HOARY BAT
SUMMER ROOSTING 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 hoary bat (*Lasiurus cinereus*) 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 hoary bat 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 hoary bat is the largest bat found in Canada with a length of 15 cm and wing span of 42 cm (Banfield 1974). Hoary bats are silvery brown in colour with tawny patches on the throat, shoulders, arms, and around the ears and wings (Banfield 1974). The ears are rounded, which differs from most North American bat species. This forest species forages primarily in open areas or above the tree canopy. Hoary bats are a solitary, tree roosting species (Pybus 1986). They occur across Canada from the boreal forest south, including all of Alberta. The use of bat detectors has revealed that hoary bats are common in many places (van Zyll de Jong 1985), but are rarely encountered. In Alberta, the population status of hoary bats is unknown (Wildlife Management Division 1996).

Hoary bats leave the northern boreal forest in August and winter in southern U.S. and Mexico (Banfield 1974, van Zyll de Jong 1985). There is a marked sexual segregation in spring and early summer, with males and females occupying separate geographical areas (Banfield 1974). Most hoary bats in Alberta are females and their young (Pybus 1986). Little is known of their distribution in the FMF.

3. FOOD

Hoary bats use echolocation for prey detection (Barclay 1986). They are adapted for fast, unmaneuverable flight so foraging occurs primarily in open areas or above the tree canopy (Barclay 1986, H. Smith, personal communication). Hoary bats are opportunistic feeders and will eat any large insects such as moths, beetles and dragonflies (Barclay 1985). Barclay (1986) observed hoary bats chasing away other hoary bats, indicating the possibility of a minimum habitat size requirement.

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4. COVER

Hoary bats roost in the branches of trees during the day (Banfield 1974). They are primarily associated with coniferous trees, and infrequently with aspen (R. Barclay personal communication, Pybus 1986). Because they normally drop on take-off, tall trees are required (Pybus 1986). Groups of trees are important sources of thermal protection for roosting bats. In southern Ontario, roosting cover was often adjacent to feeding habitat (Holroyd et al. 1994). In British Columbia, hoary bats were observed to roost in cavities of old (>200 years) Douglas fir (*Pseudotsuga menziesii*) and cedar (*Thuja plicata;* Holroyd et al. 1994). At Delta Marsh, Manitoba, where conifers are lacking, hoary bats roosted in American elm (*Ulmus americana*) and other deciduous species (W. Bessie, personal communication).

5. REPRODUCTION

Hoary bats breed in late summer and fall, probably on winter ranges south of Alberta or during fall migration (Banfield 1974, van Zyll de Jong 1985). In June, shortly after migrating north, young are born in litters of 1-4, but usually 2 (Banfield 1974). Females and young roost high in trees, branches, cavities or behind loose bark (Barclay 1984, H. Smith, personal communication). During lactation, the mother makes short night feeding trips and returns frequently to nurse. Young are carried by the mother for about a month before flying on their own and roosting alongside the mother (Banfield 1974), but nursing often continues for several weeks. Male hoary bats do not take part in rearing the young.

6. HABITAT AREA

Home range, foraging territory size, and population density information is not available. Since this bat does not breed in the FMF and may not be present every year (Barclay 1984), minimum viable population estimates are not valid. Habitat management which supplies well-distributed roosting sites is an interim strategy until inventory and habitat use information is available.

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Hoary Bat (*Lasiurus cinereus*).

Habitat Evaluated: Roosting Habitat.

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

Seasonal Applicability: Summer.

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 required before an area will be occupied by a species. Specific information on the minimum habitat area was not found in the literature. Because these bats are long-range flyers, it is unlikely that islands of habitat segregated from the main forest would limit them. Thus, no minimum habitat area is specified.

Model Output: The model will produce Habitat Units (HU) of summer roosting habitat 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 of this model is potential carrying capacity (adult female bats per hectare). Model output should be correlated to estimates of carrying capacity to verify the model's performance.

Carrying Capacity (Adult Females per ha where HSI = 1.0): Based on Barclay (personal communication), the current estimate of the maximum number of hoary bats is 2 adult females per hectare.

Verification Level: The reliability of this model has not been evaluated against local data. The verification level is 1: the model is based on literature review and 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 hoary bat 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

Roosting areas are considered the most important component of the summer range in the FMF. Foraging areas and food supply are assumed not limiting. The interspersion of foraging and roosting areas is not considered important because bats can fly between suitable roosting and foraging areas. The habitat model for hoary bats considers only the amount and quality of roosting habitat.

7.2.1 Habitat Variables and HSI Components

Tree canopy closure is used to predict the first component (S_1) because hoary bats have poor flying maneuverability and prefer forested areas that are fairly open. Hoary bats roost in tall spruce, pine, or fir trees, even within deciduous dominated stands. Overstory height is used to predict HSI component S_2 and percentage of conifer trees in the tree canopy is used to predict HSI component S_3.

Table 1. Relationship between habitat variables and life requisites for the hoary bat model.

HSI Component	Life Requisite	Habitat Variables	Habitat Variable Definition
S_1	Cover (Thermal)	Tree Canopy Closure (%)	Percent of ground covered by a vertical projection of tree crown areas onto the ground. Includes all trees ≥ 8 cm diameter at breast height (dbh at 1.3 m).
S_2	Roosting (Take off Height)	Tree Canopy Height (m)	Average top height of 100 trees/ha that have the largest dbh.
S_3	Cover and Roosting	Pine, Spruce, Fir and Larch in Tree Canopy (%)	Percent composition of all conifer species in the tree canopy.

7.2.2 Graphical HSI Component Relationships

S_1 Stands with 6-70% tree canopy closure are assumed to provide optimum cover considering the conflicting need for thermal and protective cover and flight maneuverability. Stands with > 70% tree canopy closure are assumed too dense for easy access to and from roosting sites, so the value of S_1 drops from 1 at 70% to 0 at 100%. Stands with 0% tree canopy closure are assumed unfit for roosting ($S_1 = 0$) but suitability rises to 1 at 6% closure (Figure 1a).

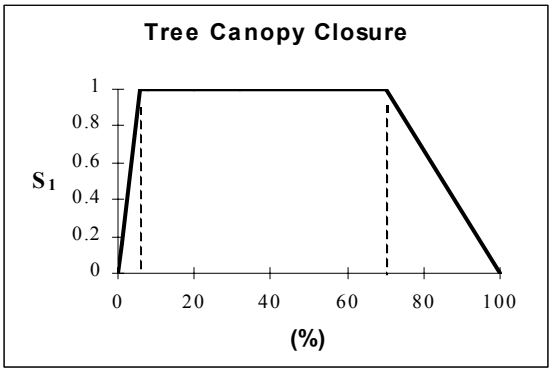
S_2 Stands with a mean tree canopy height of 0-8 m are assumed too short for hoary bats to achieve take-off flight from roosts. S_2 is set at 0 at heights ≤ 8 m. The value of S_2 rises to 1 at heights ≥ 20 m (Figure 1b).

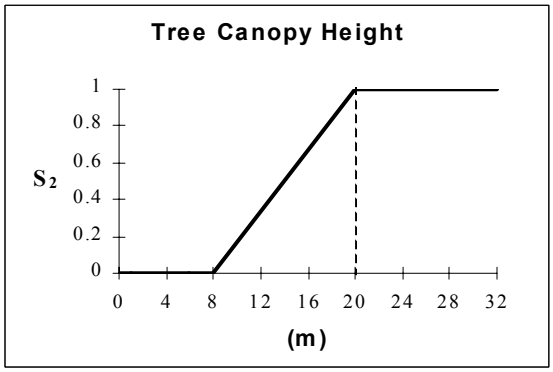
S_3 Pure deciduous stands are assumed to have no value for roosting. However S_3 becomes optimum ($S_3 = 1$) when the conifer component reaches 1% (Figure 1c). This component restricts the model to produce positive values for mixedwood or pure conifer sites only.

7.3 MODEL ASSUMPTIONS

1. Hoary bats are not limited by food resources, foraging areas, or by the distance to foraging areas.
2. Hoary bats are not affected by human disturbance or roads.
3. Water resources are not limiting.
4. Stands predicted as suitable roosting habitat also provide suitable predation cover.

5. Deciduous forests do not provide useful roosting habitat, unless a conifer component is present.





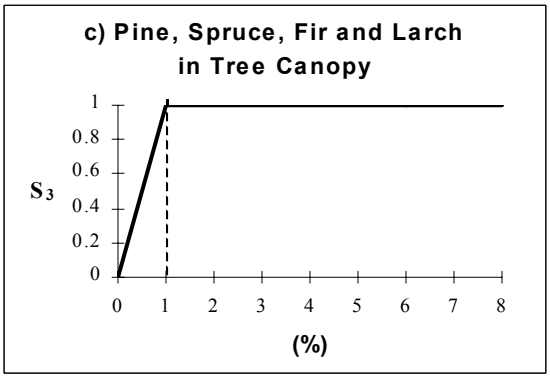


Figure 1. Graphical relationships between habitat variables and HSI components of the hoary bat model.

7.4 EQUATION

S_1 and S_2 are considered compensatory with each other (i.e. low values of one can be compensated by high values of the other). The third variable (S_3) can not be compensated by the first or second components.

$$\text{HSI (roosting habitat)} = (S_1 \times S_2)^{1/2} \times S_3.$$

8. SOURCES OF OTHER MODELS

No other HSI models were found for hoary bats.

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 Ralph Heinrich 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.

9. LITERATURE CITED

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