ratti *et al*. 1984; De Francheschi and Boag 1990), fungi, various herbaceous plants and shrubs, and arthropods (mostly juveniles, Francis and Lumbis 1979; Ratti *et al*. 1984; Godfrey 1986; De Francheschi and Boag 1990).

In late summer, early fall, and winter, it is considered an upper-canopy forager (DeGraaf *et al*. 1985) and feeds almost exclusively on the buds and needles (Naylor and Bendell 1989) of spruce, lodgepole pine, and fir trees (Ellison 1976; Herzog and Boag 1978; Francis and Lumbis 1979; Pietz and Tester 1982; Allan 1985; De Francheschi and Boag 1990; Turcotte *et al*. 1993; Turcotte *et al*. 1994). In winter, the Spruce Grouse will roost and feed around the same trees, which are called "activity trees" by Ratti *et al*. (1984).

2.2 Cover Requirements

The Spruce Grouse dwells in coniferous and mixedwood habitat often associated with forested wetlands (Pietz & Tester 1982; Allan 1985; Godfrey 1986; Bouta and Chambers 1990; Schroeder and Boag 1991; Semenchuk 1992). However, the animal's connection with wetlands may only be related to the black spruce-tamarack habitat type and not to soil moisture conditions.

In southwestern Alberta, Spruce Grouse begin to use lodgepole pine forests once such stands have reached ten years of age, with population density increasing to a maximum of 24 birds per 100 ha in 30-year-old pine stands (Boag and Schroeder 1987). The suitability of the stand begins to decline at 40 years of age (Boag 1991) and the bird population again decreases (Schroeder and Boag 1991) as the stand ages. Spruce Grouse habitat use and population density is thought to be associated with shorter canopies, lower densities of *Populus* spp., and higher densities of spruce (Boag and Schroeder 1987). Although the research of Boag and Schroeder (1987) has shown that pine-dominated stands can support Spruce Grouse populations, a more recent study completed by the same authors (Schroeder and Boag 1991) indicated that habitat suitability increases when even a few shade-tolerant conifers are interspersed with the pine.

Cover requirements differ during the wintering and breeding and nesting seasons (Allan 1985; Ouellet 1995). In winter, the Spruce Grouse will dwell in dense coniferous stands (Allan 1985; Naylor and Bendell 1989) where it can forage on buds and needles. In addition to providing food, dense coniferous stands also act as thermal cover (DeGraaf and Rudis 1992).

2.3 Reproduction Requirements

In spring, males move to their breeding ground and will choose habitat with a clear understorey where they will display themselves to females. Immediately after a male has found its mate, the pair returns to a coniferous stand with a dense understorey that will offer them protection from predators as the female nests and the male moults (Ellison 1971).

The Spruce Grouse hen incubates its eggs for approximately 23 days (McCourt *et al.* 1973) in shallow excavated depressions, lined with pine needles, leaves, and grass (Redmond *et al.* 1982). The presence of suitable nest sites is considered critical to the maintenance of a Spruce Grouse population since predation pressure by Red Squirrels (D'Eon 1997) and Coyotes (Boag 1991) is high. Effective concealment of the eggs is essential.

In Alberta, 55% of nest sites are located at the base of a lodgepole pine tree (Keppie 1978), within 10 cm of the bole, often beneath a low branch, and sheltered either by shrubby understorey of willow, alder, or buffaloberry, or by a piece of downed woody debris (Redmond *et al.* 1982). Keppie and Herzog's study (1978) revealed that significant concealment by both lateral vegetation and overhead shelter is critical for nest success. Redmond *et al*. (1982) suggested that denser stands are generally preferred, reinforcing these results.

Little is known about habitat selection by chicks. Spruce Grouse young are able to fly by one week of age, but the hen continues to protect her brood for approximately 12 weeks (Johnsgard 1973). Juveniles disperse in mid-fall (Schroeder 1985; Schroeder 1986) into habitats that are generally of lower quality than the adults' home range (Whitcomb *et al*. 1996).

2.4 Habitat Area Requirements

The home range size of the Spruce Grouse varies with season, sex, and reproductive status (Turcotte *et al*. 1994). According to Ellison (1973), the entire territory may be quite large, ranging from 100 to 150 ha. Population density is highly variable, ranging between four and 50 individuals per km^2. In optimal habitat in Alberta, an average density of 12.2 territorial males per km^2 is common (Boag 1991; Schroeder and Boag 1991).

Whitcomb *et al*. (1996) suggested that patches of suitable habitat smaller than 4 ha are too small to support breeding populations of grouse. In fact, the smallest known occupied patch of suitable habitat is 8 ha.

2.5 Landscape Configuration Requirements

Studies by Fritz (1979), Bouta and Chambers (1990), and Whitcomb *et al*. (1996) suggested that Spruce Grouse form metapopulations. The species has been shown to be sensitive to forest fragmentation (Fritz 1985) as the young must be able to find suitable habitat to establish a range within their 9 km^2 dispersal radius (Whitcomb *et al*. 1996). Though coniferous forests are preferred, deciduous stands are not an absolute dispersal barrier (Whitcomb *et al*. 1996).

2.6 Sensitivity to Human Disturbance

Keppie and Herzog (1978) found that nest success decreased with proximity to a trail or a seismic line (< 10 m). Proximity of nests to trails is not thought to increase the chance of a nest being disturbed by predators (D'Eon 1997) but does increase exposure to human activity. Since the bird does not flee when disturbed by a human, it can easily be killed. Its "tameness" might have been responsible for its extirpation from the southern part of its traditional range (Godfrey 1986).

3.0 MODEL

3.1 Envirogram

Three elements are included in the Spruce Grouse envirogram: winter food resources, protection from predators (particularly during the nesting season), and thermal cover (Figure 2). Summer food is not thought to be a factor influencing population size since food is plentiful for its omnivorous diet in that season. Its winter diet is critical, however, and is restricted to the needles and buds of coniferous trees. The second element considered in the HSM is the availability of winter roosting sites. A closed canopy of coniferous trees provides effective thermal cover. In particular, preferred roosting sites are located in mature white spruce trees. Finally, hiding cover is required since nest success is dependent on visual concealment. Display sites are probably not a restrictive resource and the literature review did not suggest that their availability could affect population size. Therefore, this variable is not considered in the HSM.

3.2 Application Boundaries

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

Habitat Area: Since a minimum breeding range size of 8 ha has been estimated by Whitcomb *et al.* (1996), we will perform home range smoothing for the nesting SI calculation within an area of 10 ha in size (window of radius 175 m). During winter, Spruce Grouse range further, expanding their territory to 100 to 150 ha (Ellison 1973). Therefore, a home range size of 104 ha (575 m radius) will be used for smoothing of the winter food and cover SIs.

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

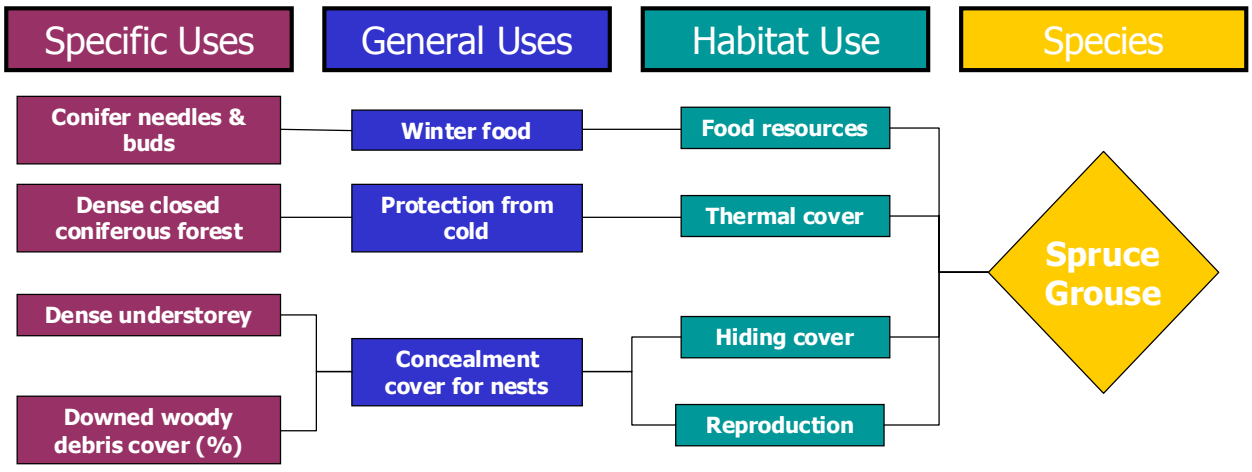

Figure 2. Envirogram of Spruce Grouse based on available habitat information for HSM development.

3.3 Model Description

The HSM structure for Spruce Grouse year-round habitat follows the envirogram (Figure 3). The winter food SI depends on the percentage of desirable coniferous trees in the stand and their canopy closure. No compensation is allowed between these two variables.

The cover SI reflects the need for thermal cover and roost trees in winter. Again, canopy closure and softwood proportions are involved in the calculation. In addition, stand age is considered. There is no compensation between these three variables. As white spruce is the preferred species for roosting, the cover SI is improved with higher proportion of that species.

Finally, the nesting SI relates to the provision of visual concealment cover. Spruce Grouse nest in coniferous stands with a relatively high degree of closure. Although visual cover must hide the hen in the immediate vicinity of the nest, it should not obstruct her view as she watches for predators or hinder her ability to flee if necessary. The hen has the ability to select her preferred nesting site beneath the cover of a shrub, tree with low height to crown, or piece of coarse downed woody debris. Therefore, these three variables are fully compensatory. The resulting value is then multiplied by the canopy closure and softwood representation ratings. Finally, a penalty of 0.1 is incurred if the area is coincident with a road, seismic line, or utility line since proximity to human activity has a negative impact on habitat suitability.

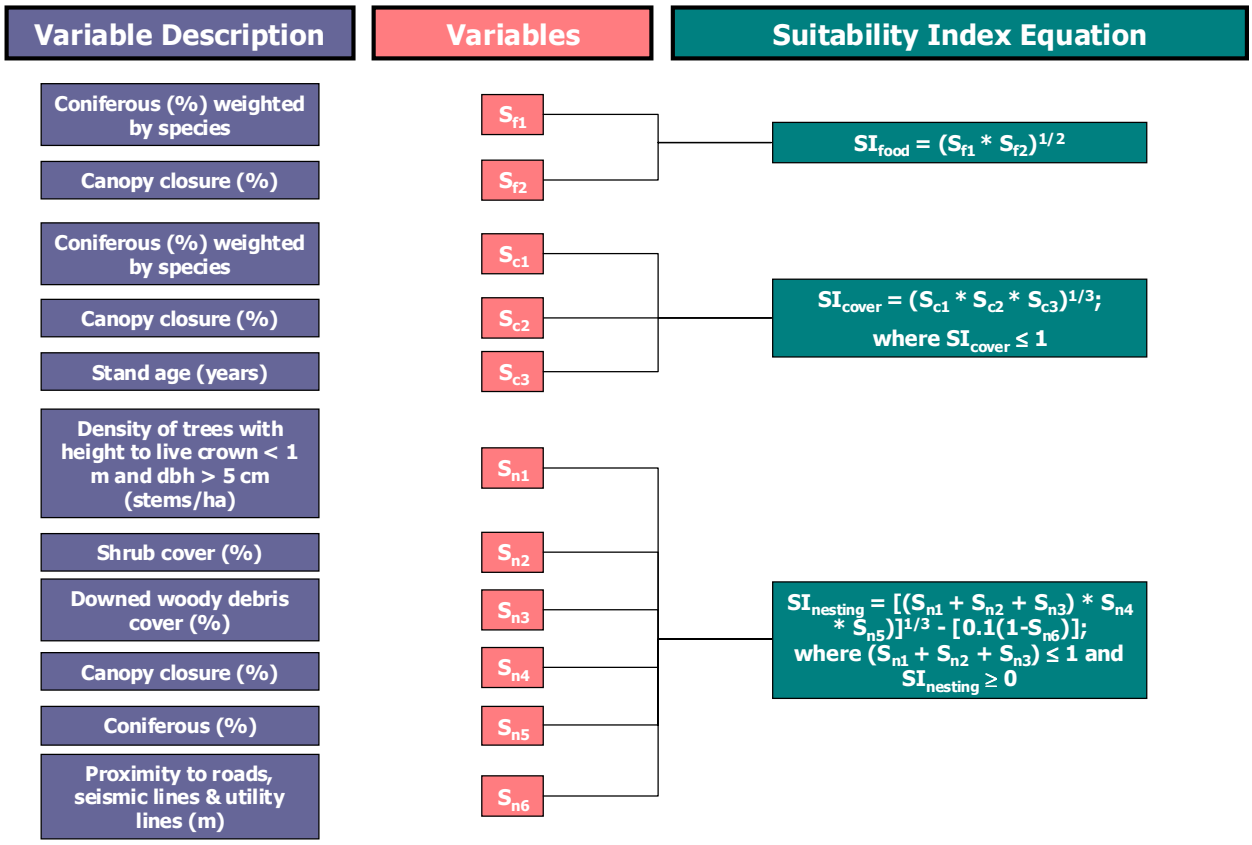

Figure 3. HSM structure for the Spruce Grouse within Millar Western's FMA area.

3.4 Habitat Variable SIs

Food

In the Spruce Grouse HSM, winter food availability is believed to increase linearly with the proportion of desirable coniferous species (S_{f1}, Figure 4). The literature review has revealed that spruce and pine are the most desirable species. The Spruce Grouse prefers relatively pure coniferous stands. Therefore, it is thought that suitability increases linearly to a maximum at 75% desirable tree species representation. As bud and foliage production is likely related to crown closure, food availability increases with canopy closure, peaking at 75% (S_{f2}, Figure 5).

Cover

The cover SI is related to the proportion of softwoods in the stand (S_{c1}), canopy closure (S_{c2}), and age (S_{c3}). For canopy closure, we use the same SI curve as that developed for the food SI (Figure 5). In addition, habitat suitability increases linearly with presence of desirable tree species, peaking at 25% representation (Figure 6). White spruce is particulary desirable and is, therefore, weighted 1.1. A stand becomes suitable as cover at ten years of age, is most suitable at 30 years, and begins to decline in value at 40 years of age (Figure 7).

Nesting

Suitability of nesting habitat increases linearly with density of trees of dbh at least 5 cm and height to live crown less than 1 m (S_{n1}, Figure 8) since Spruce Grouse appreciate the opportunity to raise their young beneath their shelter. Maximum suitability occurs at a density of 2,000 suitable trees per ha. It is assumed that this will provide the pair with a choice of nesting sites. Shrub cover (S_{n2}) weighted by height also improves the suitability of nesting habitat as it increases from 0 to a maximum at 25% (Figure 9). Downed woody debris cover improves suitability (S_{n3}) by providing nest sites and concealment cover. Maximum suitability is reached at 15% coverage (Figure 10). Canopy closure is maximised at around 75% closure, S_{n4} (Figure 5). Suitability increases linearly with increasing coniferous cover, S_{n5} (Figure 11). The value received for variable S_{n6} is equal to 1 if the pixel is not coincident with a seismic or utility line or road. If a seismic line, utility line, or road is present within the pixel, its value for S_{n6} is 0.

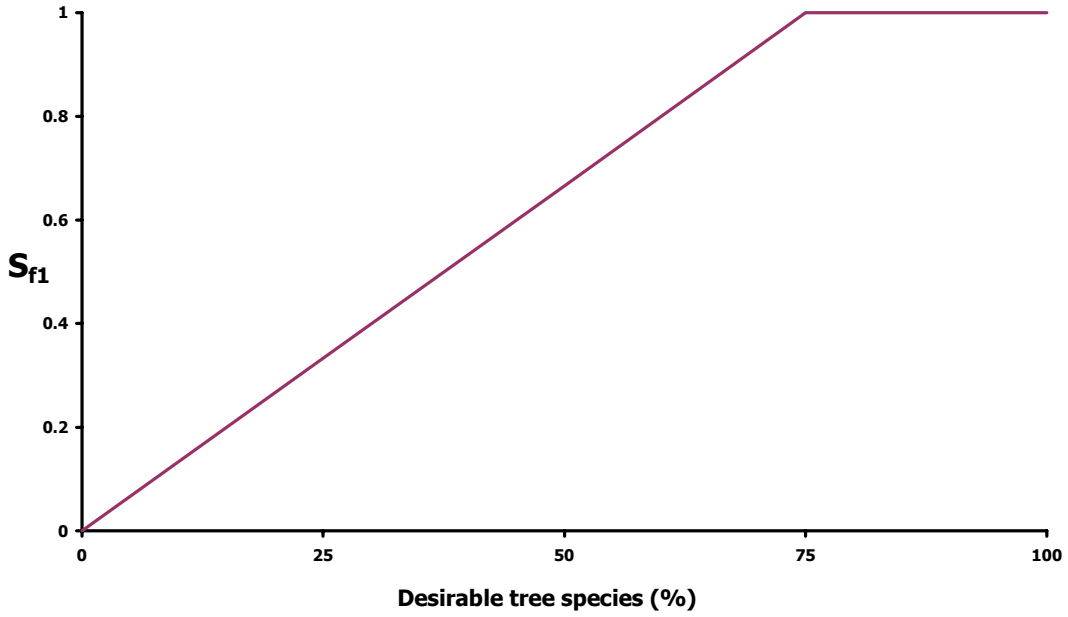

Figure 4. Spruce Grouse foraging habitat suitability in relation to % desirable tree species in Millar Western's FMA area. Weighting: spruce/pine = 1; fir = 0.8, others = 0.

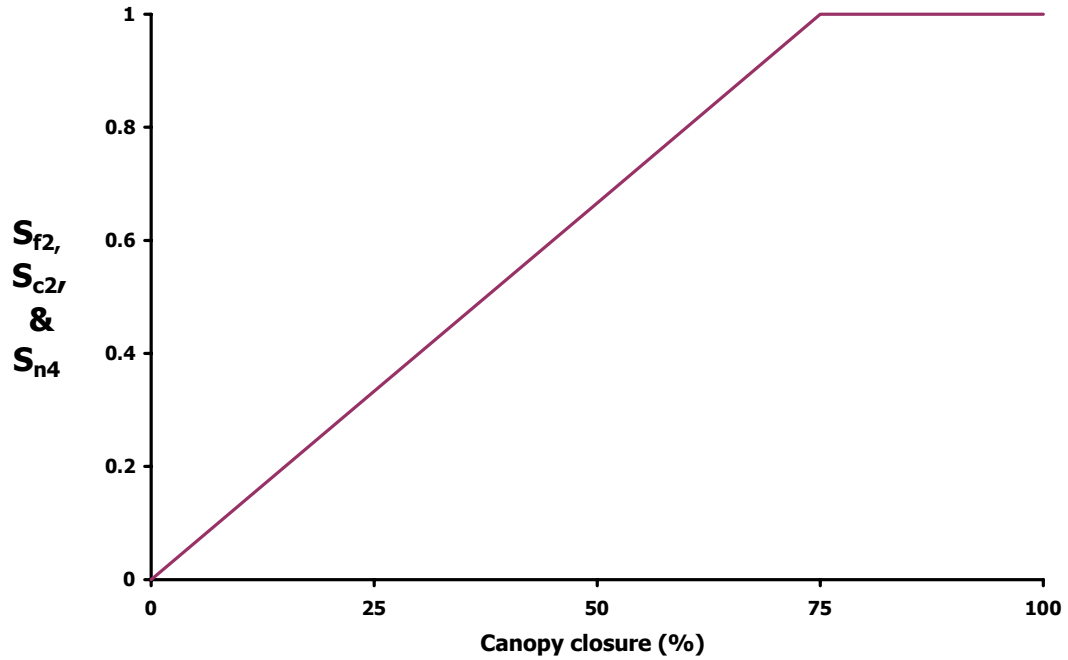

Figure 5. Spruce Grouse foraging habitat suitability in relation to canopy closure within Millar Western's FMA area.

Figure 6. Spruce Grouse cover habitat suitability in relation to % desirable tree species within Millar Western's FMA area. Weighting: whi te spruce = 1.1; black spruce = 1.0, fir = 0.9, pine = 0.9; others = 0.

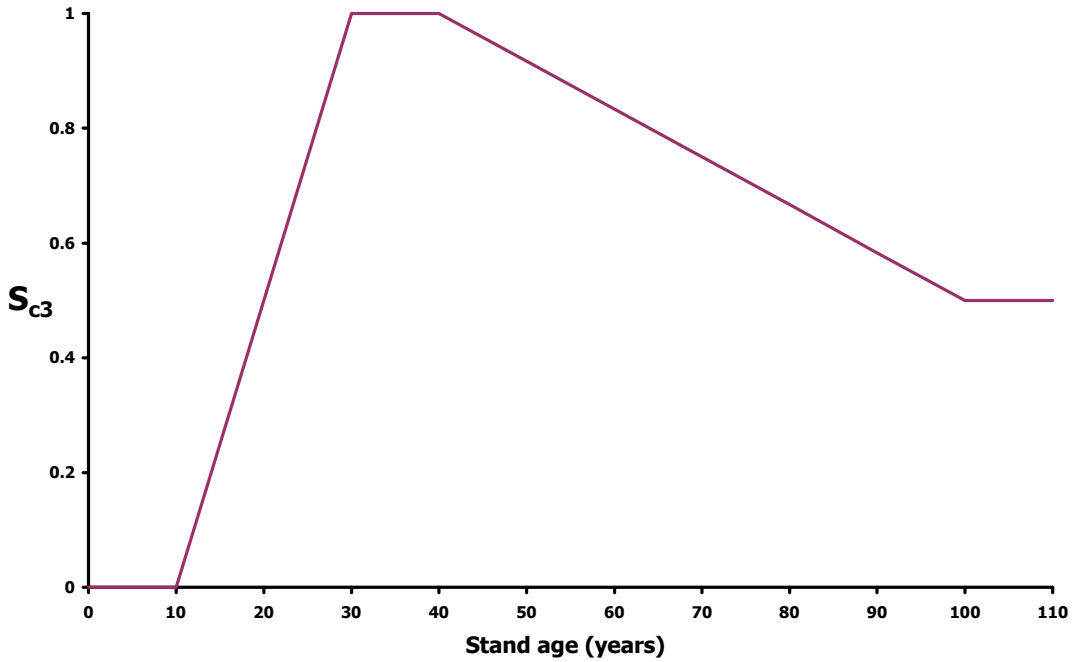

Figure 7. Spruce Grouse cover habitat suitability in relation to stand age within Millar Western's FMA area.

Figure 8. Spruce Grouse nesting habitat suitability in relation to density of trees with height to live crown < 1 m and dbh > 5 cm per ha within Millar Western's FMA area.

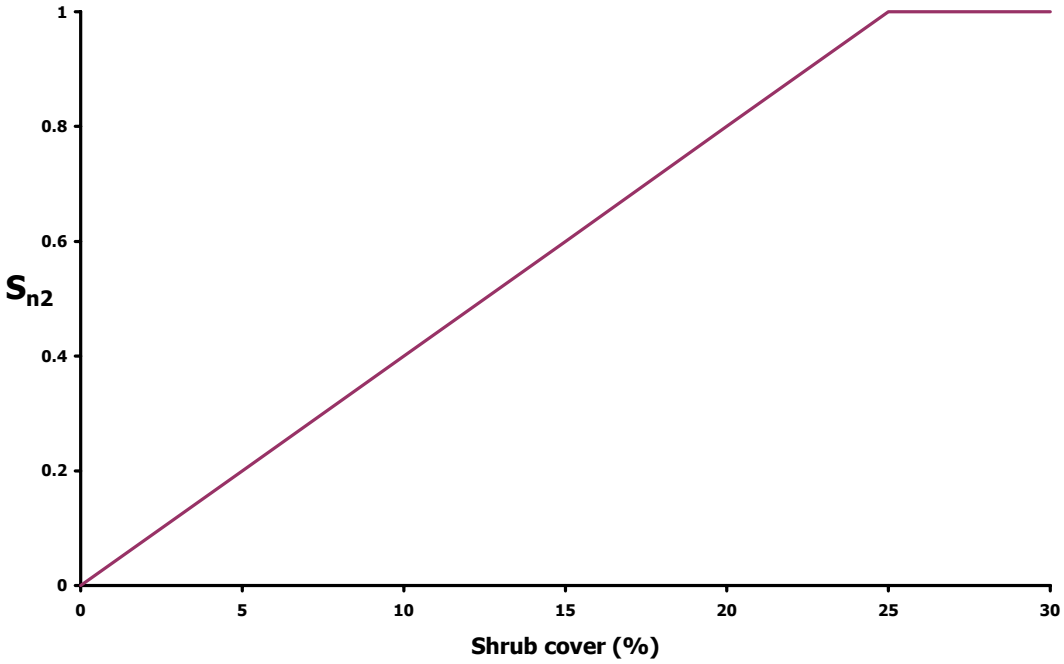

Figure 9. Spruce Grouse nesting habitat suitability in relation to shrub cover within Millar Western's FMA area. Weighting: 0 -25 cm = 0, 26 - 50 cm = 0.25, 50 cm - 1 m = 0.65, 1.1 - 3 m = 1, > 3 m = 0.2.

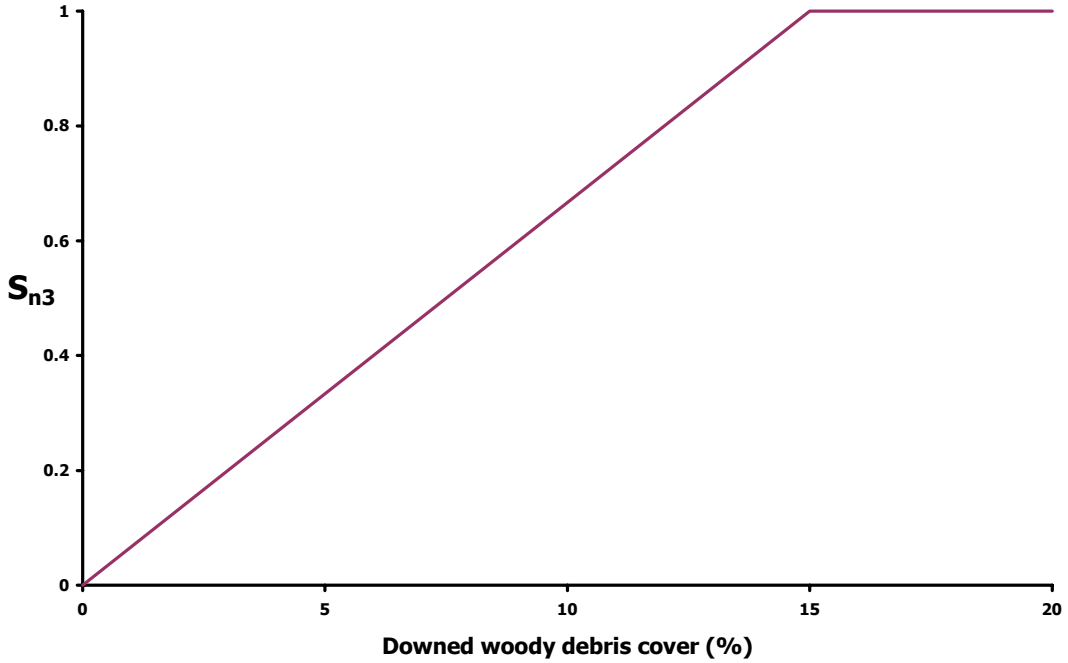

Figure 10. **Spruce Grouse nesting habitat suitability in relation to downed woody debris cover within Millar Western's FMA area.**

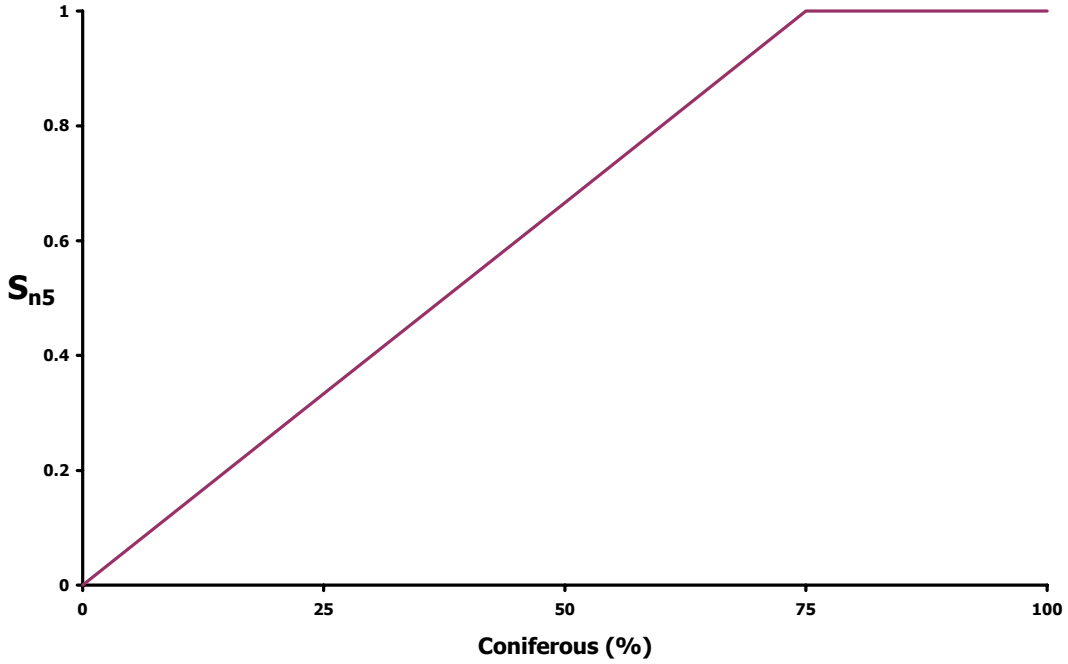

Figure 11. **Spruce Grouse nesting habitat suitability in relation to coniferous representation within Millar Western's FMA area.**

3.5 Computation

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

Foraging Habitat Index

The value of each pixel of forested habitat as foraging area is first assessed using the equation:

$$\mathbf{SI_{food} = (S_{f1} * S_{f2})^{1/2}}$$

Cover Habitat Index

The potential of each pixel to provide cover to Spruce Grouse is evaluated by:

$$\mathbf{SI_{cover} = (S_{c1} * S_{c2} * S_{c3})^{1/3};}$$

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

Nesting Habitat Index

The quality of each pixel as nesting habitat is first determined using the equation:

$$\mathbf{[(S_{n1} + S_{n2} + S_{n3}) * S_{n4} * S_{n5}]^{1/3}}$$

$$\mathbf{where\ (S_{n1} + S_{n2} + S_{n3}) \leq 1.}$$

A penalty is applied to take into account the reduced suitability of pixels that represent seismic or utility lines or roads. If a seismic or utility line or road is present within any pixel, the pixel's nesting habitat suitability rating is reduced by 0.1 as shown in the following equation:

$$\mathbf{SI_{nesting} = [(S_{n1} + S_{n2} + S_{n3}) * S_{n4} * S_{n5}]^{1/3} - [0.1\ (1 - S_{n6})];}$$

$$\mathbf{where\ (S_{n1} + S_{n2} + S_{n3}) \leq 1\ and}$$

$$\mathbf{SI_{nesting} \geq 0.}$$

Home Range Smoothing

The potential of each pixel as the centre of a Spruce Grouse home range is assessed. While winter ranges are approximately 100 ha in size, breeding habitat is only ~10 ha. Since Spruce Grouse are highly mobile, these two ranges need not be concentric.

Two separate windows move over the grid representing Millar Western's FMA area. One window has a radius of 175 m (10 ha) and represents a breeding range. It moves over the grid with each pixel, in turn, acting as its centre. The other has a radius of 575 m (104 ha) and represents a winter range. It also moves over the grid but in such a way that the circles' centres are 575 m (one full radius) apart.

Breeding range

The $SI_{nesting}$ ratings of all pixels within the 10 ha circle are averaged. This average value is applied to the centre pixel as its $SI_{nesting}$. The SI_{cover} need not be calculated for breeding range as cover requirements have been taken into account in the nesting SI. The SI_{food} values are not smoothed within this circle since they represent winter foraging suitability, an element irrelevant to breeding habitat quality.

Winter range

The SI_{food} and SI_{cover} values within the larger circle are averaged. These average values are recorded as the SI_{food} and SI_{cover} of the pixel at the centre of the circle. The $SI_{nesting}$ values need not be averaged, as this element is not important during the winter months.

4.0 EXTERNAL REVISION

W. Robert Watt, Terrestrial Ecosystems Team Leader, at Northeast Science & Technology, Ministry of Natural Resources in Ontario reviewed the Spruce Grouse HSM on August 13, 1998. Based on the review, we made the following changes from the original version of the document.

1) Balsam fir is now ranked below lodgepole pine as a food source in S_{f1}.

2) Tamarack is now set to provide no value for winter cover in S_{c1}.

3) We have changed the formula for the cover SI. There is now no compensation between stand composition and canopy closure. We have removed the small conifer tree density as an improvement of cover.

4) Based on the literature provided by Watt, we changed the variables in the nesting SI. Instead of the density of small conifer trees that we previously used for visual concealment, we used density of trees with low height to crown and ground vegetation cover. Downed woody debris was still used but we reduced the threshold for the variable to reach a plateau at 15% coverage.

5) The detrimental effect of edge was removed from the HSM as no scientific evidence has confirmed this relationship.

6) Watt believed that the canopy closure relationship should peak earlier than 100% because in stands with canopy closure of 70 to 80%, the trees are likely to have deep crowns as well as dense understoreys.

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