
FISHER WINTER COVER

HABITAT SUITABILITY INDEX MODEL VERSION 3

Last modified: 20 October 1999

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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 fisher (*Martes pennanti*) applies to forests 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 fisher habitat area and carrying capacity throughout an entire forest management cycle (200 years).

2. SPECIES DESCRIPTION AND DISTRIBUTION

The fisher is a large member of the weasel family (94 cm long, 2.6-5.5 kg; Banfield 1974) and has a broad head, a long bushy tail and long body (Douglas and Strickland 1987). The fur colour is chocolate brown to black with white tipped hairs on the head and shoulders (Banfield 1974). Females are similar to males but are about 20% smaller (Banfield 1974, Douglas and Strickland 1987). This misnamed member of the weasel family rarely fishes and it is thought the name may have been meant for the similar looking mink (*Mustela vison*) which does eat fish (Gadd 1995). The fisher is usually observed on the ground (Powell 1993). Tracks are often observed in the winter and are similar to those of marten (*Martes americana*) but larger.

Fisher occur throughout mountainous regions from Alaska to northern California (Coast and Interior Ranges), along the Rocky Mountains from northern British Columbia to Colorado, and throughout the boreal forest to Quebec and Labrador, normally inhabiting coniferous or mixedwood areas (Burt and Grossenheider 1952) near water (Banfield 1974). In Alberta, fishers are found in the northern half of the province (Banfield 1974). Fishers are considered a sensitive species in Alberta (Wildlife Management Division 1996). Their population status is currently unknown (Wildlife Management Division 1996).

3. COVER

Fishers are associated with dense tree canopy closure (> 50%; Kelly 1977) and complex physical structure near the ground in the form of standing dead and down woody debris or low branches (Powell 1993). Coniferous, mixedwood, and deciduous stands are suitable for fishers, although deciduous stands are not as frequently used (Kelly 1977, Allen 1983). Fishers show seasonal variation in their use of habitats (Buskirk and Powell 1994). During the winter, fishers use old coniferous forests more than young hardwood forests and use many different habitats during the summer (Kelly 1977, Buskirk and Powell 1994). Fishers generally avoid recent clearcuts and open forests during the winter likely because the lack of overhead cover results in deep ground-level snow making it difficult for the fisher to hunt and travel (Kelly 1977, Powell 1982, Allen 1983, Johnson 1984, Douglas and Strickland 1989). During the winter in Michigan, fishers seemed to prefer forests with trees > 27 cm dbh, percent tree canopy closure > 47%, and 14-76% deciduous in the tree canopy (Thomasma et al. 1994). In the Parklands of

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Alberta, translocated fishers moved through small deciduous and mixed woodlots (< 1km²), scrub patches, marsh and grasslands however the majority of locations were in continuous deciduous forests (Proulx et al. 1994).

Fishers use temporary shelters and resting sites such as tree cavities and hollow logs, brushpiles, rockpiles, dens of other animals and snow dens (Douglas and Strickland 1989). Temporary shelters are often near a food source and can be used for several days (Douglas and Strickland 1989).

4. REPRODUCTION

Fisher maternity dens are usually located in tree cavities (de Vos 1952, Bradle 1957, Morse 1961, Powell 1982, Soper 1964, Thomas 1979, Allen 1983) which are often in deciduous trees (Leonard 1980). The minimum tree diameter at breast height (dbh at 1.3 m) for a maternity den is approximately 50 cm (Thomas 1979).

Fishers are born in late March to late April. The adults mate soon after birth and implantation is delayed for approximately 10 months (Banfield 1974). The litter of 1-4 (usually 2 or 3) are helpless for several months and take 1 year to fully mature (Douglas and Strickland 1987).

5. FOOD

Fisher are opportunistic carnivores. They feed on small rodents such as mice and voles (Family Cricetidae), especially red-backed voles (*Clethrionomys gapperi*), red squirrels (*Tamiasciurus hudsonicus*), porcupines (*Erithizon dorsatum*), hares (*Lepus* spp.), grouse (Tetraonidae), other birds and occasionally fish (Douglas and Strickland 1987). Porcupines are killed by biting their nose and mouth to suffocate them. Fisher will consume the carrion of large animals (Banfield 1974, Allen 1983) and also feed on berries (Banfield 1974). The fisher appears to adjust dietary items in relationship to availability of prey, as indicated by the wide range of prey consumed from different study locations (Giesbrecht and Todd 1977).

Prey abundance may determine the types of habitat used by fishers. Dense tree canopy closure and complex physical structure near the ground were associated with snowshoe hares, the fisher's preferred prey (Powell 1993). Foraging habitat in Michigan was in lowland conifers (Powell 1993).

6. HABITAT AREA

Fishers exhibit intrasexual territoriality where home ranges overlap between the different sexes but are defended between members of the same sex (Douglas and Strickland 1987). Male fishers defend large territories whereas female's territories are smaller and located within a male's territory. As fishers are polygamous (Douglas and Strickland 1987) the female territory may be considered occupied by a breeding pair.

Mean home range size for adult female and male fishers were 540 ha (N = 7) and 920 ha (N = 3) respectively with a density of 0.003 fishers/ha in an untrapped population in Gatineau Park, Quebec (Garant and Crete 1997). Mean home range size for adult female and male fishers were 1630 ha (N = 6) and 3090 ha (N = 7) respectively, with a winter density of 1 fisher per 830-2000 ha and a summer density of 1 fisher per 280-1050 ha in an intensely trapped area in Maine (Arthur et al. 1989). A pre-trapping density in Algonquin Park was estimated at 1 fisher/650 ha (Douglas and Strickland 1989). Female territory sizes were 750 ha in Wisconsin (Johnson 1984), 360 ha in California (Buck et al. 1979), and 1500-3500 ha in Wisconsin and Michigan (Powell 1982).

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Fisher (*Martes pennanti*).

Habitat Evaluated: Food and Thermal Cover.

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

Seasonal Applicability: Predictions are for the winter season.

Cover Type: 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 required before an area can be occupied by a species (Allen 1987). The fisher is highly mobile and will likely make use of patches within a large habitat area, therefore no minimum contiguous habitat area is specified.

Model Output: The model will produce Habitat Units (HU) of winter cover for each stand type based on HSI value and stand area. Habitat units are calculated by multiplying the HSI score with the area in hectares. The performance measure for the model is carrying capacity (fishers/ha). These HU must be correlated to estimates of carrying capacity to verify the model's performance.

Carrying Capacity (Adult Fishers per ha where HSI = 1.0): The maximum number of fisher in fully suitable habitat is assumed to be 0.001 fishers per hectare (Arthur et al. 1989).

Verification Level: The reliability of this model has not been evaluated using local data. The verification level is 3: the model has been reviewed by species experts.

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 fisher 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 fisher winter habitat assumes the life requisites of food and cover are limiting. Availability of prey is an important component of fisher habitat. Small mammals and hares make up a large part of their diet. As these mammals occur in high densities in mature coniferous forests, particularly spruce (*Picea* spp.) and fir (*Abies* spp.; Hayward et al. 1993), this model assumes the fisher's food requirements are met in spruce and fir forests with sufficient sized trees and canopy closure.

7.2.1 Habitat Variables and HSI Components

This model evaluates potential winter cover on the basis of stand structural maturity described by tree canopy closure, S_1 , and stand dbh, S_2 (Table 1). The characteristics of mature stands are large trees with decreased growth rates, and increased susceptibility to damage from climatic extremes or insect or fungal infestations. This results in a greater distribution and abundance of dying and dead trees in mature stands than in younger, more vigorous stands (Spurr and Barnes 1980). Adequate cover, potential den sites, and complex stand structure to support prey populations are assumed provided in mature forest communities.

Suitable winter cover for fishers is assumed to occur in multistoried stands with high structural diversity which provides cover, potential den sites, and prey habitat. Components S_3 and S_5 in the HSI equation are used to evaluate the structural diversity of forest stands for fisher. S_3 is predicted from shrub cover over 1 m height, and S_5 is predicted from the percent of spruce and fir in the tree canopy.

HSI component S_4 is predicted from the percent deciduous in the tree canopy. Stands that have no deciduous in the canopy are utilized by fishers, however, the deciduous component is important for providing tree cavities for winter resting sites. This component is used to partially compensate for mixedwood conditions.

Table 1. Relationship between habitat variables and life requisites for the fisher HSI model.

HSI Component	Life Requisite	Habitat Variable	Habitat Variable Definition
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S ₁	Food/Cover	Tree Canopy Closure (%)	Percent of ground covered by a vertical projection of tree crown areas onto the ground. Includes trees ≥ 8 cm dbh.
S ₂	Food/Cover	Stand dbh (cm)	Mean diameter of canopy trees at 1.3 m height in the stand.
S ₃	Food/Cover	Shrub Cover ≥ 1 m in height (%)	Percent of ground covered by a vertical projection of shrub crown areas onto the ground. Includes only shrub species which normally attain heights ≥ 1 m.
S ₄	Food/Cover	Deciduous in Tree Canopy (%)	Percentage composition of all deciduous tree species in the tree canopy.
S ₅	Food/Cover	Spruce + Fir in Tree Canopy (%)	Percentage composition of all spruce and fir trees in the tree canopy.

7.2.2 Graphical HSI Component Relationships

- S₁ A S₁ value of 0 is obtained in stands with < 35% tree canopy closure. Between 35 and 80% the value increases linearly (Figure 1a). All stands with ≥ 80% closure are fully suitable (S₁ = 1).
- S₂ When the stand dbh is ≥ 30 cm, S₂ = 1. Forest stands with a mean dbh < 20 cm represent unsatisfactory winter habitat for fishers (S₂ = 0; Figure 1b).
- S₃ Shrubs ≥ 1 m in height also add to winter cover for fisher and their prey. At ≤ 5% shrub cover S₃ = 0, whereas at 15% or greater S₃ = 1 (Figure 1c).
- S₄ A S₄ value of 0.75 is obtained in stands with no deciduous vegetation and this rises linearly to 1 at 25% deciduous trees. Optimal winter cover (S₄ = 1) occurs in stands with 25-50% deciduous vegetation in the overstory. Fishers usually avoid pure deciduous stands so S₄ then drops to 0.4 at 75% deciduous trees, and then to 0.2 at 100%.
- S₅ This component is equal to 0 when there is no spruce or fir in a stand and increases linearly to 1 when 50% spruce and fir in the tree canopy is attained.

7.3 MODEL ASSUMPTIONS

1. The life requisites of food and cover are equally limiting and are provided by the same habitat structures, since prey species need cover under trees and shrubs throughout the winter period.
2. Potential den sites and suitable reproductive habitat are met by the same parameters that provide essential winter food and cover.
3. The availability of water is not a limiting component of fisher habitat.
4. Fishers are not affected by proximity to human settlements, roads, or other activities in this model.
5. Mean stand dbh is indicative of stand structural complexity and is therefore representative of habitat quality.

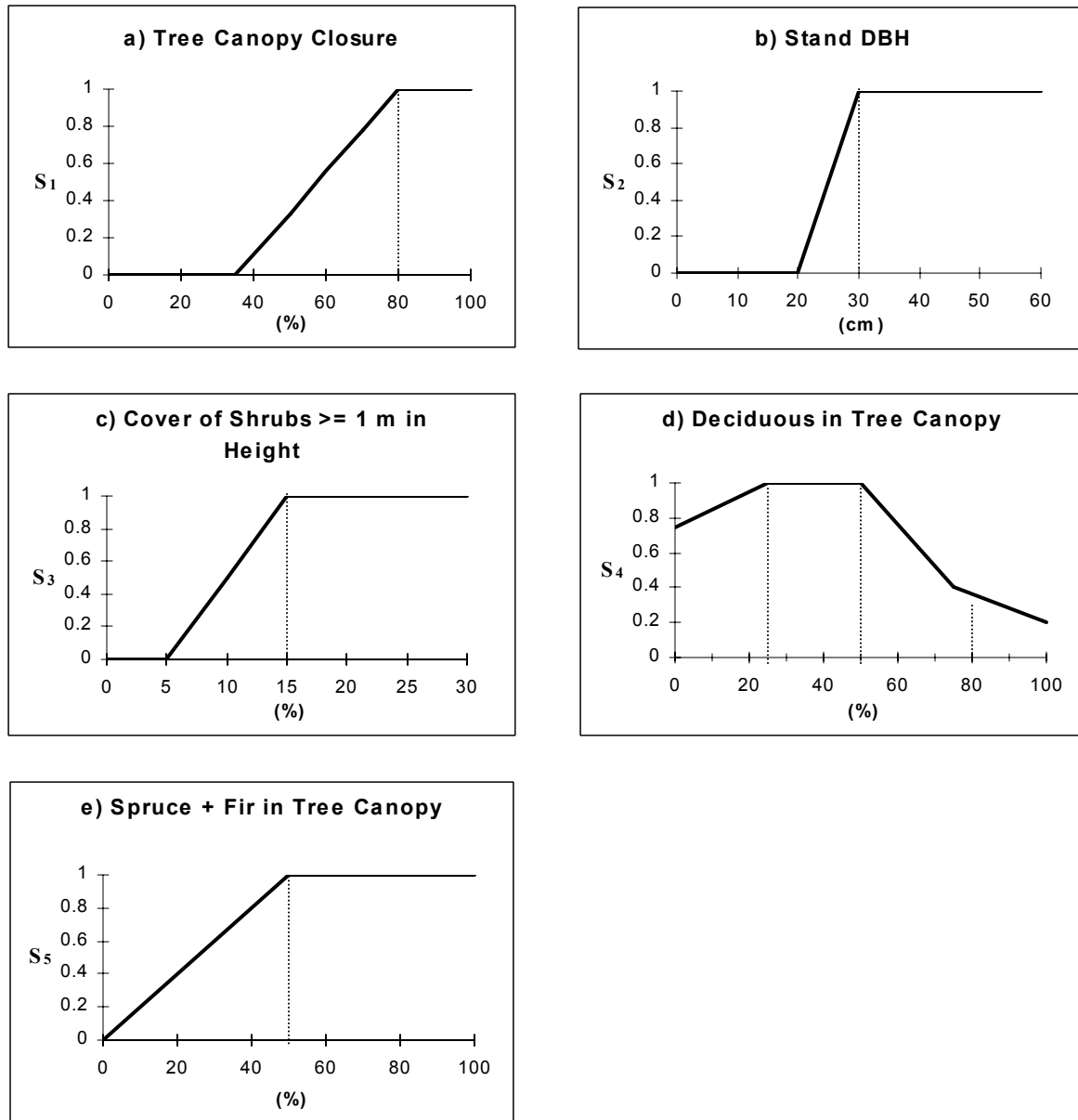


Figure 1. Graphical relationships between habitat variables and HSI components in the fisher model.

7.4 EQUATION

This equation which measures the habitat suitability for food and cover contains a compensatory combination of spruce/fir composition and shrub cover which we called stand structural diversity (SD):

$$SD = \text{Min} (1, [0.2 + 0.55 (S_3) + 0.85 (S_5)])$$

The structural diversity equation gives a minimum value of 0.2 and a maximum value of 1 when optimum shrub and spruce/fir composition exists. Shrub cover does not increase the structural diversity if there is less than 5% shrub cover or if spruce and fir in the tree canopy is ≥ 50 . Spruce and fir will always increase the structural diversity, with or without shrub cover.

The full equation is the geometric mean of S_1 , S_2 , and SD. To reflect the suitability of stands that do not have optimum deciduous in the tree canopy, the component S_4 is multiplied to the geometric mean of the other three components. This formula has been set to reflect the fishers preference for habitat as an average condition of the three structural components (canopy closure, tree size, and structural diversity) which is heavily weighted by a low

value of any one component. S_4 never decreases below 0.2 and is therefore a modifying component which does not determine where fisher habitat is unsuitable, only where habitat is more suitable.

$$HSI = (S_1 \times S_2 \times SD)^{1/3} \times S_4$$

8. SOURCES OF OTHER MODELS

The U.S. Fish and Wildlife Service developed an HSI model for fisher (Allen 1983).

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 (1995) was written by Ben Olsen in a habitat modelling course at the University of Alberta.
- Version 2 (1996) was edited and reformatted by Wayne Bessie and sent to species experts for critical comment.
- Version 3 (1999) was revised by Karen Graham, Rick Bonar, Barb Beck, and Jim Beck to incorporate reviewer comments and information from recent literature.

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