THREE-TOED WOODPECKER

(Picoides tridactylus)

Source: Salt and Salt (1976)

Prepared for Millar Western Forest Products' Biodiversity Assessment Project

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1.0 CONSERVATION AND THE EFFECT OF FOREST ACTIVITIES

1.1 Introduction

The Three-toed Woodpecker (*Picoides tridactylus*) is considered a rare and inconspicuous but year-round member of the bird community throughout its range (Bock and Bock 1974; Semenchuk 1992; Cyr and Alvo 1995). It breeds in northern Canada, the northeastern United States, and through the Rocky Mountains (Figure 1, Semenchuk 1992; Zapisocki *et al.* 1995). The subspecies found in Alberta, *P. t. fasciatus*, is uncommon and its current status is not known (Semenchuk 1992).

The number of toes on its feet and the white bars on its dorsal side can distinguish the Three-toed Woodpecker from other woodpeckers (Semenchuk 1992; Cyr and Alvo 1995). Its morphology promotes efficient foraging activity as its odd number of toes allows it to effectively dig out wood-boring insect larvae from beneath the bark of trees (Bock and Bock 1974).

The Three-toed Woodpecker inhabits mature to old coniferous or coniferous-dominated forests (Steeger and Dulisse 1997a; Steeger and Dulisse 1997b; Wells *et al.* 1999) but will quickly populate open areas such as burns or clearcuts if a sufficient supply of insects is present (Gauthier and Guillemette 1991; Semenchuk 1992; Zapisocki *et al.* 1995). It has a definite preference for spruce or lodgepole pine forests (Bock and Bock 1974; Semenchuk 1992; Cyr and Alvo 1995; Wells *et al.* 1999). Within these stands, it selects dead or dying coniferous trees for both foraging and nesting activities (Godfrey 1986; Semenchuk 1992; Villard 1994; Cyr and Alvo 1995; Steeger and Dulisse 1997a; Steeger and Dulisse 1997b; Wells *et al.* 1999).

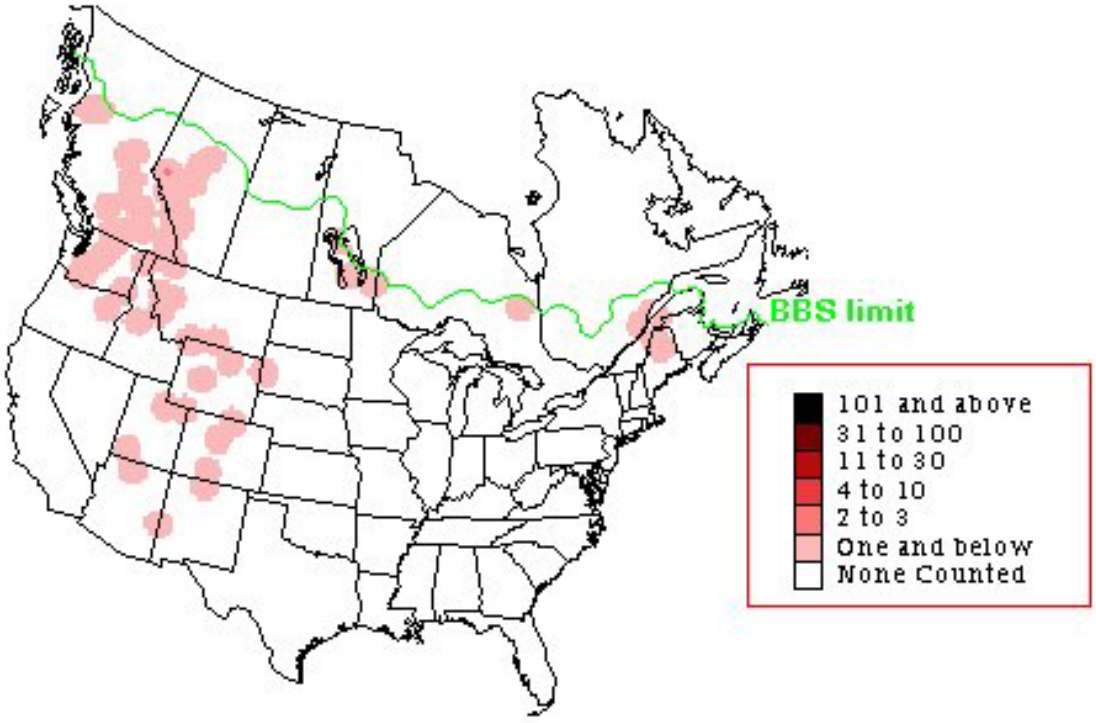

Figure 1. Breeding distribution of the Three-toed Woodpecker in North America, BBS data (Gough *et al.* 1998).

The Three-toed Woodpecker plays two important ecological roles in the forest. It is both a primary cavity-nester and a significant predator of wood-boring insects. The bird excavates its own nesting holes in partially decayed wood. Abandoned cavities subsequently provide nest or den sites for secondary cavity-nesting birds and mammals. As it scales the bark from dead or dying conifers, it exposes its principal food source, the larvae of wood-boring insects (Gauthier and Guillemette 1991; Semenchuk 1992). Since these birds are the most significant predators of bark beetles in North America (Steeger *et al.* 1998), the woodpecker guild is thought to contribute strongly to natural regulation of beetle populations (Steeger and Dulisse 1997b).

1.2 Effects of Forest Management Activities

Forest activities may jeopardise Three-toed Woodpecker habitat if managers do not take into account the bird's dependence on dead or dying coniferous trees (Godfrey 1986; Semenchuk 1992; Villard 1994; Cyr and Alvo 1995; Steeger and Dulisse 1997a; Wells *et al.* 1999) and on insect-infested trees (Steeger pers. comm. 1999). The removal of snags during forestry operations may limit the potential of the stand to provide woodpecker habitat (Marcot 1983; Scott and Oldemeyer 1983; Goggans 1989; Harestad and Keisker 1989; Loose and Anderson 1995; Steeger and Dulisse 1997a). In fact, research has shown that the local woodpecker population declined by between ~50% (Marcot 1983; Scott and Oldemeyer 1983) and 77% (Loose and Anderson 1995) following timber harvest operations that included snag removal. In addition, only 42.9% (British Columbia, Steeger and Dulisse 1997a) and 55% (Oregon, Goggans 1989) of nesting pairs were able to successfully fledge at least one chick in monitored logged forests. It is thought that this poor nesting success may have been due to snag removal.

Though Loose and Anderson (1995) suggested that, in Wyoming, the birds do not nest in exposed snags since cover is insufficient, this behaviour has been regularly exhibited in British Columbia (Steeger pers. comm. 1999). Steeger (pers. comm. 1999) noted that although the woodpeckers will breed and nest in small clearcuts (< 20 ha), along logging roads, and at the edge of cutblocks, they tend to forage in relatively closed canopy forests. The literature review summarised below did not reveal information on the difference between survival rates of young raised in clearcuts and young raised in closed forests. As discussed in Section 2.3 below, however, this issue may require further investigation.

2.0 HABITAT USE INFORMATION

2.1 Food Requirements

The Three-toed Woodpecker consumes a variety of insects as well as cambium and sap (Semenchuk 1992). In particular, it is the larvae of wood-boring insects of the Orders *Coleoptera* and *Lepidoptera* that constitute a large percentage of its diet (75 to 90%, Bock and Bock 1974; Salt and Salt 1976; Otvos and Stark 1985; Gauthier and Guillemette 1991; Semenchuk 1992; Cyr and Alvo 1995). Since conifers act as hosts to bark beetles, coniferous representation within the stand is important (Steeger and Dulisse 1997a).

During early summer, when the food demand of nestlings is high, the woodpeckers feed on bark beetle larvae that are generally plentiful at that time (Steeger and Dulisse 1997a). During winter, when insects at the tree surface are not as readily available, the birds turn to secondary wood-boring insects (Steeger and Dulisse 1997a) that are found deeper within the bole of the tree (Reid pers. comm. 1999). To access these insects, woodpeckers use subsurface foraging methods including drilling and excavating (Conner 1979; Conner 1981).

The Importance of Snags

The insects preferred by the Three-toed Woodpecker are most abundant in recently dead and dying trees (Reid pers. comm. 1999). Therefore, the bird is attracted to sites offering suitable foraging opportunities, such as overmature stands or areas that have recently been influenced by pest or disease outbreaks, beaver activity, or fire (Bock and Bock 1974; Salt and Salt 1976; Semenchuk 1992; Cyr and Alvo 1995). Evans and Conner (1979) and MacCallum and Ebel (1984) suggested that the food requirements of the Three-toed Woodpecker can be met by a stand that possesses at least one suitable foraging tree per ha. Conversely, research in British Columbia (Steeger, pers. comm. 1999) has shown that the birds sample virtually every tree within their territory and feed from many of them. Steeger suggested that though the presence of ten suitable trees per ha may suffice, more than 25 per ha would best represent optimal foraging habitat.

Characteristics that contribute to a tree's suitability for foraging are dbh, height, species, and degree of decay.

Tree diameter

In general, large trees can support more insects and larvae than smaller trees (Loose and Anderson 1995). As well, larger snags often remain standing for longer periods of time (Bull 1983). However, the abundance of available insects also varies with tree species (Steeger pers. comm. 1999) and with degree of decay (Reid pers. comm. 1999). Tree or snag dbh must be at least 10 cm to provide the woodpecker with a suitable foraging substrate. They will better serve the purpose if their dbh is between 25 and 30 cm (Evans and Conner 1979; Gauthier and Guillemette 1991; Loose and Anderson 1995; Steeger and Dulisse 1997a). However, the experience of Steeger (pers. comm. 1999) suggests that Three-toed Woodpeckers do not often use trees of dbh greater than 30 cm. The rate of use of foraging trees tends to decline as dbh increases greater than 30 cm.

Tree height

Observation by Steeger (pers. comm. 1999) suggested that Three-toed Woodpeckers will feed both at high and low positions on a tree trunk depending on the habitat preference of the target insect species. He recommended that taller trees are better for foraging as birds are given the opportunity to select their preferred foraging height.

Tree species composition

Since dead or dying spruce, pine, or fir trees are the preferred foraging sites, their presence in the stand is important (Villard 1994; Steeger and Dulisse 1997a). While at least 25% spruce, pine, and/or fir representation is thought to be required for Three-toed Woodpecker habitation, the species is most commonly found in stands of at least 50% spruce, pine, and/or fir (Zapisocki *et al.* 1995).

Degree of decay

Research by Steeger and Dulisse (1997a) in British Columbia revealed that most foraging activity occurs in trees that are either diseased or that have recently died. This result received support from the experience of Reid (pers. comm. 1999) who also noted that both bark beetles and other wood-boring insects prefer recently dead trees.

2.2 Cover Requirements

Three-toed Woodpeckers tend to be found in mature to old coniferous-dominated forests (Bock and Bock 1974; Salt and Salt 1976; Godfrey 1986; Steeger and Dulisse 1997a; Steeger *et al.* 1998; Wells *et al.* 1999). Though they are thought to have the ability to nest in a variety of coniferous-dominated habitat types, including both closed forest and clearcuts, they normally forage in stands with greater than 50% canopy closure. Relatively closed stands are chosen since bark beetle abundance is high and energetic efficiency of foraging (numerous trees existing in proximity to each other) is maximised (Steeger pers. comm. 1999).

Habitat preference studies by Bock and Bock (1974) have shown that the birds use spruce-dominated forests most often (39% of observations), but also nest in fir or pine forests (13% each), stands supporting other conifer species (7%), deciduous stands (9%), burned forests (9%), and dead stands (9%). The use of dead and burned stands is ordinarily considered a feeding response to the associated insect outbreaks (Blackford 1955; Bock and Bock 1974).

The Three-toed Woodpecker excavates cavities within recently dead or dying trees for use during the nesting season but also for year-round shelter from inclement weather conditions (Zapisocki *et al.* 1995). The suitability of a tree for cavity creation varies with dbh, height, and degree of heartwood decay (McClelland and Frissell 1975; Mannan *et al.* 1980; Scott and Oldemeyer 1983; Raphael and White 1983; Schreiber and de Calesta 1992). It has been recommended that suitable cover habitat should have at least three nest/shelter trees present per ha (Steeger pers. comm. 1999).

Tree diameter

For the woodpecker to create a cavity of suitable size, the tree must be of sufficient dbh. Research suggests that the density of Three-toed Woodpecker populations is greatest in older forests (Mannan *et al*. 1980), which is likely due to the greater proportion of large snags present in older stands (Bull 1983). Suitable nesting trees must be at least 15 cm in dbh but will preferably exceed 30 cm dbh (Evans and Conner 1979; Gauthier and Guillemette 1991; Cyr and Alvo 1995; Loose and Anderson 1995; Steeger pers. comm. 1999).

Tree height

Observations have shown that the height of Three-toed Woodpecker nests range from 1 to 24 m above the ground (Cyr and Alvo 1995). In British Columbia, the average nest height was 5.2 m above ground (Steeger and Dulisse 1997a). Evans and Conner (1979) suggested that suitable snag trees of 4 to 12 m height should be retained as woodpecker nesting sites. Based on personal experience, Steeger (pers. comm. 1999) recommended that suitable nesting trees of > 20 m height should be allocated for Three-toed Woodpecker use.

Heartrot

Considerable energy is expended excavating a cavity nest. The work is less intensive when cavities are created in trees with some internal decay (McClelland and Frissell 1975; Conner *et al*. 1976; Harestad and Keisker 1989; Welsh and Capen 1992). Decay should not be so advanced, however, that the wood can not hold the shape of the nest (Conner *et al*. 1976). Research by Bull (1983) has shown that 87% of Three-toed Woodpeckers nest in snags with broken tops. Most of these nests were seen within 2 m of the top of the tree, closest to the break. As broken trees are far more susceptible to heartwood rotting fungus than are intact trees, broken snags are probably easier to excavate (Bull 1983).

2.3 Reproduction Requirements

The breeding season begins in mid- to late April with courtship (Goggans 1989). The male, perched on the side of a coniferous snag (Cunningham *et al*. 1980), drums in an attempt to attract a mate (Cyr and Alvo 1995). Three-toed Woodpecker pairs are generally monogamous and will stay together for the season and possibly for several consecutive years (Cyr and Alvo 1995).

In mid-May, Three-toed Woodpeckers will excavate an average of three cavities per pair (Goggans 1989) to provide them with nesting and over-wintering sites for the year (Goggans 1989; Cyr and Alvo 1995). Alternatively, they may elect to re-use cavities from previous years (Steeger pers. comm. 1999).

The female will lay between three to five eggs per year (Salt and Salt 1976; Steeger and Dulisse 1997a). Duties relating to the incubation of the eggs and care of the young are shared by the male and female (Cyr and Alvo 1995). Family cohesion remains strong well into the summer (Godfrey 1986).

The behaviour of chicks as they wait in the cavity nest for food tends to attract predators. Nestlings become increasingly loud with age and predators have, on occasion, been observed to take all of the young from within the cavity (Steeger and Dulisse 1997a). Though the literature review did not uncover any published evidence that the rate of predation on young in clearcuts is higher than that on those in closed forests, this is thought to be a factor worthy of consideration. Monitoring efforts for the Three-toed Woodpecker should include an analysis of the relationship between forest cover condition and survival rate of the young. If it is found that more young birds survive to maturity when hatched in closed canopy forest, a variable indicating canopy closure should be added to the nesting suitability index at that time.

2.4 Habitat Area Requirements

Although there is no information available on the breeding densities of Three-toed Woodpeckers in Alberta, observations in Washington and Oregon have found densities of 2.3 to 3.2 pairs per km^2 (Zapisocki *et al.* 1995). These breeding densities translate into a territory of 0.3125 km^2 or ~30 ha per pair (Cyr and Alvo, 1995; Zapisocki *et al.* 1995).

2.5 Landscape Configuration Requirements

Optimal habitat for the Three-toed Woodpecker has the following characteristics:

- Spruce-, pine-, or fir-dominated (at least 25% but preferably > 50%);
- Foraging tree density of one to 25 per ha;
- Nesting/shelter tree density of one to three per ha;
- Canopy closure at least 5% but prefer ably > 50% in foraging areas (50% of territory) and;
- At least 30 ha suitable habitat.

The Three-toed Woodpecker is known to quickly take advantage of situations in which abundant insect populations become available. With sophisticated fire suppression and insect control technology now in place to limit these outbreaks within Millar Western's FMA area, it will not be possible to predict the occurrence of these disturbance events nor to explicitly model the woodpecker's response to them.

2.6 Sensitivity to Human Disturbance

The Three-toed Woodpecker is a quiet, solitary bird that seems to be sensitive to human disturbance (Semenchuk 1992). While it is possible to approach an individual within approximately 5 m, moving closer to the bird will cause it to hide itself behind the tree trunk (Cyr and Alvo 1995). Observation by Gibbon (1966) indicated that the Three-toed Woodpecker will nest within 23 m of a well-used logging road. This idea has been confirmed by Steeger (pers. comm. 1999) who has observed that the birds will nest along roadways and at the edges of cutblocks.

3.0 MODEL

3.1 Envirogram

Three elements have been identified as potentially critical for the Three-toed Woodpecker: obtaining food, finding an adequate supply of nest trees, and sheltering itself from inclement environmental conditions and predators. The forest features thought to influence the birds' ability to achieve these objectives are shown in the envirogram below (Figure 2).

The density of large dead, damaged, and diseased trees in the stand is thought to be the most important habitat variable with respect to the provision of appropriate food resources, nesting sites, and shelter from environmental conditions. Therefore, stand-level characteristics, such as the density of dead and dying trees and the percentage of coniferous trees in the stand, as well as the individual tree-level features of height, dbh, and species must all be considered. Additionally, canopy closure is important as it improves both foraging success and energy use efficiency.

3.2 Application Boundaries

Season: The model produces SI values for use year-round.

Habitat Area: Home range size used for home range smoothing is 30 ha.

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

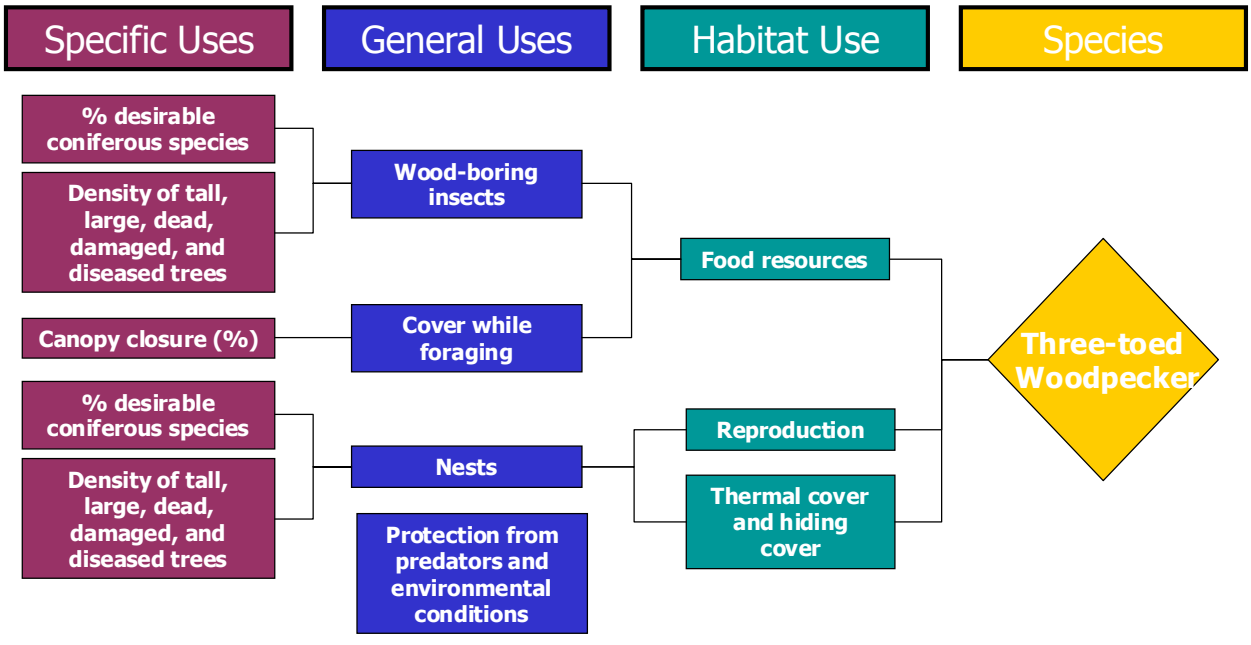

Figure 2. Envirogram of the Three-toed Woodpecker based on available habitat information for HSM development.

3.3 Model Description

The HSM structure for Three-toed Woodpecker year-round habitat follows the envirogram (Figure 3). As both elements are critical and needed at the same time, no compensation is allowed between them.

The SI_{food} takes into account all of the habitat variables necessary for acquiring appropriate food resources: density of suitable dead, damaged, and diseased trees and coniferous representation. In addition, the degree of canopy closure is important. These are non-compensatory variables.

The variables taken into account in $SI_{nesting}$ are density of suitable nesting trees and percentage of coniferous trees within the stand. Since Three-toed Woodpeckers may nest in clearings, the canopy closure variable is not included in this SI. There is no compensation allowed between these two variables.

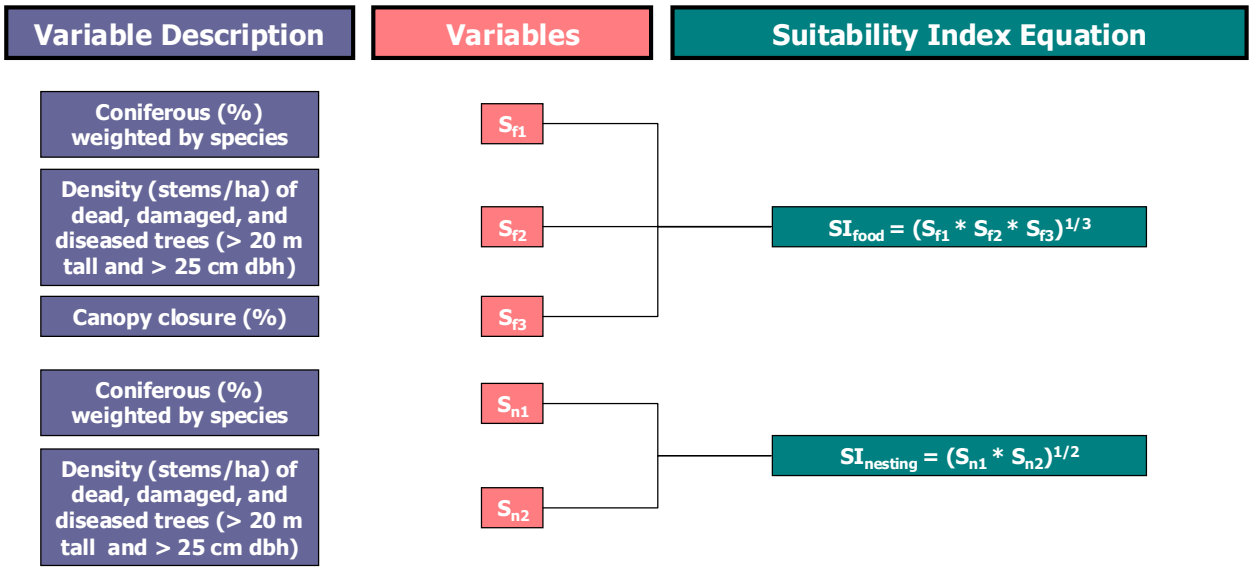

Figure 3. HSM structure for the Three-toed Woodpecker within Millar Western's FMA area.

3.4 Habitat Variable SIs

Food

The first variable included in the SI_{food} is S_{f1}, coniferous representation (Figure 4). Suitability increases linearly from 25%, peaking at 50%. S_{f2} takes into account the density of suitable foraging trees. As previously mentioned, a published estimate of the optimal density of foraging trees is one suitable tree per ha (Evans and Conner 1979; MacCallum and Ebel 1984). Conversely, Steeger (pers. comm. 1999) suggested that at least 25 suitable trees comprise optimal foraging habitat but that ten suitable trees per ha will suffice. We have selected an optimal foraging tree density of ten trees per ha for development of this HSM (Figure 5). This number must be updated as additional Alberta-specific information becomes available. Canopy closure (S_{f3}) must be at least 5% to provide foraging habitat but is best at > 50% cover (Figure 6).

Nesting

As shown in Figure 4 and described above, nesting habitat suitability increases linearly with coniferous representation weighted by species (S_{n1}). Nesting habitat is optimal where at least three suitable nesting trees (S_{n2}) exist per ha (Figure 7).

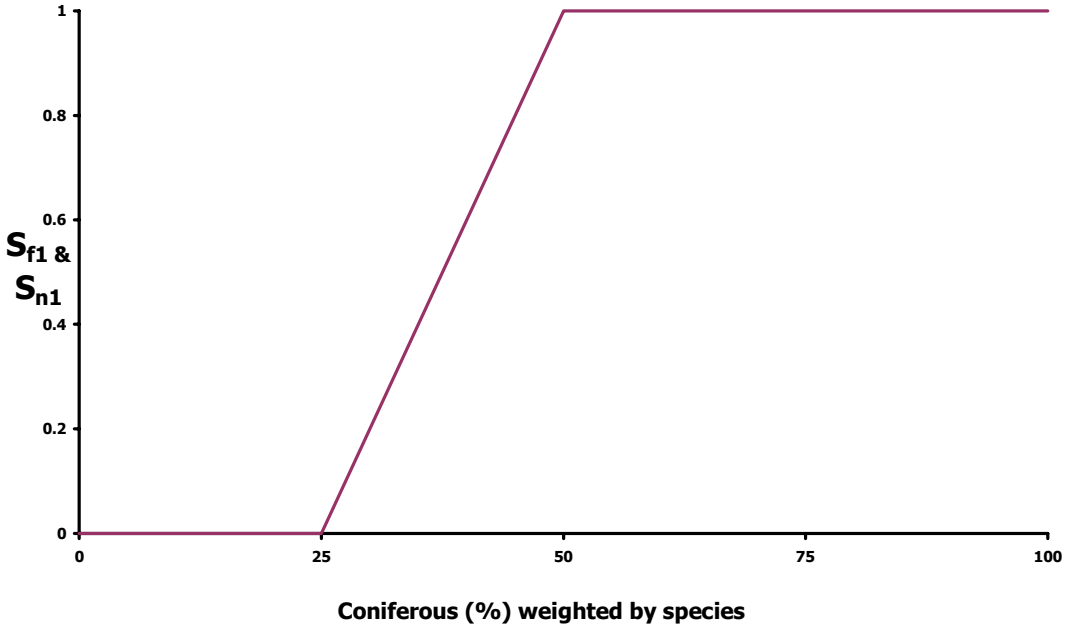

Figure 4. Three-toed Woodpecker foraging habitat suitability in relation to % coniferous representation within Millar Western's FMA area. Weighting: white spruce = 1; pine = 0.8; fir = 0.6; other conifers = 0.4; others = 0.

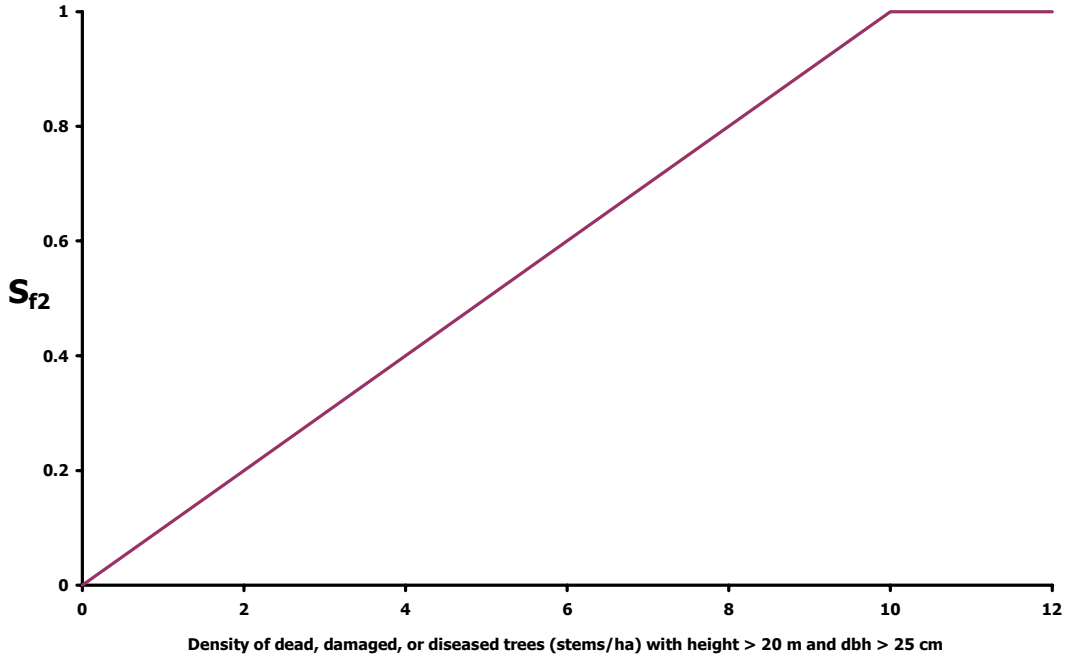

Figure 5. Three-toed Woodpecker foraging habitat suitability in relation to the density of suitable foraging trees per ha within Millar Western's FMA area.

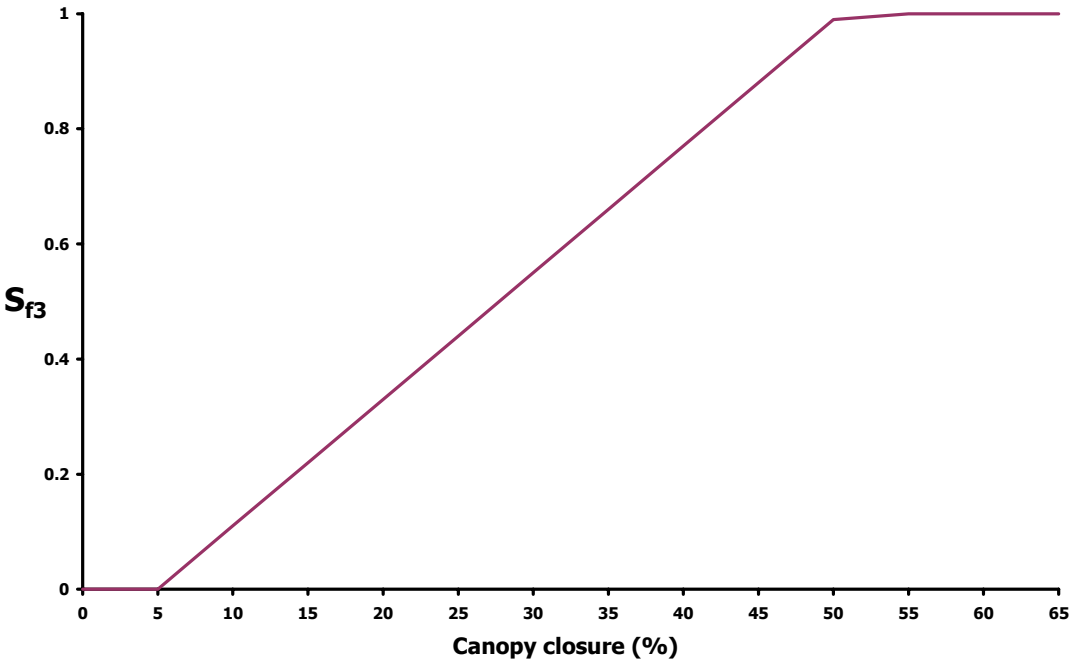

Figure 6. Three-toed Woodpecker foraging habitat suitability in relation to canopy closure within Millar Western's FMA area.

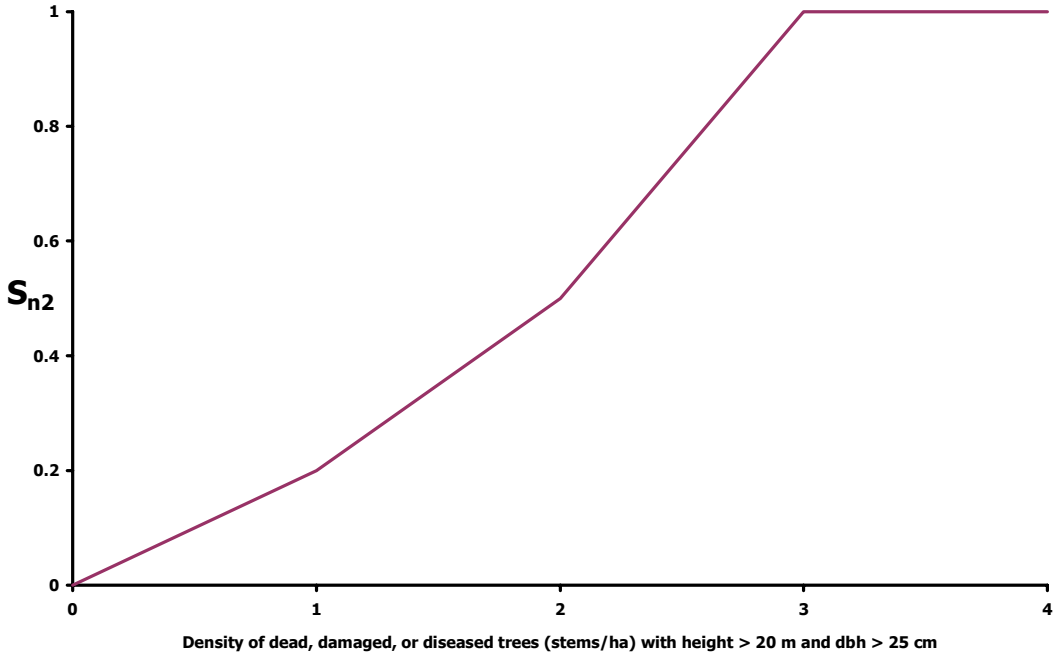

Figure 7. Three-toed Woodpecker nesting habitat suitability in relation to density of suitable nesting trees per ha within Millar Western's FMA area.

3.5 Computation

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

Foraging Habitat Index

Each pixel of forested habitat receives a rating based on its coniferous representation, canopy closure, and density of suitable foraging trees. These variables are brought together in the following equation:

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

Nesting Habitat Index

The quality of each pixel of forested habitat as nesting area is assessed through the equation:

$$SI_{nesting} = (S_{n1} * S_{n2})^{1/2}$$

Home Range Smoothing

The Three-toed Woodpecker will use foraging and nesting habitat within home ranges of 30 ha. As recommended by Steeger (pers. comm. 1999), it is assumed that 50% of the habitat must supply suitable foraging habitat while the other 50% should provide nesting zones.

A circular window of radius 300 m (~28 ha) moves over the grid in such a way that centres are located 300 m (one full radius) apart. The top 50% of the SI_{food} values within the circle are averaged and this value is recorded as the SI_{food} for the pixel at the centre of the circle. Similarly, the top 50% of the $SI_{nesting}$ values within the circle are averaged and the result is applied to the pixel at the centre.

4.0 EXTERNAL REVISION

A draft version of the Three-toed Woodpecker HSM was reviewed by Dr. Mary Reid of the University of Calgary and by Chris Steeger of Pandion Ecological Research in Ymir, British Columbia on June 7, 1999 and June 21, 1999, respectively. Though Dr. Reid does not have a great deal of experience with Three-toed Woodpeckers specifically, her work with bark beetles and other wood-boring insects has given her insight into the suitability of their foraging habitat. Chris Steeger has spent time researching the feeding and nesting requirements of Three-toed Woodpeckers and has published numerous articles on their habitat preferences and the influence of forest management activities on their habitat. The following changes were made from the original document based on their advice:

1) Though the research of Loose and Anderson (1995) had suggested that Three-toed Woodpeckers will nest only in stands with relatively closed canopy but will feed on snags in clearings, Steeger's experience did not support this idea. Since Loose and Anderson's work was done in Wyoming and Steeger's was carried out in the interior of British Columbia, we have chosen to follow Steeger's advice and include the variable of canopy closure with foraging habitat suitability.

2) Both Reid and Steeger suggested that the original SI for snags be broken up into SI_{food} and $SI_{nesting}$.

3) Though some research had shown that only one suitable foraging and nesting tree should be present per ha, Steeger suggested that ten to 25 foraging trees and one to three nesting trees per hectare are needed.

4) Though some sources showed that trees with broken tops would be preferred nesting trees since they were more likely to be rotting and would be easy to excavate, Steeger mentioned that most Three-toed Woodpeckers in his area excavate cavities in whole trees. Additionally, Reid stated that unless Three-toed Woodpeckers feed on downed woody debris (which they do not), older broken snags will not be as valuable to their foraging habitat as we had indicated in the original model. She suggested that disease may be a more predictive variable than stand age. For these reasons, we have removed the trees with broken tops and the stand age variables from the model and have included density of dead, damaged, or diseased trees to include both broken and whole trees of all ages.

5) Steeger's experience and data has helped to refine the SI curves, making them more suitable for western Canada.

6) Some sources had shown that the bark coverage on foraging and nesting trees covered with bark was an indicator of suitability for these purposes. Both Reid and Steeger suggested that this variable be altered or removed since trees with little bark will not contain abundant insect life.

7) Steeger suggested that since the habitat preference of Three-toed Woodpeckers is so variable with geographic location, it is important that Millar Western undertake some local wildlife inventory work for the modelled species.

Arlen Todd, wildlife biologist with the Natural Resources Service, Fisheries and Wildlife Management Division, in Whitecourt, Alberta also reviewed a draft version of the Three-toed Woodpecker HSM on June 18, 1999. He indicated that he had little experience with this species but suggested that it appeared to him that the model was credible.

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