

# **NORTHERN GOSHAWK**

*(Accipiter gentilis atricapillus)*



Source: Salt and Salt (1976)

**Prepared for Millar Western Forest Products'  
Biodiversity Assessment Project**

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# Table of Contents

<b>1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES .</b>	<b>1</b>
<b>1.1 Introduction .....</b>	<b>1</b>
<b>1.2 Effects of Forest Management Activities .....</b>	<b>1</b>
<b>2.0 HABITAT USE INFORMATION .....</b>	<b>3</b>
<b>2.1 Food requirements .....</b>	<b>3</b>
<b>2.2 Cover Requirements .....</b>	<b>4</b>
<b>2.3 Reproduction Requirements .....</b>	<b>4</b>
<b>2.4 Habitat Area Requirements .....</b>	<b>5</b>
<b>2.5 Landscape Configuration Requirements .....</b>	<b>6</b>
<b>2.6 Sensitivity to Human Disturbance .....</b>	<b>6</b>
<b>3.0 MODEL .....</b>	<b>7</b>
<b>3.1 Envirogram .....</b>	<b>7</b>
<b>3.2 Application Boundaries .....</b>	<b>7</b>
<b>3.3 Model Description .....</b>	<b>7</b>
<b>3.4 Habitat Variable SIs .....</b>	<b>8</b>
<b>3.5 Computation .....</b>	<b>12</b>
<b>4.0 EXTERNAL REVISIONS .....</b>	<b>13</b>
<b>5.0 LITERATURE CITED .....</b>	<b>14</b>

# List of Tables

Table 1. Northern Goshawk nesting habitat suitability ratings, by habitat type. .... 10

# List of Figures

Figure 1.	Breeding distribution of the Northern Goshawk in North America, BBS data (Gough et al. 1998). .....	1
Figure 2.	Envirogram of the Northern Goshawk based on available habitat information for HSM development. ....	7
Figure 3.	HSM structure for the Northern Goshawk within Millar Western's FMA area. ....	8
Figure 4.	Northern Goshawk foraging habitat suitability in relation to tree height within Millar Western's FMA area. ....	9
Figure 5.	Northern Goshawk foraging habitat suitability in relation to flying space within Millar Western's FMA area. 0 = clear, 10 = entangled, > 0 and < 10 = porous to obstructed. ....	10
Figure 6.	Northern Goshawk foraging and nesting habitat suitability in relation to canopy closure within Millar Western's FMA area. ....	11
Figure 7.	Northern Goshawk nesting habitat suitability in relation to proximity to roads within Millar Western's FMA area. ....	11

## 1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES

### 1.1 Introduction

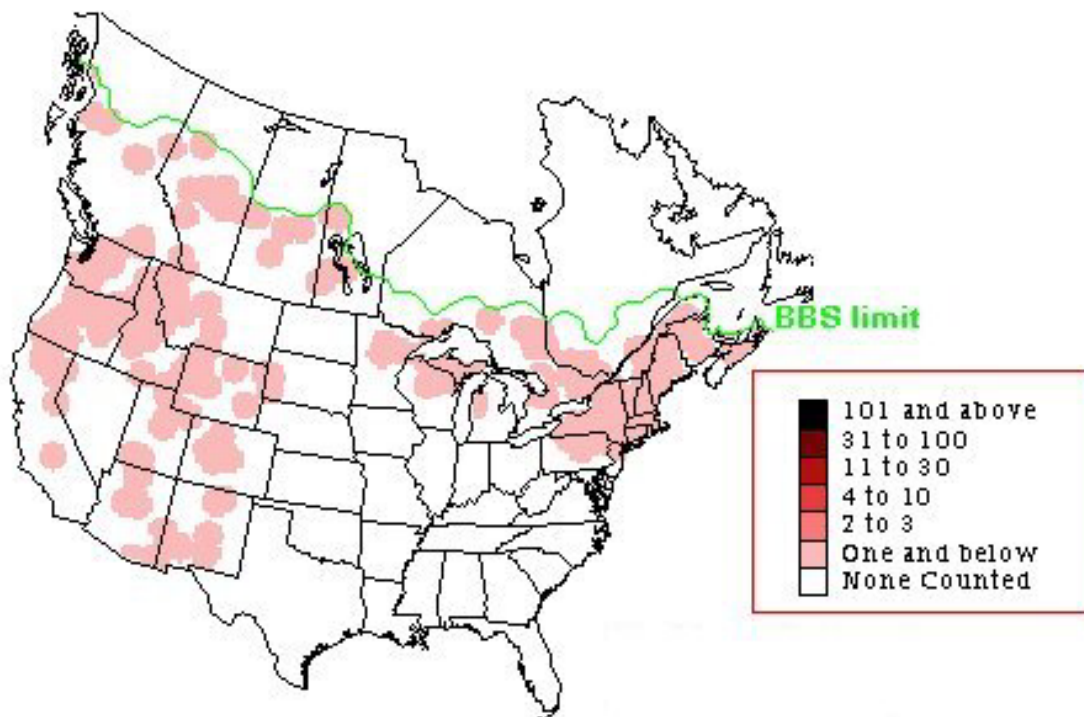
The Northern Goshawk (*Accipiter gentilis atricapillus*) is North America's largest representative of the genus *Accipiter* (Reynolds *et al.* 1992a; Lillieholm *et al.* 1993). Its range extends from northwestern Alaska, across boreal Canada, throughout the northern and western United States, and south to Mexico (Lillieholm *et al.* 1993, Figure 1). The bird is a year-round resident of Alberta when sufficient prey is available during winter (Robbins *et al.* 1983; Palmer 1988; Semenchuk 1992; Duncan and Kirk 1994).

There is a lack of information on the habitat selection and behaviour of Northern Goshawks in Alberta since no intensive studies have been undertaken in the province (Schaffer 1998). The current provincial status of this bird is unknown. It has been placed on the Yellow B

List by Alberta Environmental Protection (1996) because it is thought that it may be at risk of local extirpation in the future.

### 1.2 Effects of Forest Management Activities

Northern Goshawks require certain forest features for nesting and foraging. During the nesting season, the birds are particularly sensitive to human activity and at this time, they are in need of ample forest canopy cover and large diameter forked deciduous trees (Schaffer 1995). The requirements for foraging habitat are not as stringent as those for nesting. It is essential, however, that prey is both available and accessible and that tall perch trees are present (Benson 1979; Palmer 1988; Reynolds *et al.* 1992b; Schaffer 1995)



**Figure 1. Breeding distribution of the Northern Goshawk in North America, BBS data (Gough *et al.* 1998).**



within a closed canopy stand (Reynolds and Meslow 1984; Janes 1985; Beier and Drennan 1997). Goshawks generally find habitat containing these required elements in mature or old deciduous-dominated mixedwood forests.

Since different forest management practices influence the tree species composition and age-class structure of the forest in different ways, foresters must be aware of the conditions considered optimal for this species if its habitat is to be protected or enhanced. Research by Crocker-Bedford (1990) revealed that the birds abandoned their nesting sites in response to selective harvesting. For this reason, the author recommended that the entire range used during the sensitive breeding, nesting, and post-fledging family times (~ 2,000 ha) be withdrawn from forest management activities (Crocker-Bedford 1990).



## **2.0 HABITAT USE INFORMATION**

### **2.1 Food requirements**

#### ***Appropriate Prey***

Although the Northern Goshawk is considered an opportunistic predator, it may focus its energy on the capture of a few major prey species. The particular prey items taken will vary with local prey abundance (Storer 1966; Palmer 1988). The research results of Schaffer (1998) revealed that in west-central Alberta, the most commonly consumed prey items are Snowshoe Hare, Ruffed Grouse, Red Squirrel, Spruce Grouse, and Blue Grouse. These preferred prey species are generally taken from the ground (Schaffer 1998). Therefore, the birds tend to forage at low levels in the stand, in the ground-shrub or shrub-canopy layers (Reynolds and Meslow 1984).

Because of the bird's strong reliance on Snowshoe Hares as prey, its population tends to cycle with that of the hare (Mueller *et al.* 1977; Todd 1991). During periods of low hare abundance, the goshawk must switch to alternate prey species which include the Pika, Pileated Woodpecker, Northern Flicker, Three-toed Woodpecker, Gray Jay, Black-throated Green Warbler, Muskrat, Hungarian Partridge, Northern Saw-whet Owl, American Crow, Varied Thrush, European Starling, Domestic Chicken, and Domestic Turkey, in addition to those species mentioned above.

#### ***Method of Hunting***

The goshawk's method of hunting involves the use of tall trees as perches from which it surveys the lower branches and forest floor for small birds and mammals. It relies on substantial canopy closure to conceal it from its prey (Reynolds and Meslow 1984; Janes 1985; Beier and Drennan 1997). Upon observation of a suitable prey species, the bird takes flight and pursues the animal (Palmer 1988) in a short flight (Kenward 1982). The goshawk possesses short, rounded wings and a long tail. These morphological adaptations allow it

to move efficiently through forest stands that are much too dense for its open-forest avian counterparts, providing it with a competitive advantage (Lilieholm *et al.* 1993). If the forest cover proves too thick for successful flight, however, the hawk may land and continue the chase on foot (Schnell 1958; Bergstrom 1985; Godfrey 1986; Palmer 1988).

Optimal foraging habitat should have relatively open flight corridors and high visibility of prey from concealed perches (Reynolds *et al.* 1982; Reynolds and Meslow 1984; Janes 1985; Crocker-Bedford 1990; Beier and Drennan 1997). Snowshoe Hare and Ruffed Grouse may be more abundant in stands with dense understories (Gullion 1967; Gullion 1968; Meslow and Keith 1972; Gullion 1972; Wolff 1980; Buehler and Keith 1982; Litvaitis *et al.* 1985; USDI 1985; Radvanyi 1987; Semenchuk 1992). It is unlikely that goshawks will select such a stand as foraging habitat, however, as low-level flying space may be insufficient (Bosakowski and Smith 1992). Kenward (1982) suggested that clearcuts may represent good goshawk foraging habitat. However, Crocker-Bedford (1990) warned that these results were based on observations of tamed goshawks feeding on released pheasants.

#### ***Suitable Foraging Habitat***

Though acquired prey may change with the seasons, preferred hunting habitat has been shown to remain constant year-round (Widen 1989). The presence of tall trees and snags from which the search for food begins is essential. Research has shown that stands become suitable as goshawk habitat once the trees have reached an average height of 25 m (Lilieholm *et al.* 1993), though trees of 16 m will often suffice. Stands with trees of less than 8 m height are generally avoided (Schaffer 1995).



It is vital that appropriate prey species are both available and accessible. Prey is most easily accessed in mixedwood stands with relatively clear understories, allowing the goshawks to quickly pursue prey. In addition, competing open-forest raptors with lesser agility and manoeuvrability are discouraged from foraging in the area (Crocker-Bedford 1990; Reynolds *et al.* 1992a; Austin 1993; Bright-Smith and Mannan 1994; Hargis *et al.* 1994; Beier and Drennan 1997). Hunting occurs within stands of canopy closure between 60 and 89%, with a strong aversion to areas with less than 40% cover. Observation in Alberta has revealed that goshawks tend to forage in mature to old aspen-dominated mixedwood forests (Lilieholm *et al.* 1993; Schaffer 1995).

Recent clearcuts and dense young stands are thought to be unsuitable as goshawk foraging habitat for three reasons: 1. tall trees are not available as perches; 2. thick canopy cover is not present for concealment; and 3. the understory is too thick for efficient movement.

The high nutritional requirement of young goshawks during the first few weeks of life means that the area surrounding the nest, termed the post-fledging family area, must contain excellent foraging habitat. In fact, Newton (1976) and Ward and Kennedy (1996) suggested that the breeding success of the Northern Goshawk may be limited by food availability.

Based on the above discussion, the characteristics contributing to good foraging habitat include:

- ◆ Mixedwood, preferably aspen-dominated forest;
- ◆ Relatively clear understory;
- ◆ Tall trees for use as perches; and
- ◆ Canopy closure of 60 to 89%.

## **2.2 Cover Requirements**

Northern Goshawks are forest dwellers (Palmer 1988) and have the ability to utilise a wide variety of forest ages, structural conditions, and successional stages (Francis and Lumbis 1979; Reynolds *et al.* 1992a; Reynolds *et al.* 1992b) for most of the year. During nesting, their habitat requirements become more demanding. These requirements will be discussed in the following section.

The Northern Goshawk's position high in the food web limits its predators to large birds such as the Great-Horned Owl and carnivorous mammals such as the Fisher (Crocker-Bedford 1990; Reynolds *et al.* 1992b; Erdman *et al.* 1998). Canopy closure for protection from predators and concealment from prey is necessary particularly during the nesting season.

## **2.3 Reproduction Requirements**

Monogamous Northern Goshawk pairs of central Alberta move to their nesting territory in early March and remain within the post-fledging family area until late August (Schaffer 1998). At this time, they will either select a pre-existing platform nest (Godfrey 1986; Semenchuk 1992) that they may use for up to five subsequent years (Crocker-Bedford 1990) or will establish a new nest (Knopf 1977). Stick nests are approximately 1 m in diameter and are built 5 to 23 m above the ground (Godfrey 1986; Semenchuk 1992).

Some biologists believe that Northern Goshawks prefer to establish their nest sites in overmature coniferous stands (Dubois *et al.* 1987). Others argue that appropriate cover conditions can be provided by mature stands of any species composition (Widen 1989; Squires and Ruggiero 1996) as long as sufficient canopy cover exists to protect young from predation and conceal foraging adults from prey (Hennessy 1978; Forsman 1980; Moore 1980; Shuster 1980; Hall 1982; McCarthy *et al.* 1987; Crocker-Bedford and Chaney 1988; Hayward and Escano 1989;





## ***Northern Goshawk HSM***

Warren *et al.* 1989; Squires and Ruggiero 1996). While the birds may build nests in forests with canopy closure of as little as 40%, denser canopies (>80%) are preferred (Hennessy 1978; Forsman 1980; Moore 1980; Shuster 1980; Hall 1982; Crocker-Bedford and Chaney 1988; Hayward and Escano 1989; McCarthy *et al.* 1987; Warren *et al.* 1989).

A review of literature surrounding the goshawk revealed that optimal nesting sites contain a selection of large (> 20 cm dbh is acceptable and > 40 cm dbh is optimal) trees (Mannan and Meslow 1984; Schaeffer 1995; Squires and Ruggiero 1996) within dense mixedwood stands (Semenchuk 1992; Schaffer 1995). In fact, Squires and Ruggiero (1996) have noted that in Wyoming, the birds select the largest trees available in the stand as nest sites. Large trees are sufficiently strong to hold the weight of the nest and likely have well-developed canopies to shelter both the nest and the adult birds as they forage. Deciduous trees commonly develop forked structures (Squires and Ruggiero 1996). It is thought that this may be the reason that deciduous trees are used as nesting sites. It has been recommended that a minimum of six deciduous (Speiser and Bosakowski 1987) trees per ha of dbh > 20 cm, but preferably > 40 cm, be maintained as nest trees (Schaffer 1995).

Research suggests that the birds tend to build nests less than 400 m (Todd 1991) from a small (0.04 to 0.4 ha) forest opening (Godfrey 1986; Semenchuk 1992), gap in the canopy, or woodland trail (Schaffer 1998). It has been suggested that proximity to these small gaps may be important to the birds as they provide flyways. Alternatively, Doyle (pers. comm. 1999) suggested that the perceived goshawk preference for proximity to gaps may be an artefact of sampling error, as people may be more likely to identify stick nests in small clearings or while walking along trails.

The important components of goshawk nesting habitat are:

- ◆ Deciduous-dominated stands;
- ◆ Large trees with forked structure; and
- ◆ Canopy closure of at least 40% but preferably > 80%.

## **2.4 Habitat Area Requirements**

Information pertaining to the home range size of the Northern Goshawk in Alberta is lacking. To effectively protect Northern Goshawk habitat, radio-telemetry methods must be employed to collect baseline data on the size of a home range and the stand types encompassed within it (Schaffer 1998).

There is thought to be an inverse relationship between the size of a Northern Goshawk's home range and habitat quality. The best habitat can support as many as 1.1 nesting pairs per 1,000 ha of forest (Crocker-Bedford 1990), though this density estimate is considered by some to be higher than optimal. Alternatively, one family may require as much as 5,700 ha of forested land to successfully perform their daily activities during the winter months or in substandard habitat (Widen 1989).

In mature forests (Kochert 1986), the nesting site is about 12 ha in size (Reynolds *et al.* 1992a; Reynolds *et al.* 1992b). Within a home range, there are typically two to four alternative, suitable nest sites (Reynolds *et al.* 1992a; Reynolds *et al.* 1992b), which makes the optimal area of suitable nesting zones 48 ha. The territory used once the young have left the nest but remain in the parents' home range is referred to as the post-fledging family area (Reynolds *et al.* 1992a; Reynolds *et al.* 1992b; St. Clair 1992). This area may be up to 2,000 ha in size (Reynolds 1983) and must contain excellent quality foraging habitat (Reynolds *et al.* 1992a; Reynolds *et al.* 1992b) as the food requirement of the young goshawks is high (Newton 1976; Ward and Kennedy 1996).



## **2.5 Landscape Configuration Requirements**

It has been suggested by Schaffer (pers. comm. 1999) that future research efforts should be directed at determining the placement of goshawk nest sites with respect to other landscape features such as water bodies, roadways, and different types of clearings. In addition, work must be done to discover the macrohabitat characteristics most influential in goshawk habitat selection (stand composition, interspersions of stand types, area and shape of habitat patches, Schaffer 1998).

The presence of streams, trails, and small natural clearings may be important due to the supposed desire of the goshawk to build nests near natural paths of flight (Godfrey 1986; Semenchuk 1992). Since this idea has not yet been confirmed and did not receive support from goshawk researchers in western Canada, it will not be considered further in this HSM.

## **2.6 Sensitivity to Human Disturbance**

It is thought that Northern Goshawks are sensitive to timber harvesting (Crocker-Bedford 1990), forest fragmentation (Erdman *et al.* 1998), and human disturbance around the nesting site (LeFranc and Millisap 1984). In fact, loud human voices can be enough to keep hawks from their nests and even short absence can lead to loss of eggs or nestlings to predation (Call 1979). In addition, it has been shown that the birds experience limited breeding success when human activities are carried out in the vicinity during this sensitive time (Reynolds *et al.* 1992b; Kennedy and Stahlecker 1993). In areas where human activities were not sufficiently restricted around nests, the recorded rate of nest occupancy was 75 to 80% lower and nestling production was 94% lower (Crocker-Bedford 1990).

It is recommended that human interference be minimised within at least 50 m of a goshawk nest (Schaffer 1995; Erdman *et al.*

1998). Based on the research of Jones (1979), Richardson and Millar (1997) suggested that it would be preferable to place a buffer of 450 m around Northern Goshawk nests. Reynolds *et al.* (1983) recommended that timber harvesting activities be restricted within the entire ~2,000 ha area used by the hawks for post-fledging foraging during the post-fledging family period while other human activities that do not alter the habitat structure could continue.

### 3.0 MODEL

#### 3.1 Envirogram

Two elements have been identified as potentially important components of Northern Goshawk habitat: the capacity to obtain food and to successfully produce young (Figure 2). Shown in the envirogram below are the forest attributes that are thought to influence the birds' success in achieving these endeavours.

Three features relating to the availability and accessibility of prey have been distinguished as vital elements of suitable foraging habitat: tall trees for use as perches, understory of appropriate density for manoeuvrability, and canopy closure to hide the birds as they search for prey.

To successfully construct stable stick nests, the goshawk must find suitable large-diameter trees. Research in Alberta has shown that the birds typically select relatively closed mixedwood stands for nesting. Within these forests, deciduous trees are commonly chosen as nest trees. In addition, proximity to roads reduces habitat quality.

#### 3.2 Application Boundaries

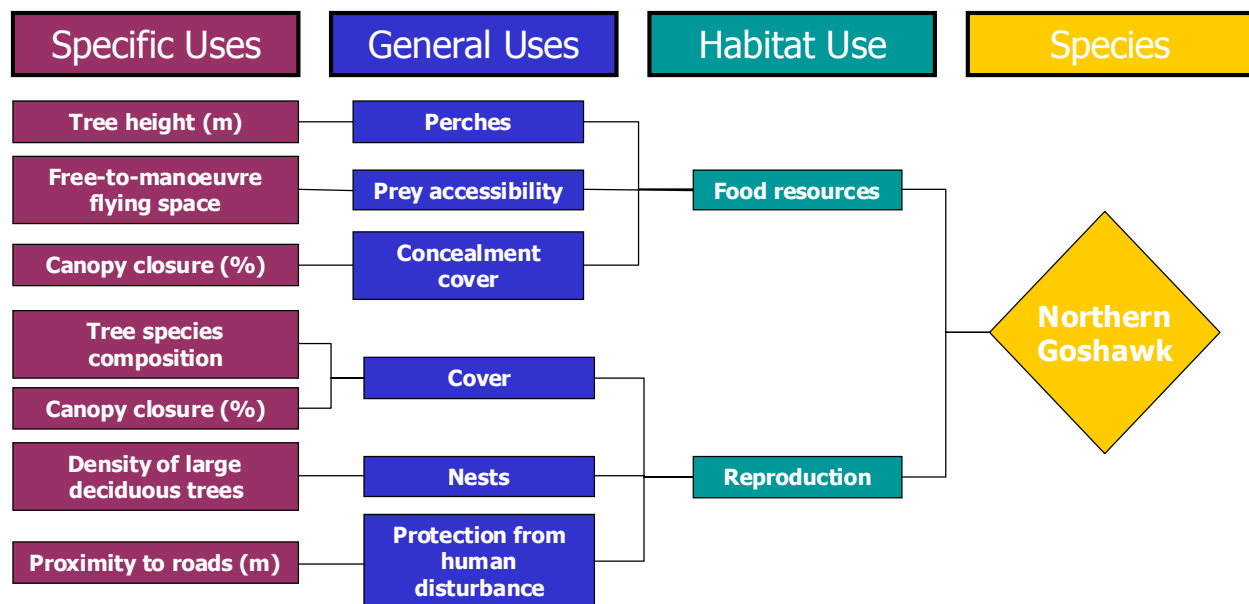
**Season:** This model produces SI values for use during the breeding season and post-fledging family time.

**Habitat Area:** Home range size used for home range smoothing is 2,000 ha for a family.

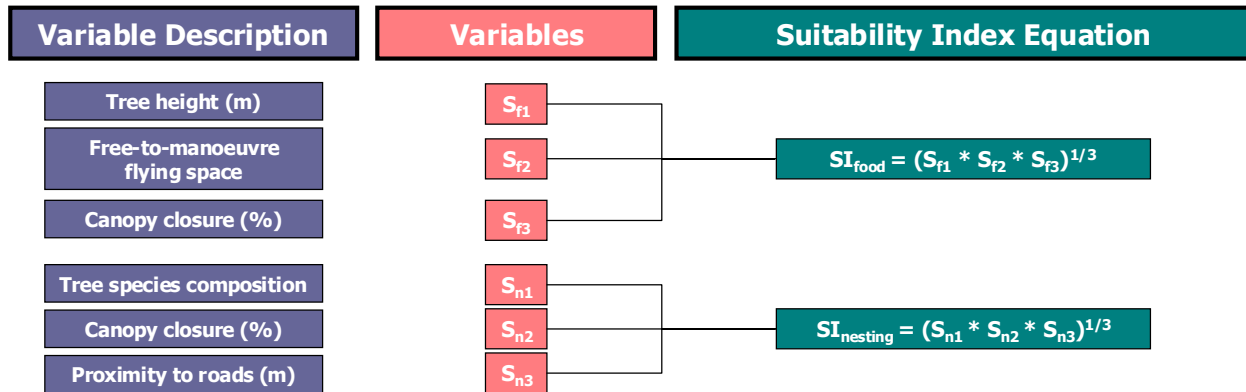
**Model Output:** The model assigns SI values for foraging and nesting habitat suitability to each 25 m pixel of forested habitat.

#### 3.3 Model Description

The HSM for Northern Goshawk habitat follows the structure described in the envirogram (Figure 3). As foraging and nesting habitats are both critical and needed at the same time during the breeding and post-fledging family season, no compensation is allowed between them.



**Figure 2. Envirogram of the Northern Goshawk based on available habitat information for HSM development.**



**Figure 3. HSM structure for the Northern Goshawk within Millar Western’s FMA area.**

The  $SI_{food}$  consists of an evaluation of the stand’s capability to satisfy the bird’s hunting requirements: appropriate manoeuvrability as well as the presence of tall trees for use as perches, and canopy closure for concealment. As all of these variables are required for successful hunting, no compensation is allowed between them.

The  $SI_{nesting}$  consists of the tree species composition and degree of canopy closure of the stand. It also takes into account the proximity of the potential nesting site to roads. Goshawks are likely to find suitable nest sites in large deciduous trees. In particular, trees greater than 40 cm dbh make the best nest sites. As previously mentioned, a density of at least six large deciduous trees per ha will likely suffice. We expect that an appropriate number of nest trees will readily be found in mature hardwood, old hardwood, and old hardwood-dominated mixedwood stands. Goshawks may also be successful in finding nest sites in mature hardwood-dominated mixedwood stands. Research has indicated that the birds seem to prefer mixedwood stands over pure deciduous stands as shelter. In addition, a nesting site is considered most suitable if it is distant from roads.

### 3.4 Habitat Variable SIs

#### Food

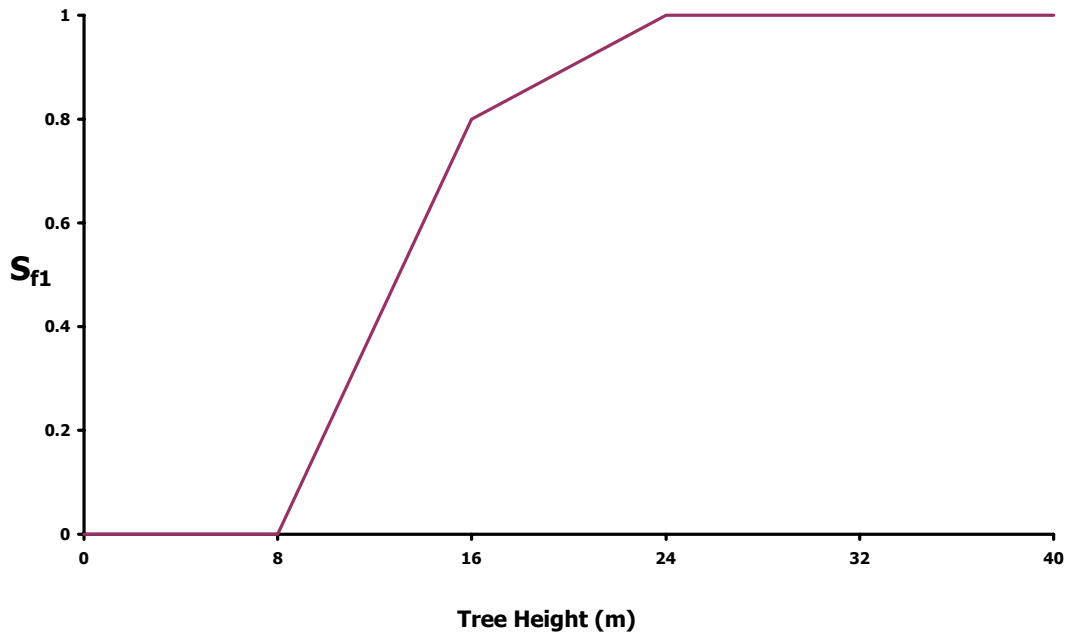
Successful foraging will occur where prey is accessible. The variable,  $S_{f1}$ , considers the goshawks’ need for tall trees or snags as perches by taking into account the average height of the trees in the stand. Although they may inhabit stands of height > 8 m, 16 m mean height is generally preferred by the birds, and > 24 m is considered optimal (Figure 4). Variable  $S_{f2}$ , manoeuvrability, assigns a suitability index of 0.5 for a clear understorey since the competitive pressure exerted on the goshawks by other raptors may result in reduced suitability of the habitat. An entangled understorey is not appropriate for goshawk foraging and, therefore, receives a value of 0 and porous to obstructed habitats, which are considered optimal, are given a value of 1.0 (Figure 5). To hide itself from prey as it hunts, the goshawk requires significant canopy closure ( $S_{f3}$ , Figure 6). In particular, it prefers stands with canopy closure of at least 60%. Suitability declines, however, in stands with > 90% canopy closure.



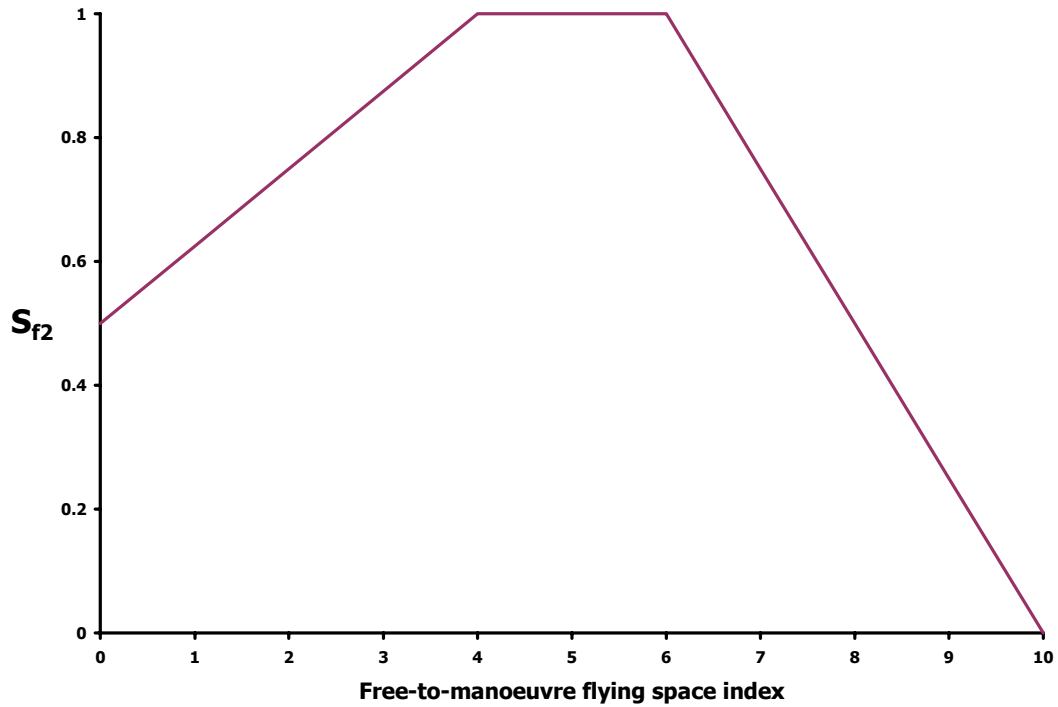
**Nesting**

To successfully reproduce, Northern Goshawks must find trees of suitable size within stands of appropriate cover near good hunting areas, in which to build their nests. The  $SI_{\text{nesting}}$  takes into account the tree species composition of the stand ( $S_{n1}$ ), its canopy closure ( $S_{n2}$ ), and proximity to roads ( $S_{n3}$ ). An appropriate density of suitable nest trees is expected to be found in mature and old hardwood stands and old hardwood-dominated mixedwood stands, and perhaps in mature hardwood-dominated mixedwood stands. Table 1 shows nesting suitability ratings by habitat type. As explained above, Figure 6 displays the relationship between canopy clo-

sure and habitat suitability. Suitability increases with distance from roadways as shown in Figure 7. Since the hawk prefers to nest at least 50 m, but preferably > 400 m, from human activity, the suitability of a potential nest site is reduced with proximity to roadways. Roads with intense traffic are expected to have a more significant influence on nest site suitability. Therefore, highways as well as primary and secondary logging roads within 50 m of the nest site reduce the suitability value to 0 while tertiary roads result in a minor penalty. It is assumed that roads situated further than 400 m of the nest site do not influence suitability.



**Figure 4. Northern Goshawk foraging habitat suitability in relation to tree height within Millar Western’s FMA area.**



**Figure 5. Northern Goshawk foraging habitat suitability in relation to flying space within Millar Western’s FMA area. 0 = clear, 10 = entangled, > 0 and < 10 = porous to obstructed.**

**Table 1. Northern Goshawk nesting habitat suitability ratings, by habitat type.**

Broad	Specific	Opening		Developing		Forest		Old
		Clearcut	Regenerating	Young	Immature	Mature	Old	
Hardwoods	Aspen					0.5		0.5
	Poplar					0.5		0.5
	White birch					0.5		0.5
Hardwood Mixed	Aspen-Pine					0.75		1
	Aspen-White spruce					0.75		1
	Aspen-Black spruce					0.75		1
	Poplar-Pine					0.75		1
	Poplar-White spruce					0.75		1
	Poplar-Black spruce					0.75		1
Softwood Mixed	Pine-Poplar							
	Pine-Aspen							
	White spruce-Poplar							
	White spruce-Aspen							
	Black spruce-Poplar							
	Black spruce-Aspen							
Conifers	Pine							
	White spruce							
	Black spruce							
	Larch							

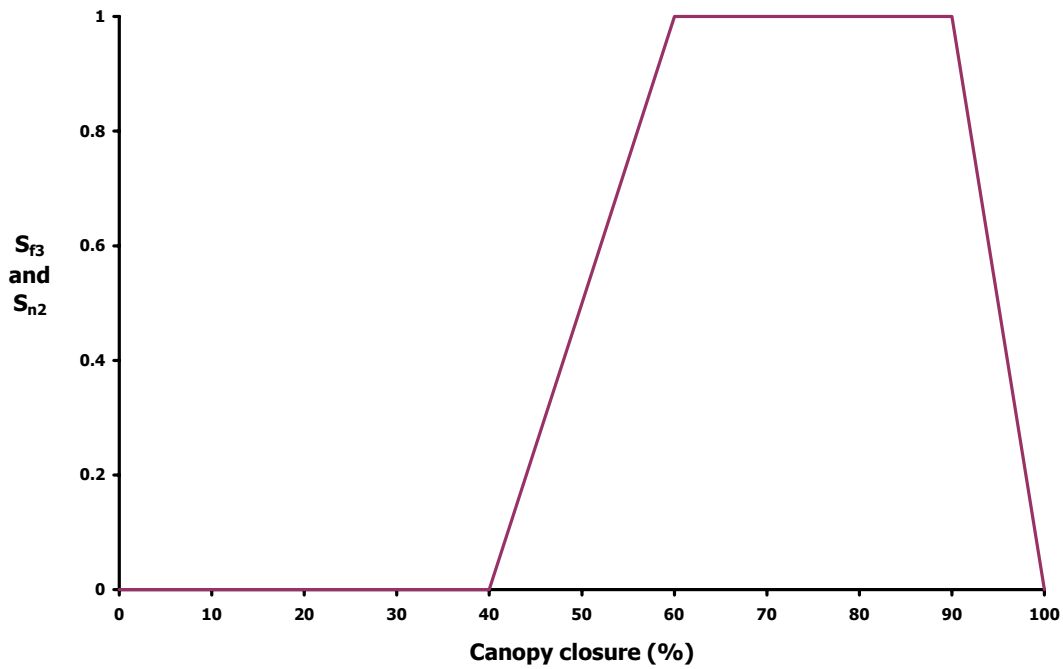


Figure 6. Northern Goshawk foraging and nesting habitat suitability in relation to canopy closure within Millar Western’s FMA area.

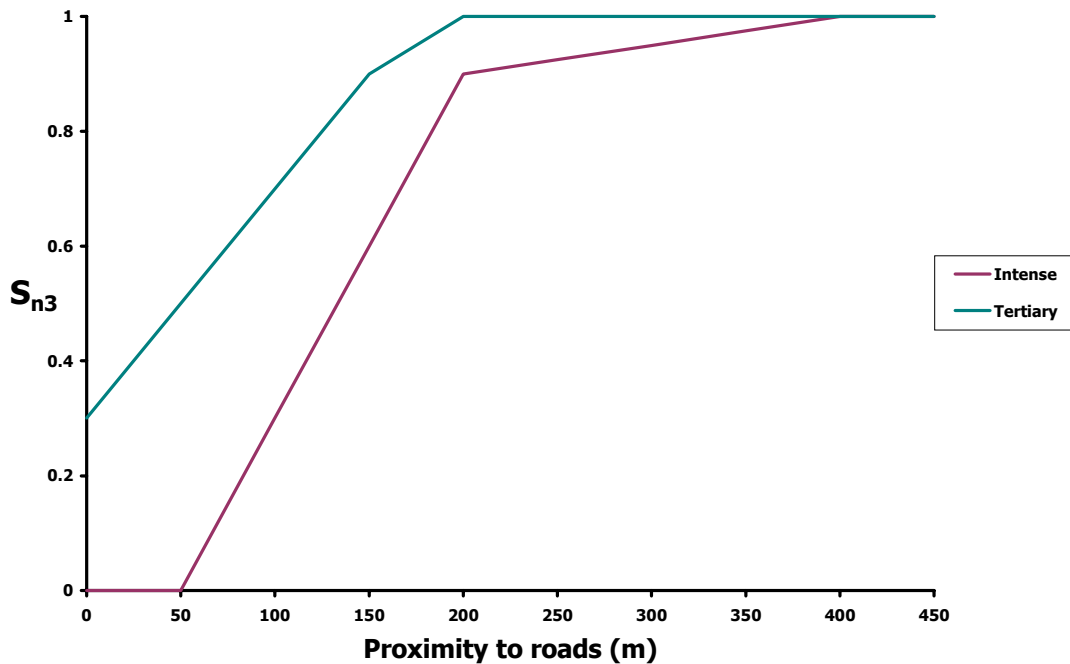


Figure 7. Northern Goshawk nesting habitat suitability in relation to proximity to roads within Millar Western’s FMA area.



### 3.5 Computation

Our goal is to create HSMs that allow the user to identify potential impacts of proposed forest management strategies on foraging and nesting habitats. Therefore, the outputs of the  $SI_{\text{food}}$  and  $SI_{\text{nesting}}$  calculations are considered individually to display trends in habitat availability.

#### **Foraging Habitat Index**

The ability of each pixel of forested habitat to provide foraging opportunities is measured. The following equation is solved for each pixel:

$$SI_{\text{food}} = (S_{f1} * S_{f2} * S_{f3})^{1/3}$$

#### **Nesting Habitat Index**

One of the variables,  $S_{n3}$ , included in  $SI_{\text{nesting}}$  requires calculation of the distance of each pixel from roadways of varying intensity. To apply a suitability rating for this variable to each pixel, all roads are buffered to a distance of 400 m. Each pixel within the buffer receives a suitability rating based on the distance-dependent relationship shown in Figure 7. All pixels outside of the buffered areas receive a suitability rating of 1.

The value of each pixel as nesting habitat is then assessed by the following equation:

$$SI_{\text{nesting}} = (S_{n1} * S_{n2} * S_{n3})^{1/3}$$

Since the hawks require nesting sites of at least 12 ha in size, the  $SI_{\text{nesting}}$  values are averaged within a moving window of 12 ha. In this way, each pixel is given a suitability rating for nesting that takes into account the suitability of the surrounding 12 ha of habitat. A home range generally contains a number of alternate nesting sites. These sites should not be too close together since the birds may be required to move to another site if the first becomes disturbed. We estimate that nesting sites should be at least 500 m apart for the birds to be offered viable nesting options in the face of disturbance. To identify potentially suitable nesting sites, the FMA area

is divided into non-overlapping squares of length 500 m. The maximum  $SI_{\text{nesting}}$  value within each square is found. These are considered the best nesting sites located an acceptable distance apart.

#### **Home Range Smoothing**

A pair of goshawks use an area of approximately 2,000 ha to forage as they raise their young during post-fledging family time. Because extensive clearings are detrimental to goshawk habitat, contiguous forest is optimal. Therefore, to identify the total value of each potential home range within Millar Western's FMA area as goshawk habitat, the  $SI_{\text{food}}$  and  $SI_{\text{nesting}}$  ratings are averaged within a circle the size of one home range. A circle of radius 2,525 m (2,000 ha) moves over the grid with centres 2,525 m (one full radius) apart. All of the  $SI_{\text{food}}$  ratings are averaged together within the 2,000 ha circle to give an indication of the value of the entire home range as foraging habitat. In addition, since the birds require a choice of nesting sites in case of disturbance, we average the highest four nesting suitability ratings as derived above. This provides an estimate of the suitability of four alternate nesting sites within the home range. The two average values (food and nesting SIs) are applied to the pixel at the centre.





## **4.0 EXTERNAL REVISIONS**

Arlen Todd, wildlife biologist with Alberta Environment, Fisheries and Wildlife Management Division, in Whitecourt, Alberta provided comments on the Northern Goshawk model on May 27, 1999. He emphasized the following points as topics to be further researched:

- 1) The original model suggested that open areas were beneficial to Northern Goshawks as foraging habitat. Arlen Todd stated that he believes we have misinterpreted the literature and that we should reassess the suitability of open areas.

Frank Doyle, of Wildlife Dynamics Consulting in Telkwa, British Columbia, reviewed a draft of the Northern Goshawk HSM and provided comments on June 18, 1999. Based on his comments, the following alterations were made:

- 1) Doyle was concerned that we had made relatively strong statements regarding Northern Goshawk habitat preferences without equally strong supporting data. In particular, he mentioned that much of the cited literature may have no relevance to Millar Western's FMA area. Wording was altered to ensure the reader would understand the lack of empirical data available on Northern Goshawks in west-central Alberta.
- 2) Doyle suggested that models cannot be built on anecdotal evidence. Radio tracking is required.
- 3) The original model suggested that the edge habitat between clearcuts and mature forest may be beneficial as Northern Goshawk foraging habitat. Like Todd, Doyle believed that the evidence referenced was 'anecdotal at best'. In addition, he suggested that the apparent tendency of Northern Goshawks to nest close to narrow clearings may be an artefact of sampling error since researchers may simply be more likely to notice a nest when walking along a trail.

- 4) Doyle recommended that the cover SI equation be removed from the model since the habitat features relevant to it are included in the foraging and nesting SI equation. This advice was followed.

Warren Schaffer, biologist with Merlin Ecological Consultants, reviewed a draft of the Northern Goshawk model on June 3, 1999. The following changes were made, following his advice:

- 1) Schaffer pointed out some prey species erroneously included in the foraging requirements section of the model. These were removed in the next draft.
- 2) Additional references were provided that highlight the importance of understorey clearance to Northern Goshawk foraging success.
- 3) Schaffer mentioned that Northern Goshawks are commonly subject to predation by Great Horned Owls in clearings. This note was included in the literature review.



## **5.0 LITERATURE CITED**

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