SOUTHERN RED-BACKED VOLE YEAR ROUND HABITAT

HABITAT SUITABILITY INDEX MODEL VERSION 5

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1. INTRODUCTION

Habitat Suitability Index (HSI) models predict the suitability of habitat for a species based on an assessment of habitat attributes such as habitat structure, habitat type and spatial arrangements between habitat features. This HSI model for the red-backed vole *(Clethrionomys gapperi)* applies to habitats of the Foothills Model Forest (FMF) in west-central Alberta. The intended use is to predict habitat suitability at landscape scales and over long-time periods. The model will be used to determine potential changes in red-backed vole habitat area and carrying capacity throughout an entire forest management cycle (200 years). The model was primarily developed using literature review.

2. SPECIES DESCRIPTION AND DISTRIBUTION

The southern red-backed vole is a small (12-16 cm, 13-42 g) slender vole with a short tail (3-6 cm) and a chestnut coloured dorsal stripe (Banfield 1974). Red-backed voles are distinguished from most voles by the reddish back, although considerable variation in colour occurs throughout its range (Burt and Grossenheider 1952). The species occurs across Canada (excluding Newfoundland) throughout the southern boreal and western subalpine forests, including all but the southern portion of Alberta (Banfield 1974). The vole is also found throughout the Rocky Mountains and the Appalachians in the US (Banfield 1974). Red-backed voles are not a risk and Alberta and their habitat is considered secure (Wildlife Management Division 1996).

Although mainly nocturnal, these voles are occasionally active during daylight (Banfield 1974). They travel through tunnels throughout the moss and duff layers, or use fallen logs, stumps, trees and brush piles for travel routes (Banfield 1974). They are active summer and winter, and will tunnel through snow and sometimes nest on the ground surface beneath the snow (Banfield 1974). Predation from most carnivorous mammals, raptors and owls is significant (Banfield 1974). Populations of red-backed voles fluctuate widely but it is not clear what causes these fluctuations (Banfield 1974).

3. FOOD

Red-backed voles feed on fungi, lichens, seeds, berries, bark, petioles of leaves, shrub buds, wildflowers, invertebrates, and even carrion (Soper 1964, Banfield 1974, Vickery 1981, Allen 1983, Bondrup-Nielson 1987, Gadd 1995). Fungi (including ectomycorrihazae) can account for 89% of the diet in some areas (Martell 1981, Ure and Maser 1982, Allen 1983, Nordyke and Buskirk 1988). Red-backed voles also require a high daily intake of water.

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4. COVER

Dense mesic coniferous forest represents the most suitable habitat for red-backed voles (Powell and Brooks 1981, Allen 1983, Nordyke and Buskirk 1988, Wakely and O'Neil 1988). Red-backed vole populations are often directly related to downed wood cover (Maser et al. 1981, Nordyke and Buskirk 1991). Coarse woody debris provides the mesic environment necessary for fungal growth and also provides protection from predators (Martell and Radvanyi 1977, Maser et al. 1978, Merritt 1981, Allen 1983, Monthey and Soutiere 1985, Yahner 1986, Wywialowski 1987, Nordyk and Buskirk 1988). Optimal habitat has been characterized as coniferous stands of large diameter trees with a high canopy closure (> 60%), an understorey with little or no grass, abundant feather mosses, and relatively high concentrations of coarse woody debris (Allen 1983).

In mixedwood forest of Alberta, red-backed voles were in young (20-30 yr), and mature (50-65 yr) stands but were most abundant in old stands (120+ yr) (Roy et al. 1995). Features of the stands positively associated with vole numbers were the abundance of shrubs and saplings, snags, birch trees and downed woody material on the ground. Abundance was negatively correlated with herb cover (Roy et al. 1995). Red-backed voles are generally rare or absent after clearcut harvesting and while the stand is initially growing (Martell 1983), however recent (1 to 3 yr old) clearcuts in north-central Alberta still maintained small numbers of red-backed voles (R. Moses, personal communication). Voles did not approach pre-harvest numbers in spruce/fir forests in Idaho until 40 years after clearcutting (Schivner and Smith 1984). In shelterwood cuts, where 30% and 50% basal area was removed in south-central BC, mean number of red-backed voles per hectare was 1.5 times greater on shelterwood sites than controls (Von Trebra et al. 1998) and was attributed to an increase in local forage and cover. Insects, seeds and fungi may have been exposed following the logging activities and an increase in coarse woody debris occurred (Von Trebra et al. 1998).

5. REPRODUCTION

Nests are constructed of grass and plant fibres located in areas of ground cover, in hollows beneath tree roots or in downed woody debris (Soper 1964, Gadd 1995). Several broods of 4-9 young are produced in a single season (Soper 1964). Gestation averages 18 days, and around 20 days later the young are weaned (Banfield 1974). Juveniles of the spring litter can bear their first young at four months (Banfield 1974). Reproductive habitat of red-backed voles is assumed identical with cover and foraging needs (Allen 1983).

6. HABITAT AREA

Home ranges of male and female red-backed voles overlap ranges of other individuals of both sexes (Allen 1983) which indicates a low level of territoriality in this species. Therefore, habitat area estimates are based on expected population densities, not territory size. Densities for southern red-backed voles include 20 voles/ha in mature aspen forests in Alberta and the Yukon (Westworth et al. 1984, Boutin et al. 1996), and 32-64 voles/ha in Wood Buffalo National Park (Soper 1942). There is no population density information for southern red-backed vole in the FMF.

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Southern red-backed vole *(Clethrionomys gapperi).*

Habitat Evaluated: Foraging, Hiding, and Reproductive Cover.

Geographic area: This model is applicable to the Foothills Model Forest in west-central Alberta.

Seasonal Applicability: This model produces a HSI value for year-round habitat.

Cover types: This model applies to all forest and non-forest habitat areas of the Lower and Upper Foothills, Montane and Subalpine Natural Subregions (Beckingham et al. 1996) since suitability is determined from structural characteristics within stands rather than classified forest stands directly. The model should also be broadly applicable to other habitat areas dominated by vegetation similar to that in this region, including pure deciduous, mixedwood and pure coniferous forest types, as well as wetland and riparian forests, meadows, shrublands, and areas regenerating after forest harvesting.

Minimum Habitat Area: Minimum habitat area is defined as the minimum amount of contiguous habitat to which the model will be applied. Red-backed voles require relatively small areas to live and reproduce in and therefore no minimum habitat area is specified.

Model Output: The model will produce Habitat Units (HU) for year-round cover for each classified plant community stand area based on HSI value and stand area. HU are calculated by multiplying the HSI score with the area in hectares. The performance measure for the model is potential carrying capacity (animals per ha). Model output should be correlated to estimates of carrying capacity to verify model performance.

Carrying Capacity (Red-backed Voles per ha where HSI = 1.0): Currently, there is no population density information available in the FMF. The density estimate for populations in Wood Buffalo National Park reached 64 individuals/ha (Soper 1942) and will be used as the carrying capacity for optimal habitat in the FMF until density estimates for this area is obtained.

Verification Level: The reliability of this model has not been evaluated against local data. The verification level is 2: local knowledge has been incorporated into the model but the model has not been tested.

Application: This HSI model is designed to assess habitat suitability for relatively large forest landscapes using generalized species-habitat relationships and stand-level vegetation inventory. Its purpose is to predict relative changes in red-backed vole habitat supply at the landscape level over long time periods (200 years), for integration with forest management planning. The model is not designed to provide accurate prediction of suitability or use at the stand level. Approximate population size can be calculated by assuming linear habitat-population relationships, but the model is not designed to provide accurate population density estimates. Any attempt to use the model in a different geographic area or for other than the intended purpose should be accompanied by model testing procedures, verification analysis, and other modifications to meet specific objectives.

7.2 MODEL DESCRIPTION

The HSI model for southern red-backed voles assumes the life requisites of foraging, hiding, and reproductive cover are limiting. The life requisites are interrelated so the same habitat structures provide cover for each of the vole's needs.

7.2.1 Habitat Variables and HSI Components

This model distinguishes black spruce bogs separately from upland sites. Black spruce bogs provide cover in the form of a thick moss layer whereas coarse woody debris and shrubs generally provide cover in upland sites. Conifer canopy height is used in both models as an index of developmental stage and is used to predict HSI component S_1.

Tall stands in boggy areas ensure a mature forest is present. These areas tend to be fairly open, however, the thick moss layer provides suitable cover for voles and a substrate for fungal growth. Percent black spruce and larch in the tree canopy, moss cover, and tree canopy closure are components in the black spruce bog model and are used to predict S_2, S_3 and S_7 respectively. (Table 1). Tree canopy closure is included to ensure that only treed bogs are given a positive suitability.

Tall stands in upland sites have developed structurally to have a thick litter layer, a shaded understorey, and a stable moisture regime. Forests with tall trees, dead and downed woody material and/or shrub cover provide a suitable environment for fungus and lichen growth and provides cover from predators. The importance of canopy closure, overstory type and site moisture are incorporated into the model by using the percentage canopy closure by tree species. Coniferous species (as they are preferred) are weighted higher than deciduous and dry site species. Deciduous cover is only 1/5 as suitable as pine cover and pine cover is only 1/4 as suitable as white spruce and fir cover (Table 1). Weighted canopy closure, coarse woody debris cover and shrub cover are the variables used in the upland model and are used to predict S_4, S_5 and S_6 respectively

Table 1. Relationship between habitat variables and life requisites for southern red-backed vole HSI model.

HSI Component	Life Requisite	Habitat Variable	Habitat Variable Definition
S_1	Year Round Cover	Coniferous Canopy Height (m)	Average top height of 100 coniferous trees/ha that have the largest diameter at breast height (dbh at 1.3 m).
S_2	Year Round Cover	Black Spruce and Larch in Tree Canopy (%)	Percent composition of black spruce and larch in the tree canopy.
S_3	Year Round Cover	Moss Cover (%)	Percent of ground covered by all species of mosses.
S_4	Year Round Cover	Weighted Canopy Closure (%)	Tree Canopy Closure x [0.05 (% Deciduous in Tree Canopy) + 0.25 (% Pine + % White Spruce + % Fir in Tree Canopy)].
S_5	Year Round Cover	Coarse Wood Cover (%)	Projected surface coverage of dead-fall logs that are ≥ 7.6 cm in diameter.
S_6	Year Round Cover	Shrub Cover (%)	Percent of ground covered by a vertical projection of all shrub crown areas onto the ground. Includes all shrub species.
S_7	Year Round Cover	Tree Canopy Closure (%)	Percent of ground covered by a vertical projection of all tree crown areas onto the ground. Includes all trees ≥ 8 cm dbh.

7.2.2 Graphical HSI Component Relationships

S_1 Forest stands with heights ≥ 10 m is considered optimal habitat. Habitat decreases to 0 when the stand is disturbed and there are no trees (Figure 1a).

S2 Forest stands with ≥ 80% black spruce and larch in the tree canopy are optimal. Suitability decreases linearly to zero for stands which have < 80% black spruce and larch in the tree canopy.

S_3 Stands with ≥ 50% moss cover are assumed ideal. Suitability decreases linearly to zero for stands which have < 50% moss cover

S_4 Combined canopy closure is unsuitable only when there is no coverage, and increases directly over the range 0-50%. All values > 50% are optimum.

S_5 Large amounts of coarse woody debris (≥ 7.6 cm) are beneficial to red-backed voles, providing foraging substrate and hiding cover. The benefit of wood cover increases from 0-5% cover. The value remains at 1 for wood cover ≥ 5%. Only stands with no wood cover are unsuitable.

S6 Shrub cover is beneficial to red-back voles by providing cover and food. Suitability increases from 0 at 0% shrub cover to 1 at 30% shrub cover and remains at 1 for shrub cover ≥ 30%.

S7 Black spruce bogs tend to be quite open but tree canopy closure had to be included to ensure that some trees are present. Suitability is 0 at 0% tree canopy closure, and becomes 1 at 10% closure and remains at 1 for any stand with ≥ 10% canopy closure.

7.3 MODEL ASSUMPTIONS

1. Coniferous tree height is indicative of stand development such that stands with tall conifers have a stable moisture regime and allow for more non-vascular plant growth.
2. Moisture is a limiting factor for southern red-backed vole habitat, and is mediated in the model through tree species, canopy closure, and tree height.
3. All cover requisites (foraging, hiding, and reproduction) are affected by similar habitat variables.

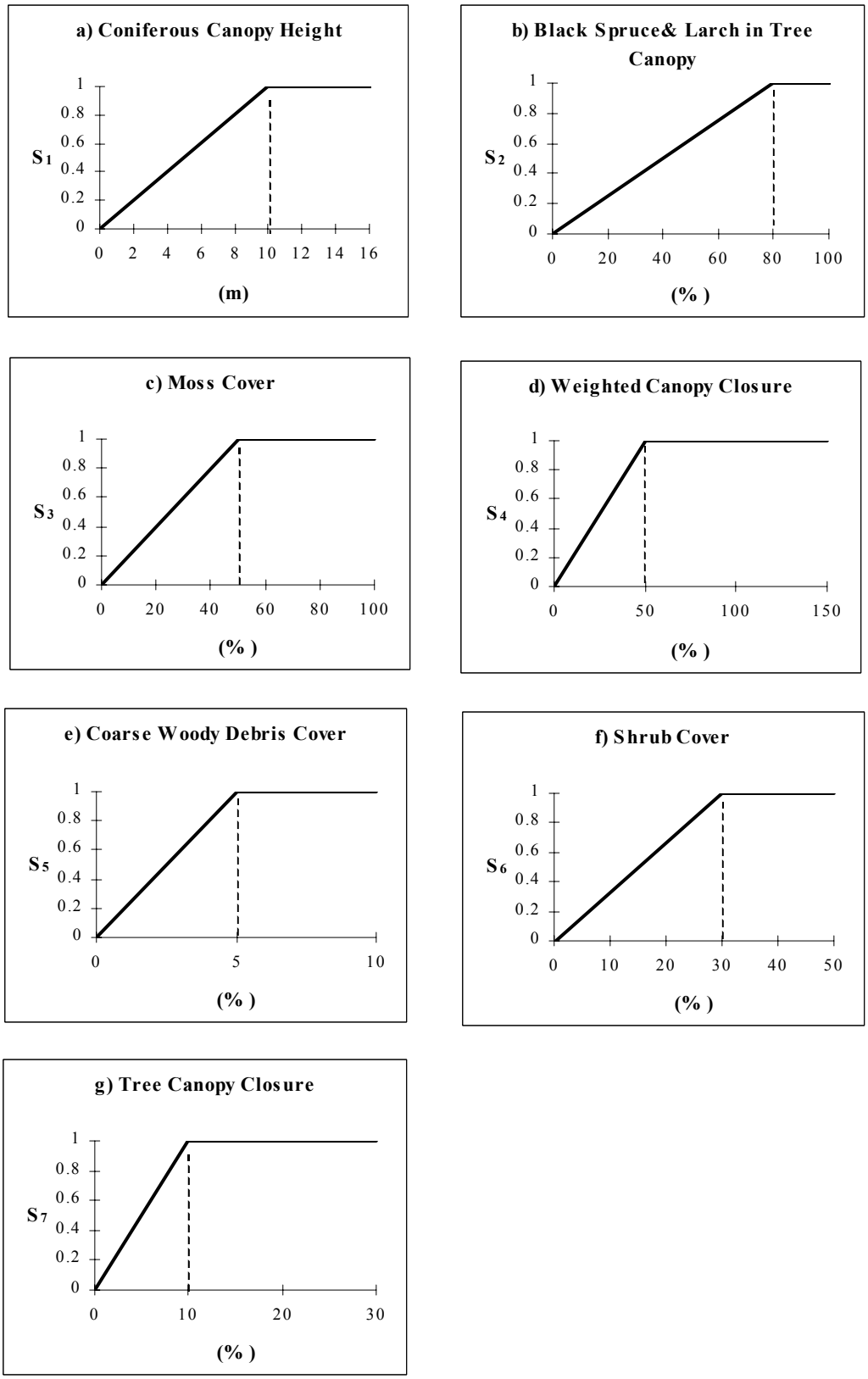

Figure 1. Graphical relationships between habitat variables and HSI components in the red-backed vole model.

7.4 EQUATION

The equation consists of two models but only the model with the highest value gives the overall suitability. The equation for black spruce bogs has all variables noncompensatory so that a low value in one cannot be made up with a high value in another. The equation for uplands has coarse woody debris and shrub cover compensatory, so areas with low woody debris cover but high shrub cover and vice versa will still produce high scores.

$$HSI = \max [S_1 \times S_2 \times S_3 \times S_7;\ S_1 \times S_4 \times (S_5 \times S_6)^{1/2}]$$

8. SOURCES OF OTHER MODELS

No other models for the red-backed vole were found.

Model History

All of the HSI models for the Weldwood Forest Management Area have undergone several revisions, and they will be revised again as new information becomes available. Contact Rick Bonar for information about the most current version.

- Version 1 (1989) was developed by the Weldwood of Canada Integrated Resource Management Steering Committee (IRMSC).
- Version 2 (1994) was revised by Barb Beck and Melissa Todd.
- Version 3 (1995) was written by Glenn Buckmaster for a special topics course in habitat modelling at the University of Alberta.
- Version 4 (1996) was edited and reformatted by Wayne Bessie.
- Version 5 (1999) was revised by Karen Graham, Rick Bonar, Barb Beck, and Jim Beck to incorporate information from recent literature.

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