SOUTHERN RED-BACKED VOLE

(Clethrionomys gapperi)

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 Southern Red-backed Vole (*Clethrionomys gapperi*) is a small, slender member of the genus, *Clethrionomys*, whose range includes all of Canada except for Newfoundland, the southeastern corner of Alberta (Buckmaster *et al.* 1995), the northwestern portion of British Columbia, and the Yukon Territory (Moses pers. comm. 1999, Figure 1). It is a common member of the small mammal community in the forests of northern Canada (Martell 1981; Bondrup-Nelson 1987).

The Southern Red-backed Vole is an important food source for several predators, including the Marten and the Barred Owl (Marks *et al.* 1984; Bosakowski *et al.* 1987; Elderkin 1987). As the population size of many small mammals, including the red-backed vole, fluctuates significantly from year to year, their increased density during population highs provides an ample food resource to those linked to it through trophic relationships (Moses pers. comm. 1999).

1.2 Effects of Forest Management Activities

Several studies have compared the abundance of Southern Red-backed Voles in uncut and harvested stands (Martell and Radvanyi 1977; Martell 1983; Monthey and Soutiere 1985; Medin 1986; Yahner 1986; Kirkland 1990). Habitat requirements of red-backed voles include mesic soil conditions (Getz 1968; Merritt 1981), coarse woody debris (Merritt 1981; Bondrup-Nelson 1987; Hayes and Cross 1987), and high total ground cover (Yahner 1986). The loss of these habitat elements may lead to the reduced vole abundance observed following clearcutting (Martell and

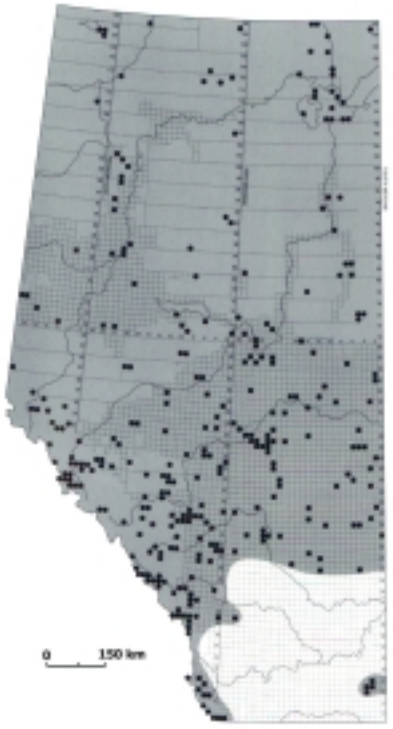

Figure 1. Estimated distribution of the Southern Red-backed Vole in Alberta (Smith 1993).

Radvanyi 1977; Martell 1983; Medin 1986). Unless the clearcut area quickly develops thick ground cover, voles may remain uncommon on the site for up to 15 years post-harvest (Martell and Radvanyi 1977). Other researchers have suggested that vole populations can actually increase in response to timber harvesting, provided thick ground cover remains on site following the completion of operations (Powell and Brooks 1981; Monthey and Soutiere 1985; Kirkland 1990).

The vole's need for ground vegetation was further clarified by research into the effect of herbicide application on red-backed vole abundance (D'Anieri *et al.* 1987; Santillo *et al.* 1989; McMillan *et al.* 1990). These studies revealed that though Southern Red-backed Voles continued to be present on sites treated with the herbicide glyphosate, their abundance was significantly reduced on treated sites compared to control sites. Through this research, it was found that the voles continued to be negatively affected for at least three years following treatment.

2.0 HABITAT USE INFORMATION

2.1 Food Requirements

In general, red-backed voles are considered herbivorous mammals that consume mainly herbs, fungi, lichens, seeds, berries, other plant material, and occasionally invertebrates (Miller and Getz 1977; Schloyer 1977; Martell 1981; Ure and Maser 1982; Carey and Johnson 1995). Along with their food requirements, these animals need a substantial daily intake of water (Getz 1968; McManus 1974), much of which they receive from their food (Getz 1968; Schloyer 1977; Maser *et al.* 1978; Martell 1981). In particular, fungi are important food resources as they assist the animals in acquiring sufficient moisture (Getz 1968; Maser *et al.* 1978; Ure and Maser 1982). Downed woody debris is also a vital element of foraging habitat since it traps water and creates the mesic conditions optimal for fungal growth (Getz 1968; Maser *et al.* 1978; Merritt 1981).

2.2 Cover Requirements

A review of the literature describing optimal red-backed vole habitat revealed several important contradictions. While some studies suggested that the animals are common in mature to old black spruce or spruce-fir stands (Martell and Radvanyi 1977; Nordyke and Buskirk 1988), Bondrup-Nelson (1987) noted high vole densities in mixedwood forests. In addition, Roy *et al.* (1995) observed a connection between vole presence and birch density. Several researchers also found that voles were abundant in regenerating clearcuts (Monthey and Soutiere 1985; Kirkland 1990; Sekgororoane and Dilworth 1995).

There appears to be some controversy over the connection between ground cover and Southern Red-backed Vole habitat quality. Though the research of Yahner and Smith (1991) suggested that voles more readily inhabit stands with low densities of logs and ground cover, other studies have shown that vole abundance is related to the presence of ample downed logs or thick ground vegetation (Miller and Getz 1972; Miller and Getz 1973; Martell and Radvanyi 1977; Maser *et al.* 1978; Merritt 1981; Powell and Brooks 1981; Yahner 1983; Monthey and Soutiere 1985; Yahner 1986; Wywialowski 1987; Nordyke and Buskirk 1988; Wywialowski and Smith 1988; Roy *et al.* 1995). We speculate that ground cover by downed woody debris and vegetation is important both to hide voles from predators and to maintain soil moisture necessary for fungal growth. In particular, the work of Hayes and Cross (1987) showed that larger diameter downed woody debris better provides cover than smaller pieces. Carey and Johnson (1995) suggested that though downed woody debris cover of at least 10% may suffice, > 20% coverage is thought to be optimal. In addition, a greater proportion of the forest floor covered with ground vegetation is considered better vole habitat. It is important to note, however, that not all ground vegetation cover contributes equally to vole habitat quality. Dense grass cover does not provide hiding cover (Walters 1991) and may interfere with foraging movements (Yahner 1982).

As suggested by Todd (pers. comm. 1999), the uncertainty regarding vole habitat use may be a function of different research methods and different site preparation and harvesting practices. Alternatively, this inconsistency could be explained by the possibility that vole habitat requirements may not be as strict as previously thought and that the animals may have the capability to use any of these habitat types equally well (Moses pers. comm. 1999). Further to this, Morris (pers. comm. 2000) suggested that it is possible that during periods of high vole density, the animals may use virtually any forested habitat type while during population lows, they may be more specific in their selection of habitat. Therefore, we must point out that vole habi-

tat requirements may not yet have been sufficiently described. It is essential that vole activity is monitored within Millar Western's FMA area and that new findings are applied to the HSM.

2.3 Reproduction Requirements

Southern Red-backed Voles breed between April and October, depending on latitude. The gestation period lasts 17 to 19 days and litter size generally ranges between four and nine young. Since the female can exhibit post-partum breeding, weaning of the first litter takes place just before the second litter is produced (Pattie and Hoffmann 1990). Several litters may be born each breeding season (Soper 1964).

Nests are constructed of grass and plant fibres and are located on the forest floor in areas well hidden from potential predators (Soper 1964). Southern Red-backed Voles do not appear to seek specific habitats when the breeding season approaches. Instead, the reproductive habitat is thought to be identical to its regular cover and feeding areas (Allen 1983).

2.4 Habitat Area Requirements

Research by Bondrup-Nelson (1987) in Alberta revealed that the mean activity radius of males is twice that of females. Average home range sizes in this study area were 1.2 to 2.68 ha for males and 0.63 to 1.33 ha for females. Pattie and Hoffmann (1990) suggested that the activity area of the vole decreases during winter, with average ranges extending over 1.4 ha in summer and only 0.14 ha in winter.

Sexually mature female red-backed voles are territorial (Bondrup-Nelson 1987) though intersexually, ranges may overlap. In Alberta, censuses have shown vole densities ranging from 19.7 individuals per ha in mature aspen forests (Westworth *et al.* 1984) to between 32 and 64 voles per ha in Wood Buffalo National Park (Soper 1942). It has been suggested that Southern Red-backed Voles will not occupy a territory unless at least 2 ha of appropriate habitat are available (Allen 1983; Buckmaster *et al.* 1995).

2.5 Landscape Configuration Requirements

In general, the abundance and diversity of small mammal communities present within an ecosystem are dependent on the complexity of the landscape features. As a species dependent on relatively moist sites (Getz 1968; Merritt 1981), Southern Red-backed Voles may be restricted from dry upland sites and may be more abundant on north-facing slopes (Yahner and Smith 1991). A study in Connecticut has shown that populations are most dense within 60 m of standing water or saturated sites (Miller and Getz 1977).

2.6 Sensitivity to Human Disturbance

Our literature review did not suggest any relationship between human activity that does not destroy habitat and the population size or behaviour of Southern Red-backed Vole communities.

3.0 MODEL

3.1 Envirogram

Two elements have been identified as potentially important components of Southern Red-backed Vole habitat: the suitability of the forest cover and the availability of hiding cover (Figure 2). Since red-backed voles can consume a variety of plant materials, food availability is not expected to be limiting. Shown in the envirogram below are the forest attributes that are thought to be preferred by the animals.

Red-backed voles seem to prefer the moist environments of spruce-dominated stands on mesic sites. Proximity to water bodies or wetlands is particularly desirable and north-facing aspect may slightly improve habitat quality. The habitat variables thought to influence their ability to hide from predators are the coverage of both downed woody debris and low trees and shrubs.

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 2 ha.

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

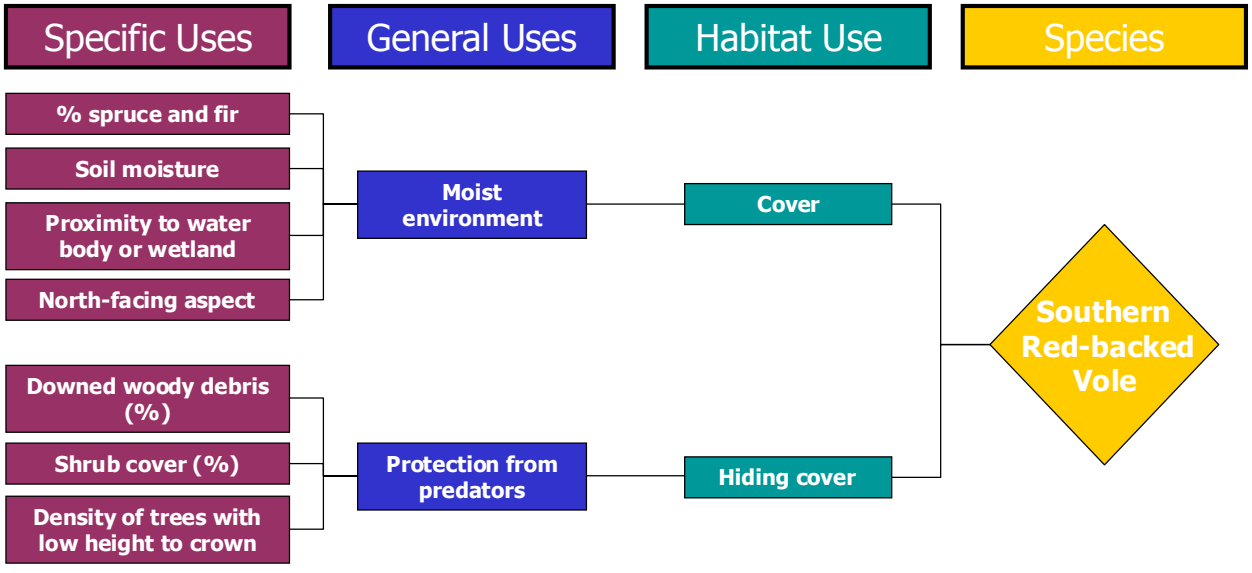

Figure 2. Envirogram of the Southern Red-backed Vole based on available habitat information for HSM development.

3.3 Model Description

The HSM for Southern Red-backed Vole habitat follows the structure described in the envirogram (Figure 3). As both elements are thought to be critical for year-round habitat, no compensation is allowed between them.

The SI_{hiding} is made up of downed woody debris cover (S_{h1}), shrub cover (S_{h2}), and small tree cover (S_{h3}). Since all of these ground materials can contribute to hiding cover for voles, there is compensation allowed between them.

The SI_{cover} is made up of tree species composition (% spruce or fir, S_{c1}), soil moisture (S_{c2}), proximity to water bodies or wetlands (S_{c3}), and aspect (S_{c4}). Spruce or fir-dominated forests on mesic soil are thought to provide the most suitable cover habitat for red-backed voles. These variables are non-compensatory. Habitat may have improved suitability when located proximate to a water body or wetland or on a north-facing slope. Therefore, these two variables are included as bonus functions in the equation.

3.4 Habitat Variable SIs

Cover

The variables included in the cover equation are % spruce or fir (S_{c1}), soil moisture (S_{c2}), proximity to water bodies or wetlands (S_{c3}), and aspect (S_{c4}). Habitat suitability is high in relatively pure spruce or fir stands (Figure 4) and on sites with mesic soil conditions (Figure 5). In addition, sites within 50 m of a water body or wetland or on a north-facing slope receive a bonus.

Hiding Cover

The variables included in the SI_{hiding} are downed woody debris cover (S_{h1}), shrub cover (S_{h2}), and density of trees with low height to crown (S_{h3}). Habitat suitability changes with downed woody debris cover as shown in Figure 6 and with shrub cover and small tree density as shown in Figures 7 and 8. Optimally, downed woody debris will cover 20% of the forest floor, low shrubs will cover 50%, and at least 12,000 trees with low height to crown will be present per ha.

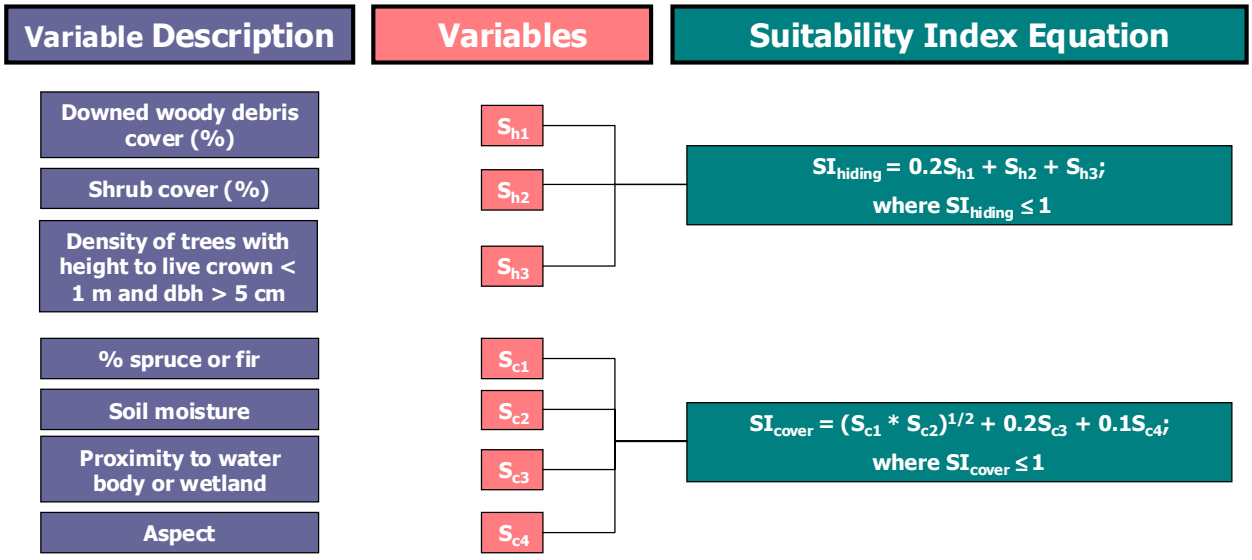

Figure 3. HSM structure for the Southern Red-backed Vole within Millar Western's FMA area.

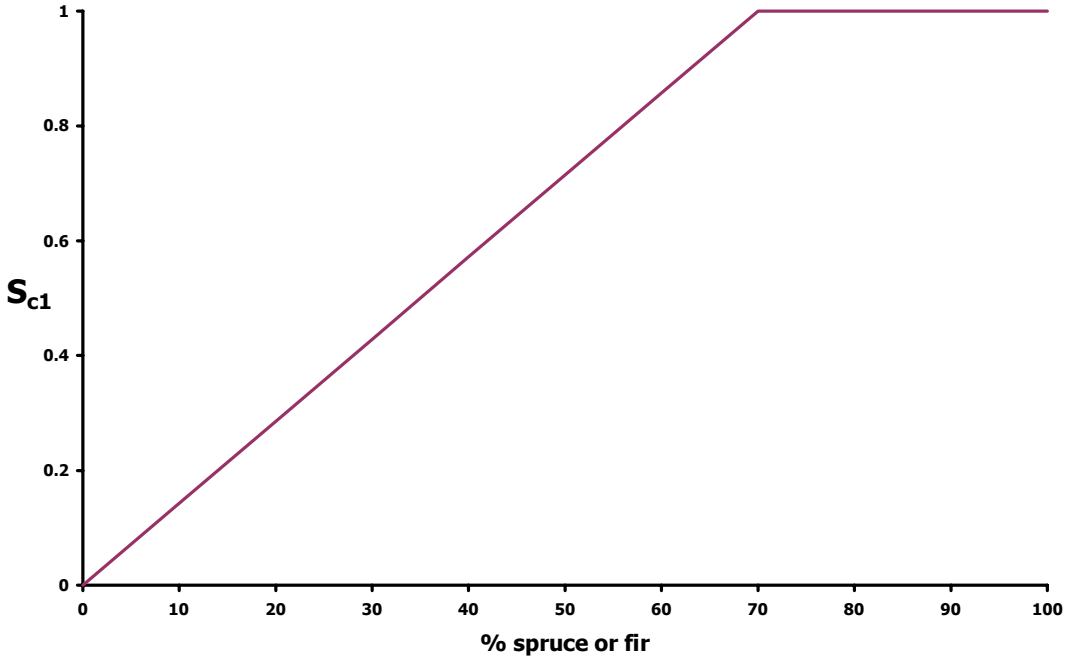

Figure 4. Southern Red-backed Vole cover habitat suitability in relation to shrub cover within Millar Western's FMA area.

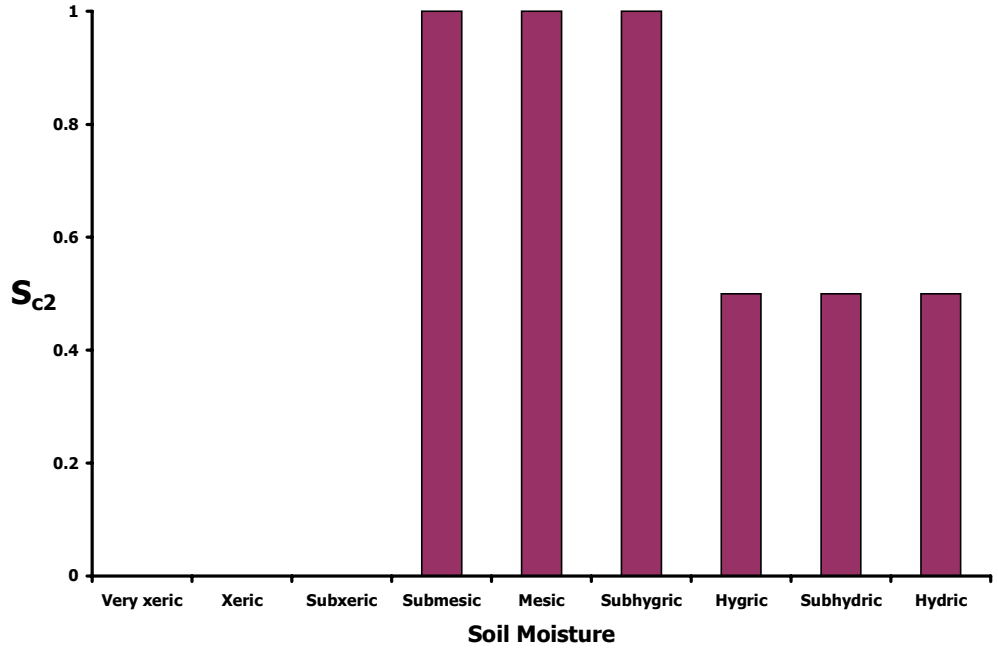

Figure 5. Southern Red-backed Vole cover habitat suitability in relation to soil moisture within Millar Western's FMA area.

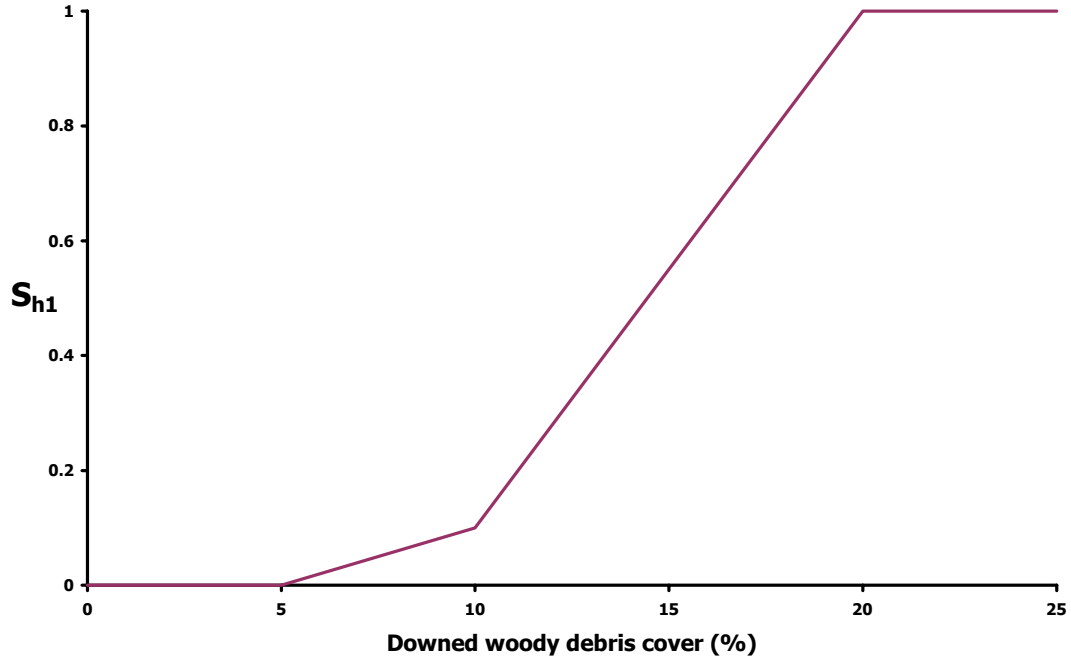

Figure 6. Southern Red-backed Vole hiding cover habitat suitability in relation to downed woody debris cover within Millar Western's FMA area.

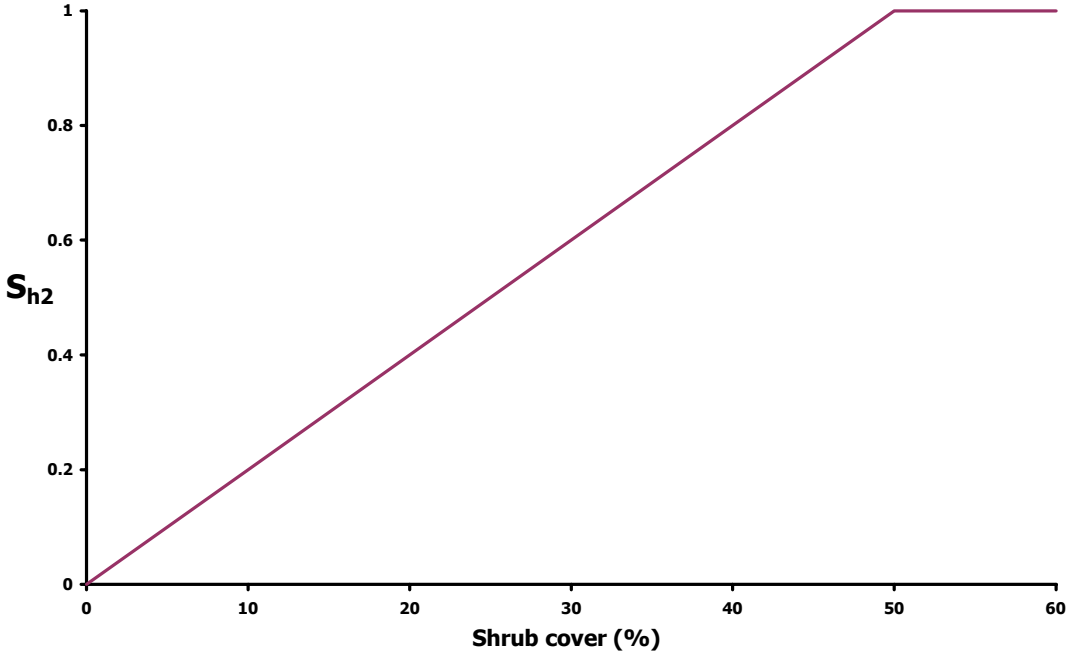

Figure 7. Southern Red-backed Vole hiding cover habitat suitability in relation to shrub cover within Millar Western's FMA area. Weighting: 0 - 25 = 0, 26 - 50 = 0.25, 51 = 1 = 0.65, 1.1. - 3 = 1, > 3 = 0.2.

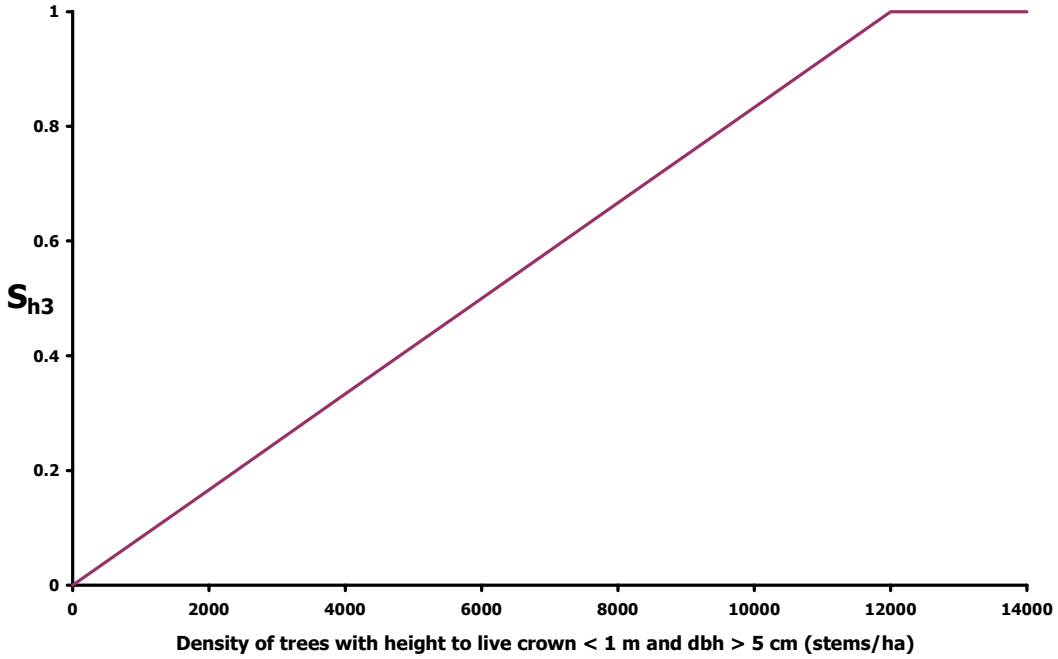

Figure 8. Southern Red-backed Vole hiding cover habitat suitability in relation to density of trees with height to live crown < 1 m and dbh > 5 cm within Millar Western's FMA area.

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 habitats and hiding cover. Therefore, the SI_{cover} and SI_{hiding} calculations are considered individually to display trends in habitat availability.

Cover Habitat Index

To determine the suitability of variable S_{c3}, all water bodies and treed muskegs (non-forested areas that have been given a moisture regime class of 8) are buffered to a distance of 50 m. All pixels within this 50 m buffer receive a suitability rating of 1 for this variable. In addition, all pixels on north-facing slopes are given a value of 1 for variable S_{c4}.

Next, each pixel of forested habitat receives a suitability rating as hiding cover using the following equation:

$$\mathbf{SI_{cover} = (S_{c1} * S_{c2})^{1/2} + 0.2S_{c3} + 0.1S_{c4};}$$

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

Hiding Cover Habitat Index

The potential of each pixel to provide hiding cover is assessed by:

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

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

Home Range Smoothing

A circular window of radius 75 m (2 ha) moves over the grid representing Millar Western's FMA area with each pixel, in turn, acting as its centre. The SI_{cover} and SI_{hiding} ratings of each pixel within the circle are averaged and recorded as the SI_{cover} and SI_{hiding} of the pixel at the centre.

4.0 EXTERNAL REVISION

Arlen Todd, wildlife biologist with Alberta Environment, Fisheries and Wildlife Mangagement Division, in Whitecourt, Alberta reviewed a draft version of the HSM for the Southern Red-backed Vole on April 27, 1999 and provided comments. The following changes were made on his advice:

1) Todd suggested that the controversy over specific habitat requirements of red-backed voles could be caused by different study methods, or by the use of different site preparation and harvesting techniques. His comment was included in the review.

2) Todd presented information on the relationship between vole population size and glyphosate herbicide treatment. Initially, these studies had not been included in the literature review but have now been added.

Richard Moses of the Department of Biological Sciences at the University of Alberta also reviewed a draft version of the red-backed vole HSM. His comments were received on June 17, 1999 and the following changes were made based on his advice:

1) In general, Richard Moses felt that the draft copy overemphasized the importance of several habitat features. He mentioned that to construct a model, incorporation of "bits and pieces of information on the habitat relationships of this species from many studies conducted over a wide geographic area in different forest types under varying logging regimes" is required. He advised that we lessen the strength with which we claim that certain habitat features are important to the voles. More research is necessary for the habitat requirements to be conclusively known.

2) As one researcher suggested that greater than 80% grass cover represents 'non-habitat', a variable formerly included in the SI_{hiding} equation was grass coverage (%). Based on Richard's advice, this variable has been removed. He noted that other substrates such as open water, peat bogs, and roads will be as unsuitable as meadows for habitation and yet have not been included. As grass cover will be negatively correlated with downed woody debris cover, its absence in suitable habitat will indirectly be taken into account.

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