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 varied thrush (Ixoreus naevius) 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 varied thrush 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

Varied thrushes are black and orange in colouration, with a black back and an orange breast. Orange bands are on the wings and above the eye, and there is a black band across the chest (Godfrey 1986). They are often heard singing at dusk and dawn during the reproductive season (April - August, occasionally until October; Salt and Salt 1976). This species breeds in a narrow band in western North America from north-central Alaska to north-western California (Godfrey 1986) and in Alberta, varied thrushes breed in the west along the mountain foothills (Salt and Salt 1976). Winter range is from southern British Columbia to California (Salt and Salt 1976). In Alberta, varied thrushes are not considered at risk and have stable populations in secure habitat (Wildlife Management Division 1996). During the reproductive season, varied thrushes are present throughout the FMF in mature coniferous forests (Farr 1995).

3. FOOD

During the summer, varied thrushes feed on ants, beetles, worms, snails and other insects from the forest floor (Salt and Salt 1976, Godfrey 1986, Ehrlich 1988). Prime foraging areas typically lack thick shrub, herb, or moss layers and include high humus content soils (Campbell et al. 1988). During the fall, varied thrushes eat small fruits and berries (Salt and Salt 1976).

4. COVER

Mature coniferous forests and coniferous dominated mixedwoods are typical habitats (Salt and Salt 1976, Peterson and Peterson 1983, T. Thormin personal communication). The best habitat is the dense, damp understorey of mature spruce or fir forests (Salt and Salt 1976). In the FMF, varied thrushes were mainly in unlogged forests dominated by spruce (black spruce in particular) and fir (Farr 1995). Abundance increased with a decrease in shrub height and shrub closure (Farr 1995).

5. REPRODUCTION

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1 Current Address: Houston Forest Products, Box 5000, Houston, B.C. V0J 1Z0
2 Contact Address
Varied thrushes usually nest in conifers from 1-8 m above ground (Godfrey 1986, Campbell et al. 1988). Three to 4 light blue eggs are laid (Salt and Salt 1976), which hatch in 14 days (Ehrlich 1988). Both sexes feed the young (Ehrlich 1988).

6. HABITAT AREA

No published information was found on home range or territory size, but densities were 0.006-0.045 pairs/ha in old growth forests in Oregon (Mannan and Meslow 1984, Anthony et al. 1996), and 0.036-0.054 singing males/ha in Engelmann spruce (Picea engelmannii)/subalpine fir (Abies lasiocarpa) forests in British Columbia (Wetmore et al. 1985). Farr (1992) found densities in old spruce forests to be 0.05 pairs/ha.

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Varied Thrush (Ixoreus naevius).

Habitat Evaluated: Reproductive Habitat (Nesting, Foraging and Cover).

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

Seasonal Applicability: This model produces HSI values for spring/summer reproductive 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. Because the varied thrush is highly mobile, it is assumed that any patch with suitable habitat will be utilized.

Model Output: The model will produce reproductive Habitat Units (HU) for each 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 (breeding pairs per ha). Model output should be correlated to estimates of carrying capacity to verify model performance.

Carrying Capacity (Breeding Pairs per ha where HSI = 1.0): Based on limited local information, the current estimate of the maximum number of breeding pairs per hectare is 0.05 (Farr 1992).

Verification Level: The reliability of this model has not been evaluated against local data. The verification level is 5: model tested/revised using local data but the predictive performance of the revised 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 varied thrush 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

Cover, food and reproductive needs of the varied thrush are assumed to be provided by the same set of habitat features and have been combined into a single measurable life requisite called reproductive habitat.

7.2.1 Habitat Variables and HSI Components
The varied thrush HSI model makes use of three elements of habitat structure (Table 1). Variable $S_1$ is the composition of spruce and fir in the tree canopy. Spruce and fir provide good ground cover where the varied thrush forages because these conifers generally do not self prune their branches. These tree species are also preferred for nesting.

Varied thrushes prefer areas with dense tree canopy closures, which provide security from predation and protection from poor weather. Tree canopy closure is used to determine the second HSI component ($S_2$). The final component, $S_3$, is a function of coniferous canopy height (Table 1). Height is necessary for suitable nest locations and is used as a stand development index. Stands with taller trees tend to have developed a forest floor good for foraging. Coniferous tree height is used to account for mixedwood situations in which conifers grows at a slower rate than deciduous trees.

**Table 1.** Relationship between habitat variables and life requisites for varied thrush HSI model.

<table>
<thead>
<tr>
<th>HSI Component</th>
<th>Life Requisite</th>
<th>Habitat Variable</th>
<th>Habitat Variable Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
<td>Cover, Nesting, Food</td>
<td>Spruce + Fir in Tree Canopy (%)</td>
<td>Percent composition of white, black and Engelmann spruce, subalpine and balsam fir species in the tree canopy.</td>
</tr>
<tr>
<td>$S_2$</td>
<td>Cover</td>
<td>Tree Canopy Closure (%)</td>
<td>Percent of ground covered by a vertical projection of tree crown areas onto the ground. Includes all trees $\geq 8$ cm diameter at breast height (dbh at 1.3 m).</td>
</tr>
<tr>
<td>$S_3$</td>
<td>Cover, Nesting</td>
<td>Coniferous Canopy Height (m)</td>
<td>Average top height of 100 coniferous trees/ha that have the largest dbh.</td>
</tr>
</tbody>
</table>

7.2.2 **Graphical HSI Component Relationships**

$S_1$ Optimal reproductive habitat occurs when stands are $\geq 75\%$ spruce + fir composition. Varied thrushes are generally not associated with habitats with $< 10\%$ spruce + fir. Between 10-75% the value rises linearly (Figure 1a).

$S_2$ Varied thrush reproductive habitat is good when tree canopy closure is $\geq 70\%$. Tree canopy closures $\leq 30\%$ are considered unsuitable (Figure 1b).

$S_3$ Stands with coniferous heights between 0-8 m do not have proper foraging, nesting, and protective cover associated with varied thrushes. Suitability increases between 8-10 m and becomes good at 10 m (Figure 1c).

7.3 **MODEL ASSUMPTIONS**

1. Water or mineral resources do not limit varied thrushes.
2. Varied thrushes forage and nest equally in spruce and fir species. Other coniferous and deciduous trees are not utilized.
3. Varied thrushes are not affected by human disturbance or other forest uses, roads, campsites, etc.
4. Tree height is indicative of developmental characteristics that are found in mature forests.
Figure 1. Graphical relationships between habitat variables and HSI components in the varied thrush model.

7.4 EQUATION

All three variables are considered equal and non-compensatory (this means low values of one variable can not be compensated by high values of the others) in defining the quality of reproductive habitat in an area for varied thrushes.

\[ HSI = S_1 \times S_2 \times S_3 \]

8. SOURCES OF OTHER MODELS

No other habitat models for the varied thrush 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 Tony Romito 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


