GREAT GRAY OWL
YEAR-ROUND HABITAT

HABITAT SUITABILITY INDEX MODEL
VERSION 3

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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 great gray owl (*Strix nebulosa*) 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 great gray owl 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 great gray owl is a large owl ranging from 64-84 cm long (Salt and Salt 1976) and has yellow eyes, conspicuous white throat markings and a large facial disc (Salt and Salt 1976). Their distribution is circumpolar (Salt and Salt 1976). In Canada, the great gray owl breeds and winters in forested areas from B.C. and the Yukon, east to Quebec (Duncan and Hayward 1994), however numbers are often erratic as populations tend to cycle with vole populations (Duncan and Hayward 1994).

In Alberta, great gray owls breed from northern Alberta south to Calgary (Salt and Salt 1976). During the winter they are in most parts of the province except on the prairies and the southern Rocky Mountains (Salt and Salt 1976). Great gray owls are naturally uncommon and considered a sensitive species in Alberta because they are associated with habitats that are or may become deteriorated (Wildlife Management Division 1996).

3. FOOD

Great gray owls prey on mice (*Peromyscus* spp.), voles (*Microtus* spp. and *Clethrionomys* spp.), pocket gophers (*Thomomys* spp.), bog lemmings (*Synaptomys* spp.), shrews (*Sorex* spp.), small birds and other small animals (Bent 1961, Brunton and Pittaway 1971, Salt and Salt 1976**,** Godfrey 1986, Osborne 1987, Servos 1987, Franklin 1988). In North America they are small rodent specialists, preying predominately on voles, pocket gophers and bog lemmings (Brunton and Pittaway 1971, Osborne 1987, Servos 1987).

Predators of great gray owls include great horned owls, northern goshawks, black bears, fishers and lynx (Duncan 1987, Bull and Henjum 1990).

Great gray owls hunt from perches in small clearings, tamarack (*Larix laricina*) wetlands, treed muskeg, margins of clear cuts, meadows or fields (wet or dry) and open forests with little shrub cover (Brunton and Pittaway 1971, Bryan and Forsman 1987, Servos 1987, Franklin 1988, Bull and Henjum 1990). Scattered trees, stumps, and shrubs are used as perching sites (Brunton and Pittaway 1971, Nero 1980, Servos 1987, Bryan and Forsman 1987, Franklin 1988, Bull and Henjum 1990). Perches are essential, as hunting from the ground or while flying is rare (Collins 1980, Nero 1980, Bull and Henjum 1990). Areas of low tree canopy closure and low shrub cover are preferred foraging habitats because they are not dense enough to impede flight or hamper the owls ability to grasp prey and are the preferred habitat of their prey (Servos 1987, Franklin 1988, Bull et al. 1989). The average perch to prey

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distance is 10.5 m (Bull and Henjum 1990). Great gray owls can locate a vole under the snow or grass up to a maximum distance of approximately 50 m (Salt and Salt 1976, Duncan and Hayward 1994).

Great gray owls may not be sensitive to human disturbance outside the breeding season. During the winter, an adult female and juvenile remained close to active logging operations, presumably to catch the displaced small mammals (Bull and Henjum 1990).

4. COVER

Great gray owls are found in a diverse mixture of treed muskeg or mature forests that are adjacent to open areas. Ninety-five percent of great gray owl sightings (N = 63) were in mature or old-growth forests (mostly lodgepole pine/ponderosa pine forests) that were less than 0.3 km from a meadow (Bryan and Forsman 1987). In Manitoba, both sexes (mature and juveniles) showed a strong preference for tamarack bogs (Servos 1987). Tamarack bogs had on average 4,500 stems/ha and a canopy cover of 35%. This habitat appeared to provide enough cover for fledglings and supported their preferred prey species, the meadow vole. Females selected treed muskeg and old burned areas. Shrub cover was denser in treed muskegs than in tamarack bogs but the shrubs were clumped in the treed muskegs so open areas suitable for hunting were present. Fledglings did not use treed muskegs or old burned areas presumably because not enough tree canopy cover was present for concealment. Stands that were > 60% black spruce were avoided. This avoidance was attributed to a low number of meadow voles. Other habitats that were avoided or neutral were marsh/muskegs and willow alder thickets likely because suitable hunting perches were not available (Servos 1987). In Saskatchewan, 25 of 27 suspected breeding locations were within 500 m of black spruce/tamarack wetlands (Harris 1984). Roost sites for males in Oregon were typically in mature forests that had dense canopy cover and were at least 3-7 m above the ground (Bull and Henjum 1990).

Great gray owls prefer dense canopy closure around the nest site (Bull et al. 1988). A dense stand of trees for cover and leaning trees that juveniles can climb to avoid predators are important habitat features around the nest site (Franklin 1988, Bull and Henjum 1990). However, nest sites in canopies lower that 45% have been observed (Servos 1987, Spreyers 1987).

5. REPRODUCTION

Great gray owls do not build their own nests and will not add materials to existing ones (Bull and Henjum 1990) They rely on locating suitable stick nests or depressions in the trunks of trees with broken tops (Nero 1982 as cited in Obsborne 1987). Three to 5 eggs are laid (Salt and Salt 1976). The female incubates and cares for the nestlings while the male brings food (Bull and Henjum 1990). Young owls are not able to fly when the young leave the nest and will use leaning trees to get off the ground (Bull and Henjum 1990). The female will remain with the chicks to protect them but after approximately six weeks the female leaves and the male continues to feed the young for up to 3 months (Bull and Henjum 1990). Typically 1 brood is raised per year (Ehrlich 1988).

In the northern boreal forest, the majority of great gray owl nests have been found in abandoned stick-nests (often old goshawk nests) but a small proportion are also in the broken tops of dead trees (Salt and Salt 1976, Bull et al. 1987, Osborne 1987, Lang et al. 1991). Mature aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*) or spruce are the most common nest tree species in the boreal forest (Oeming 1955, Bent 1961, Nero 1980, Osborne 1987). In Oregon, 25 nests were in abandoned stick nests and 10 nests were in the tops of broken trees (N = 35; Bull and Henjum 1990). In Alberta, 10 nests were in old raptor nests located in mature *populus* spp. (N = 10; Bent 1961). Similarly, 18 nests with an average height of 13 m were in old raptor or corvid stick nests in mature aspen or poplar (*Populus* spp.) trees, 3 in black spruce and 2 in tamarack (N = 23; Oeming 1955). In agricultural areas in central Alberta, nests were in forest stands that were 11 ha to 120 ha (Stepnisky 1997). All 19 nest stands were in dense mixedwood forests and in poplar trees (17 in aspen, 2 in balsam poplar). Seventeen nests were in abandoned stick nests and 2 were in chimney stumps. In Idaho and Wyoming; 60% of nests were in broken off trees and 40% were in old stick nests (N = 15; Franklin 1988). Lodgepole pine, Douglas fir and Engelmann spruce were used for nesting. Nests in fir/spruce snags had the highest reproductive success, were more stable, were higher up in the tree and had a larger nesting surface area compared with nests in lodgepole pine snags or stick nests (Franklin 1988). In lodgepole pine/Douglas fir forests in south-eastern Idaho and north-western Wyoming, nine nests were in old goshawk nests that were in Douglas fir (5 nests), lodgepole pine (3 nests) and aspen (Whitfield and Gaffney 1997). One nest was in an old red-tailed hawk nest in a lodgepole pine snag and one nest was on top of a lodgepole pine snag. Average tree diameter at breast height (dbh at 1.3 m) was 43.6 cm (24-82 cm), average nest tree height was 20 m (7-30 m), average tree canopy cover was 71% (30-99%) and average shrub canopy cover beneath the nests

was 17.2 (0-54%; Whitfield and Gaffney 1997). Nests are also in tamarack and other conifers (Bent 1961, Spreyer 1987, Lang et al. 1991). In the FMF, two nests were in broken off white spruce snags (R. Bonar, Biologist, Weldwood of Canada, Ltd, Hinton, personal communication) and four nests were in stick nests located in trembling aspen trees (Takats 1998).

Great gray owl nesting habitat is often associated with mature to old growth forests (Hilden and Helo 1981, Osborne 1987, Bull et al. 1988). Proximity of food resources may be important during the breeding season when males must sustain not only themselves but also the female and as many as five young. Increasing the distance from the foraging area to the nest site increases the male's energy expenditure. In north-eastern Oregon, males foraged 0.7-3.2 km from the nest during the nesting season (Bull and Henjum 1990). Another study found nests were within 500 m of preferred foraging areas (Lang et al. 1991).

Within the first 7 days of fledging, the young owls can move up to 140 m from the nest (Franklin 1988) and it is within this radius where protective cover is needed. Other studies revealed the following mean distance of nests from clearings; 77.1 m (Bull et al. 1988), 143 m (Franklin 1987) and 256 m (Bouchart 1991). Great gray owls have been known to nest on the edges of such habitats as well (Bull et al. 1987, Bouchart 1991).

6. HABITAT AREA

Great gray owls are not highly territorial (Brunton and Pittaway 1971, Bull and Henjum 1990). Great gray owls will often nest in close proximity to other pairs of great gray owls (Hilden and Helo 1981, Servos 1987, Bull and Henjum 1990) and home ranges often overlap (Servos 1987, Bull and Henjum 1990). However, intraspecific aggression between two great gray owls during the winter in south-western Alberta has been observed (Collister 1997) and pairs will defend a small area immediately surrounding their nest site (Bull and Henjum 1990). Breeding densities were 0.01 nests/ha in Minnesota (Spreyer 1987), and 0.004 pairs/ha in Wyoming (Craighead and Craighead 1956). The home range of five adult males during the nesting season averaged 4.5 km^2 (range 1.3 – 6.5 km^2) in Oregon (Bull and Henjum 1990). This included both the foraging and nesting areas.

The percent of forested area in the home range of nesting great gray owls ranged from 17-95% in agricultural land in central Alberta (Stepnisky 1997). The percent of foraging area around the nest site used by two males while feeding chicks in an Oregon western larch/ponderosa pine/lodgepole pine/grand fir/Douglas fir forest was determined to be approximately 50% of the area within 1 km of the nest (determined from Bull and Henjum 1990).

7. HSI MODEL

7.1 MODEL APPLICABILITY

Species: Great Gray Owl (*Strix nebulosa*).

Habitat Evaluated: Nesting, Post-Fledging and Foraging Habitat.

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

Seasonal Applicability: Year-round.

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. The minimum habitat area assumed necessary is the area around the nest used by young before they are able to fly which is 140 m or about 6 ha (Franklin 1988).

Model Output: The model will produce Habitat Units (HU) of nesting and foraging habitat for each stand type. Habitat units are calculated by multiplying the HSI value with the area in hectares. The performance measure of this model is carrying capacity (great gray owls per ha). Model output should be correlated to estimates of carrying capacity to verify the model's performance.

Carrying Capacity (Breeding Pairs per ha where HSI = 1.0): Based on work done by Spreyer (1987) in Minnesota, the estimate of the maximum number of breeding pairs per optimal hectare is 0.01.

Verification Level: The reliability of this model has not been evaluated using local data. The verification level is 2: local knowledge has been incorporated into the model but model predictions have 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 great gray owl 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 great gray owl year round habitat assumes the life requisites for reproduction are limiting. It is assumed that the needs of cover habitat are met by the same parameters that provide suitable nesting habitat, while the needs of winter and summer food are met within the parameters defined in food habitat. If trees of sufficient size and number are present to ensure the availability of potential nest sites, then the reproductive requirements of great gray owls are provided.

Great gray owls nest in dense forest stands and forage in open stands. The HSI model separates these two needs into different HSI equations so separate HU for feeding and nesting are determined. The overall habitat area is determined by ensuring that high quality habitat for both needs are available.

7.2.1 Habitat Variables and HSI Components

Five structural variables and two spatial variables are used to define seven HSI components. Five components (S_1 to S_5) are used in the HSI-nesting equation, and 2 components (S_6 and S_7) are used in the HSI-foraging equation. (Table 1).

A. Nesting

The first variable (S_1) is the density of deciduous trees with a dbh ≥ 35 cm. Great gray owls do not build their own nests and often use abandoned stick-nests. In Alberta, great gray owls utilize stick nests built by northern goshawks, which are usually located in mature (large diameter) deciduous trees with a prominent fork in them. It is assumed that stands with ≥ five mature deciduous trees per hectare are optimal habitat.

The second variable (S_2) is deciduous tree dbh, which is used as a general indicator of stand development to ensure the forest is old enough to provide large deciduous trees suitable for nests. Stands at this development stage may also have leaning trees suitable for fledglings to climb to access the tree canopy. As this is an average stand dbh estimate, there will be some trees significantly above and below the mean.

The third variable (S_3) accounts for conifer forests with broken off trees. These snags are used for nesting by great gray owls if the diameter is large enough to accommodate a family of great gray owl chicks. Stands with an average dbh of 25 cm are assumed to provide some suitable sized snags for nesting.

The fourth variable is distance from a treed area with < 6% canopy cover. The concern is that nests too close to an opening will result in increased predation of nestlings and fledglings. Based on Franklin's (1988) findings, a distance of 140 m from the nest to an opening should be sufficient for the fledglings to find suitable cover. Note that S_4 is not equal to 0 at 0, but 0.5 at 0 because great gray owls will nest on the edges of such habitat (Bull et al. 1987, Servos 1987) however, it is assumed these nests will be less productive as a result of predation.

The final variable (S_5) is percent tree canopy closure. Fledglings need suitable canopy cover to protect and hide them from predators. Great gray owls prefer tree canopy closures > 60% (Bull et al. 1988). However, nest sites have been observed in canopies less than 45%. It was assumed that stands with a tree canopy closure ≥ 35% are optimal. Stands < 6% canopy cover have a suitability of zero.

B. Foraging

A combination of tree canopy closure and shrub cover is used to predict S_6. Great gray owls prefer open areas with occasional trees or tall shrubs for perching sites when foraging. Optimal foraging occurs in habitats with canopy closures ≤ 40% (Servos 1987, Bull and Henjum 1990). Foraging habitat did not have canopy closures > 60% (Bull et al. 1988).

The second variable associated with foraging habitat is distance from areas with developed canopies (minimum of 6% closure, S_7). Great gray owls perch near cover to hunt. The average perch to prey distance for great gray owls was 10.5 m (Bull and Henjum 1990). Because this value is an average, it is assumed that foraging is optimal up to 15 m from an edge. Great gray owls can locate a vole, under the grass or snow, up to a maximum distance of 50 m (Salt and Salt 1979, Duncan and Hayward 1994) therefore we assumed that beyond this distance from an edge, foraging habitat is equal to zero.

Table 1. Relationship between habitat variables and life requisites for the great gray owl HSI model.

HSI Component	Life Requisite	Habitat Variable	Habitat Variable Definition
S_1	Nesting	Deciduous Trees ≥ 35 cm dbh/ha	Density of aspen, balsam popular and birch trees ≥ 35 cm at 1.3 m height.
S_2	Nesting	Deciduous dbh (cm)	Mean dbh of deciduous canopy trees measured at 1.3 m height.
S_3	Nesting	Conifer dbh	Mean dbh of conifer canopy trees measured at 1.3 m height.
S_4	Nesting	Distance to Open Area (m)	Distance to the nearest habitat area with < 6% tree canopy closure.
S_5	Nesting	Tree Canopy Closure (%)	Percent of ground area covered by a vertical projection of tree crown areas onto the ground. Includes all trees ≥ 8 cm dbh.
S_6	Foraging	Tall Shrub Cover, Sapling Cover and Tree Canopy Closure (%)	Percent of ground area covered by a vertical projection of tree, sapling and shrub crown areas onto the ground. Includes all trees ≥ 8 cm dbh, saplings and all shrubs ≥ 1 m in height.
S_7	Foraging	Distance to Treed Area (m)	Distance to the nearest treed area with ≥ 6% tree canopy closure.

7.2.2 Graphical HSI Component Relationships

A. Nesting

S_1 The number of large (≥ 35 cm dbh) deciduous trees per ha must be ≥ 5 for optimal suitability. The minimum value is set at zero but this will not cause the equation to become zero as the maximum between S_1, S_2 or S_3 is used in the equation (Figure 1a).

S_2 Suitable stick nests are often found in mature deciduous forests. Stands with an average dbh of 25 cm are assumed to provide deciduous trees large enough for goshawks and other large birds to build stick nests suitable for great gray owls (Figure 1b).

S_3 Suitable broken off trees are often found in mature coniferous forests. Stands with an average dbh of 25 cm are assumed to provide conifer trees large enough, that when broken off, will provide an area large enough for a great gray owl nest (Figure 1c).

S_4 Nesting too close to an open area is assumed to increase the risk of predation to the chicks. S_4 is suitable at 140 m and greater. However, pairs that nest on the edge of a clearing can also successfully raise chicks, so suitability only goes down to 0.5 if the distance to an open area is zero (Figure 1d).

S_5 Great gray owls prefer some canopy closure around the nest for thermal and predation cover. Tree canopy closure < 6% is unsuitable ($S_4 = 0$), and values greater than 35% are suitable ($S_4 = 1$) (Figure 1e).

B. Foraging

S_6 Foraging occurs in open areas. The combination of tree, sapling and shrub cover must be ≤ 40% to be good. Suitability then decreases to 0 at 80% tree canopy closure and remains unsuitable at 100% (Figure 1e).

S_7 The great gray owl perches near cover to hunt. In this model, foraging habitat is good up to 15 m from a treed area and then decreases to zero suitability at 50 m distance from a treed area (Figure 1f).

7.3 MODEL ASSUMPTIONS

1. If suitable nesting habitat is available then year round habitat is also available.
2. Cover requirements are met by the same parameters that provide suitable nesting habitat.
3. Nesting and foraging areas are separate areas.
4. Winter and summer food requirements are met within the parameters defined in food habitat.
5. The availability of water is not a limiting component of great gray owl habitat.
6. Nesting habitat quality increases as forest stands develop structurally to have large trees, dying or dead trees, and trees with broken tops or large branches for nest locations.
7. Mean dbh of trees is indicative of stand structural complexity and is representative of potential nesting habitat.

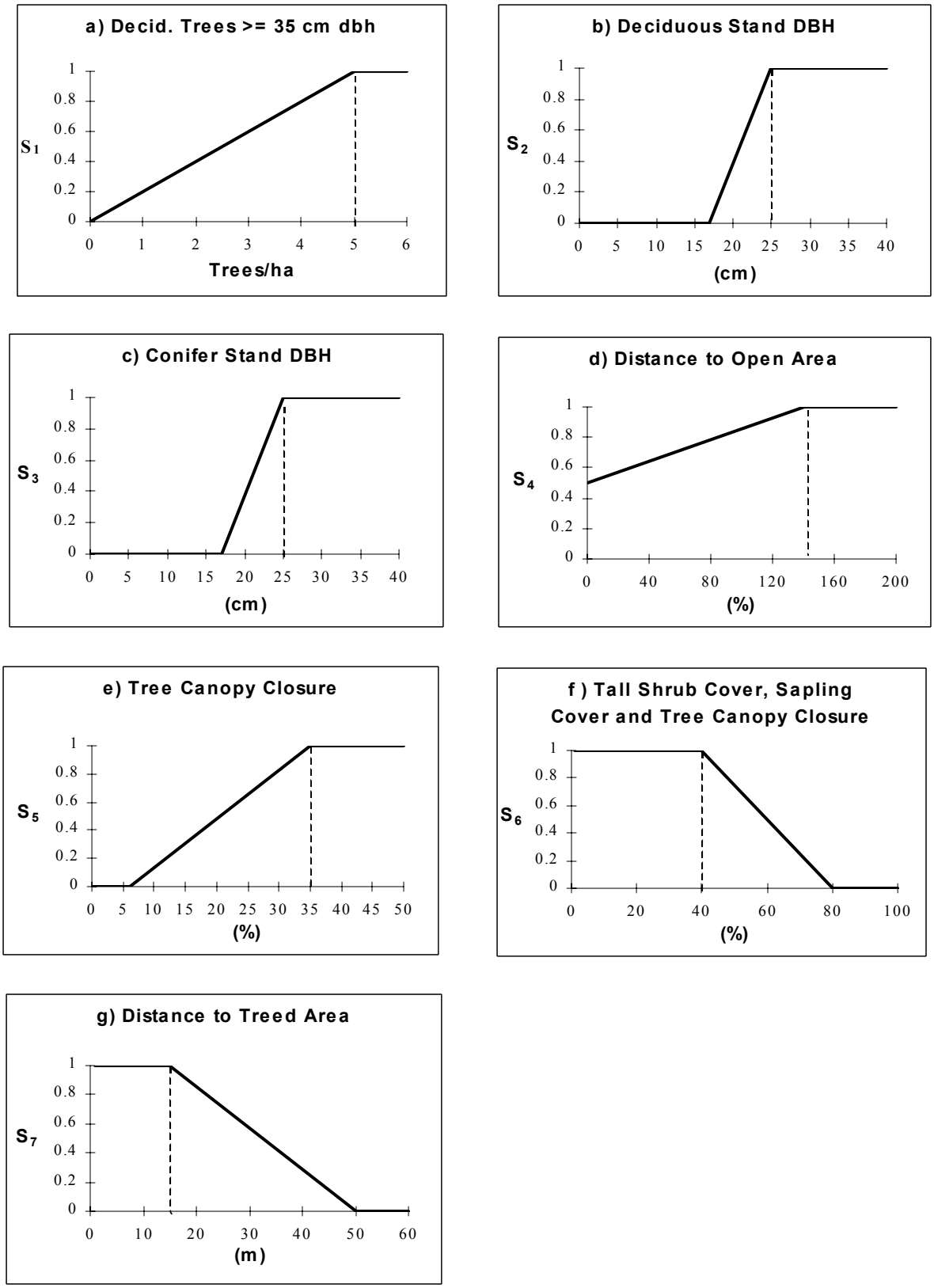

Figure 1. Graphical relationships between habitat variables and HSI components in the great gray owl model.

7.4 EQUATIONS

A. Nesting

Nesting suitability is calculated using components S_1 to S_5. Habitat in conifer stands with a large average dbh is not thought to provide as many suitable nest sites as mature deciduous stands or stand with large deciduous trees, therefore S_3 (conifer dbh) is multiplied by 0.5. This means that in a conifer stand with an average dbh of 25 cm, the highest suitability that stand will achieve is 0.5. The value of the component with the greatest suitability among S_1, S_2 or S_3 is multiplied with the value of S_4 and S_5 to give the nesting score.

$$\text{HSI-nesting} = \max (S_1, S_2, 0.5 \times S_3) \times S_4 \times S_5$$

B. Foraging

The product of the two remaining components determines the food suitability. These are considered equal and non-compensatory.

$$\text{HSI-foraging} = S_6 \times S_7$$

To ensure enough suitable nesting and foraging habitat is available in a fragmented forest, it was assumed that at least 20 HU of nesting habitat and 50 HU of foraging habitat must be present within 1 km^2 of the nest before an area is suitable for nesting great gray owls (extrapolated from Bull and Henjum 1990).

8. SOURCES OF OTHER MODELS

No other HSI models for the great gray owl 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 (1995) was written by Mark Piorecky in a habitat modelling course at the University of Alberta.
- Version 2 (1996) was edited and reformatted by Wayne Bessie.
- Version 3 (1999) was revised by Karen Graham, Rick Bonar, Barb Beck, and Jim Beck to incorporate information from recent literature.

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