June 1990 FRDA Memo No. 153

Synopsis

Topic Summary for the Operational Forester

Reducing Mammal Damage to Plantations and Juvenile Stands in Young Forests of British Columbia

INTRODUCTION

Animal damage in the forests of British Columbia is caused primarily by herbivorous mammals. Birds contribute to the overall damage problem but less so than mammals. The greatest damage is to seedlings (pre-free-growing) and juvenile stands (post-free-growing). While much of this damage is localized and minor, in some instances mammal damage may have considerable economic significance.

This summary reviews the effects of those mammal species that cause significant feeding damage in coastal forests – deer, elk, and porcupine – and in interior forests – snowshoe hares, red squirrels, and voles. Deer, hares, and voles cause damage in young plantations; hares, squirrels, and porcupines cause damage in juvenile stands. The factors which make plantations and juvenile stands susceptible to damage are identified and measures to reduce damage are recommended.

EFFECTS OF MAMMAL DAMAGE

Feeding damage by mammals can cause mortality of individual trees, and reduction of growth of trees that are not killed. Thus, both stand establishment and composition may be radically altered by a severe outbreak of damage. Sub-lethal injuries may also increase susceptibility of trees to diseases by providing entry courts for fungi and other pathogens.

POPULATION DYNAMICS

In general, most outbreaks of mammal damage may be related to the population fluctuations of a given mammal species. These fluctuations or cycles in numbers of animals may be annual or over several years. For example, the snowshoe hare has a 9- to 10-year cyclic fluctuation in abundance (Fig. 1), whereas various species of voles have 3- to 4-year population fluctuations (Fig. 2). In other situations, favourable conditions for a given mammal species may arise from certain combinations of logging, site preparation, planting practices, predator populations, and weather conditions, or from unsuccessful forest management (e.g., backlog sites). In these cases, populations of certain mammals may increase and result in damage to regeneration efforts.

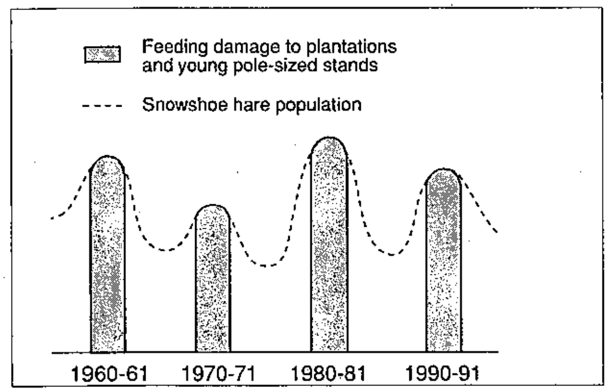

FIGURE 1. Snowshoe hare population cycle.

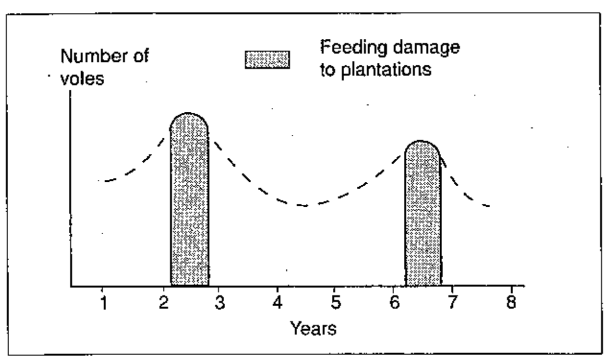

FIGURE 2. Vole population cycle.

SEEDLING DAMAGE

Deer and elk

Impact of damage

Browsing of conifer seedlings by black-tailed deer and Roosevelt elk is the most common type of damage in coastal forests. Browsing of terminal and lateral shoots leaves a ragged, splintered break (Fig. 3). Seedlings may also be uprooted when pulled on by browsing animals. Repeated browsing on seedlings may result in stunted bushy growth (Fig. 4). Bark may also be peeled from the stem by the upward scraping of incisiors (Fig. 5). Toothmarks are usually vertical and approximately 4-6 mm wide. Besides browsing, antler rubbing in the fall may strip bark from the trunk and branches from larger conifers (Fig. 6). Elk are herding animals and may damage trees by trampling.

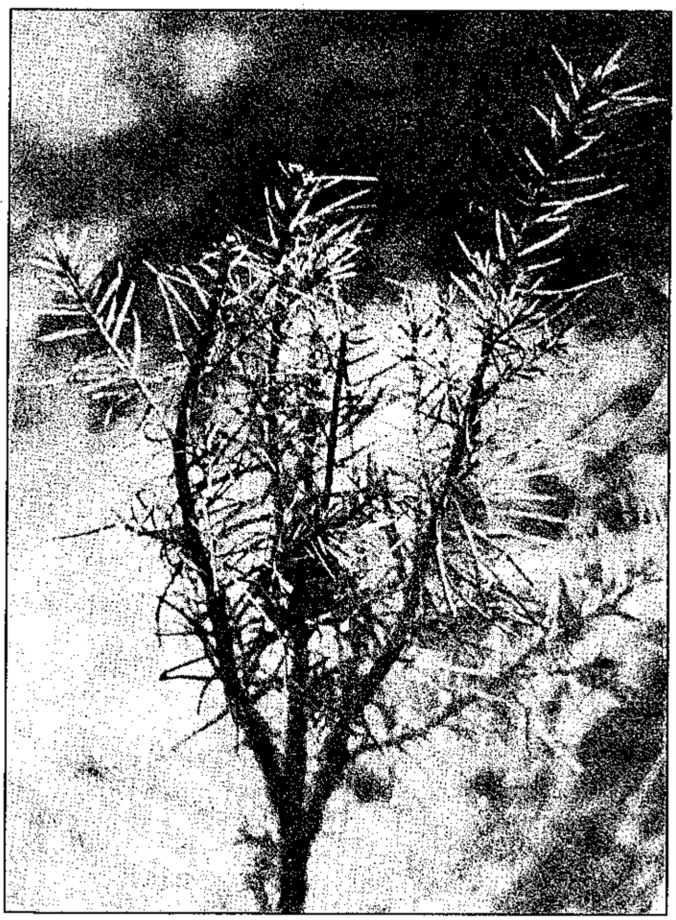

FIGURE 3. Results of deer browsing of Douglas fir seedling.

Deer prefer to feed on Douglas-fir, western redcedar, and yellow-cedar in coastal forests. Western hemlock, Sitka spruce, and grand fir may also be occasionally attacked. Foliage below the level of 1.4 m in height is susceptible. Most damage to seedlings occurs during the winter and early spring when other forage is unavailable. Feeding on seedlings in summer and fall may also occur.

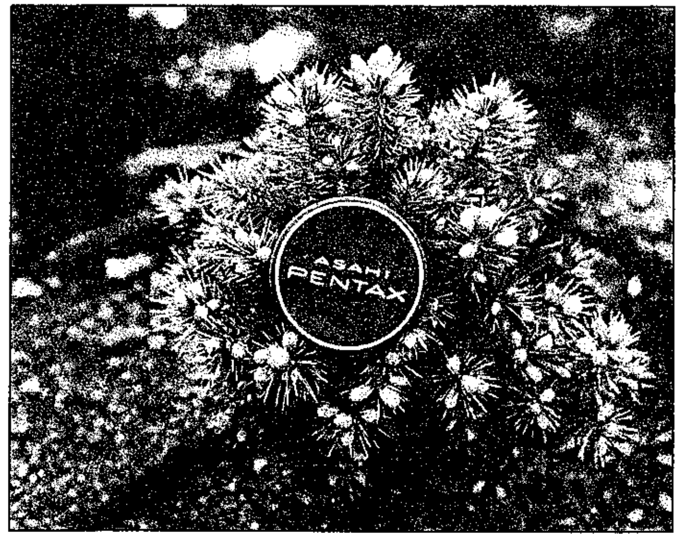

FIGURE 4. Stunted bushy growth resulting from repeated browsing.

Plantations which are **susceptible** to deer damage have one or more of the following attributes:

- small area (< 20 ha);
- improved access for deer because of broadcast burning and mechanical site preparation;
- Douglas-fir, western redcedar, or yellow-cedar present;
- small stock types;
- particular combinations of site quality, aspect, slope, and elevation (e.g., south-facing, low elevation slopes [< 400 m] near winter ranges);
- location in the landscape (i.e., proximity to hiding cover, depending on type of adjacent stands).

Damage reduction

Specific recommendations to reduce damage include:

1. Identify areas with a **high hazard** (e.g., critical wildlife area, winter range, spring/summer range, corridors) before logging (part of PHSP), to adjust harvest plans or to protect future

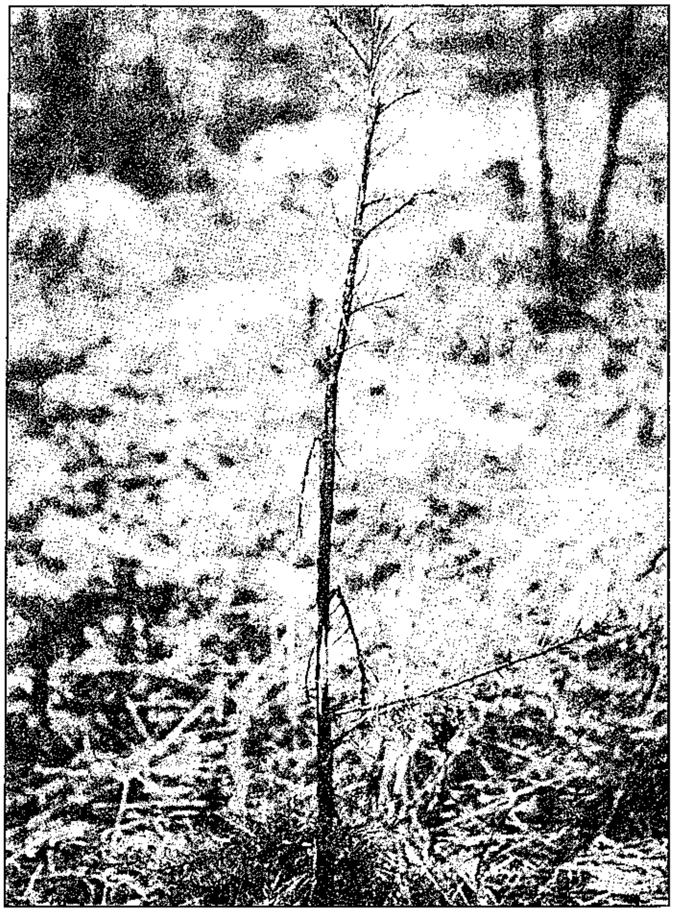

FIGURE 5. Peeling of bark from stem by the upward scraping of incisors.

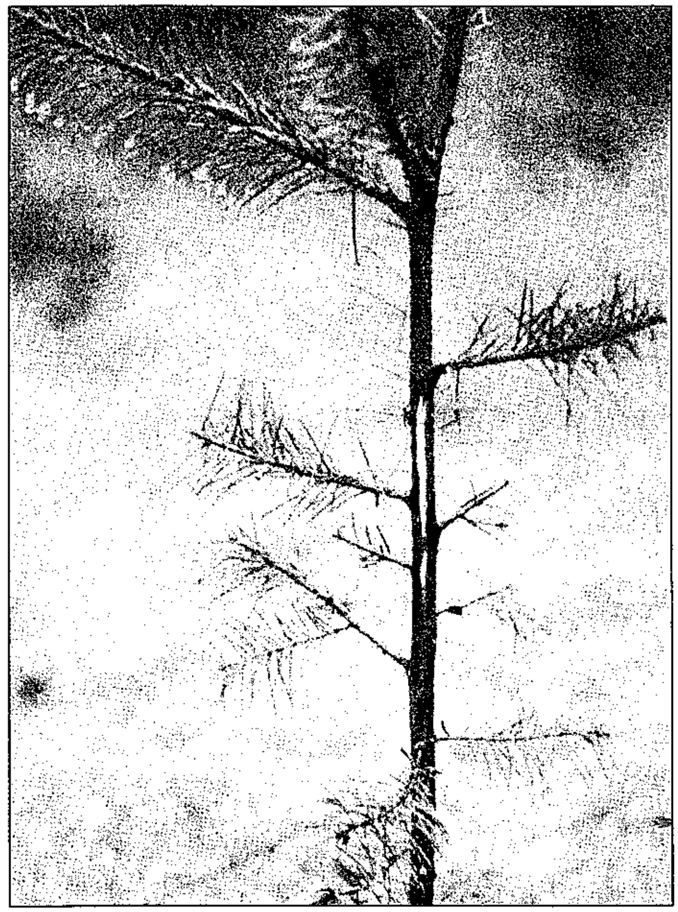

FIGURE 6. Antler rubbing on stem and branches of seedling.

plantations. In some areas, high numbers of deer are the Ministry of Environment management objective.

2. Use mechanical barriers to protect a given plantation (fencing) or individual trees (various netting devices and other obstructions). These methods are expensive, require constant maintenance, and may not be economical over large areas (Table 1).
3. Try commercial repellents (Table 1), but note that they have generally poor durability and efficacy. Biological repellents based on encapsulated predator odours and plant antifeedants are being developed.
4. Plant less-susceptible species (e.g., Sitka spruce, western hemlock) and large stock types (e.g., bareroot, 1+2 plug transplant).
5. Plant seedlings in areas with relatively heavy slash (the result of reduced or minimal site preparation) to obstruct access for deer.
6. Enhance alternative food sources such as trailing blackberry, fireweed, hawkweed, and red huckleberry.
7. Use herbicides for plantation maintenance to enhance tree growth beyond the critical 5-year size threshold. These may also make the habitat less attractive to deer, reducing alternative forage and increasing the susceptibility of conifers to browsing.
8. Increase ungulate harvest or predator pressure within particularly susceptible areas.

In general, an integrated management plan implementing several of the above recommendations will be the best approach to reduce tree mortality and growth losses from browsing. For example, planting large stock may eliminate the need for some vegetation management treatments. Similarly, management of competing vegetation could "push" trees beyond the size susceptibility threshold such that they "escape" damage. In areas where wildlife habitat management is a high priority, lower stocking levels and patchy regeneration may have to be accepted to achieve integrated management objectives.

TABLE 1. Relative costs of mechanical barriers (including maintenance) and repellents for protection of trees from deer

Treatment	Per hectare (900 trees/ha)	Per tree
Fencing	$1,200.00	$1.33
Vexar tubing	549.00	0.61
Reemay sleeves	221.00	0.25
Milk cartons	900.00	1.00
Tubex Tree shelter tubes	2,700.00	3.00
Ropel	153.27	0.17
BGR (Deer Away)	360.00	0.40

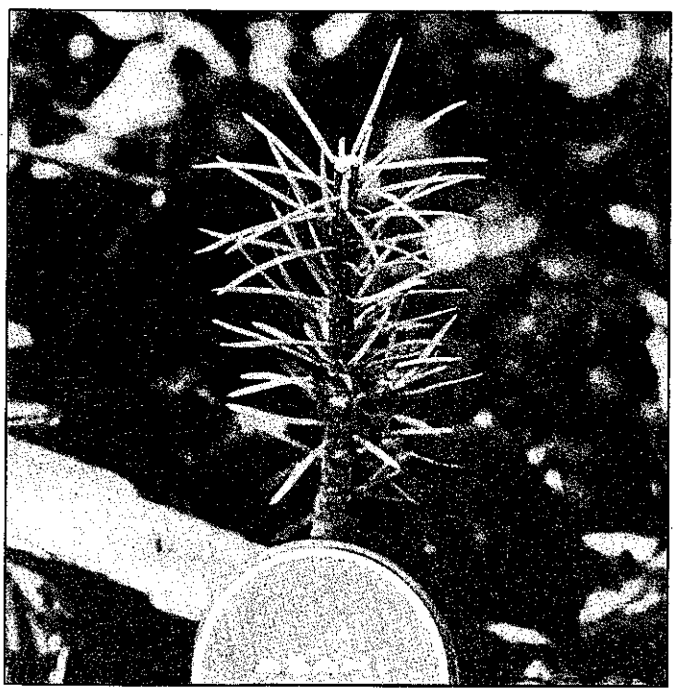

FIGURE 7. Clipping of leader of Douglas-fir by snowshoe hare.

Snowshoe Hare

Impact of damage

Damage to plantations by snowshoe hares has been reported in the interior of British Columbia. Hares damage seedlings during winter by clipping the leader or lateral shoots and this produces a smooth oblique cut (scissor-like) (Figs. 7 and 8). The presence of fecal pellets near damaged trees will also indicate snowshoe hare activity. The extent and economic significance of this browsing damage to reforestation has been clearly shown in Washington and Oregon; however, few surveys have quantified the damage in British Columbia. Feeding damage is usually most severe in those plantations near areas with sufficient cover of deciduous and coniferous species (15-25 years post-logging) to provide suitable habitat (particularly backlog areas) for hares.

Damage reduction

Several management techniques to achieve restocking of conifers in areas susceptible to hare damage include:

1. Plant mainly during the predictable 6- to 7-year period (between peaks) of relatively low hare populations (see Fig. 1).

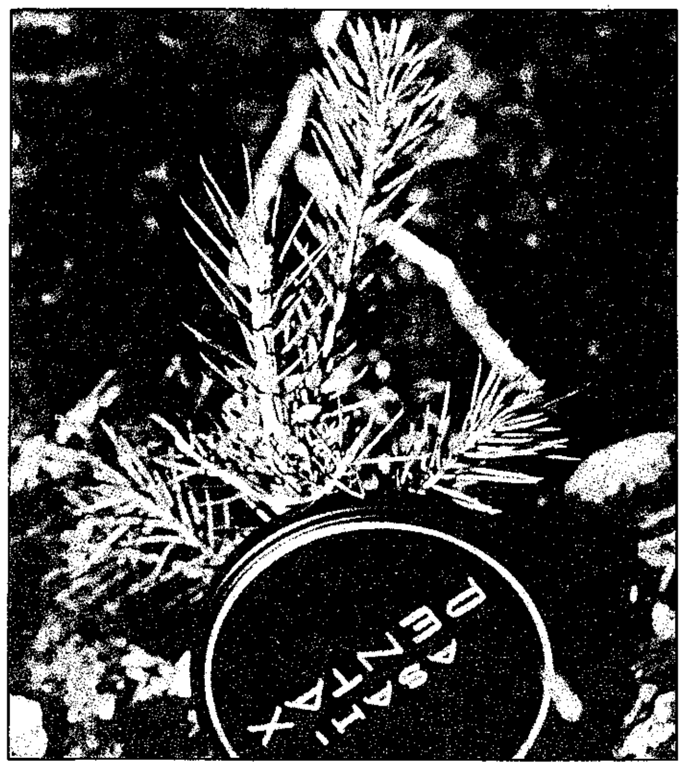

FIGURE 8. Clipping of leader of spruce seedling by snowshoe hare.

2. Use larger stock for planting.
3. Use nursery seedlings with a reduced fertilization regime which may make seedlings less susceptible to severe browsing.
4. Choose tree species according to hare preference for seedlings: Douglas-fir < lodgepole pine < white spruce < subalpine fir.
5. Use mechanical or herbicide treatments to reduce food and cover for hares.
6. Use a repellent system during the 1-3 years when peak populations of hares exist (see Fig. 1).
7. Use mechanical protection with tree guards, as described for deer (Table 1).

These recommendations have not been rigorously tested on an experimental or operational basis, but are designed to obtain sufficient growth to get plantations (particularly of pine and spruce) beyond the stage of critical hare damage. Such trees should probably be at least 2 m in height. Population reduction by poison/shooting/trapping has also received much attention but is not an effective method operationally because of the rapid colonization of depopulated areas by hares and the negative effect on non-target species such as lynx.

Voles

Impact of damage

Plantations in the south coastal region of British Columbia have been damaged by the Townsend vole, and in the northern Interior by the meadow vole, long-tailed vole, red-backed vole, and brown lemming. Voles clip terminal and lateral shoots of small seedlings (Fig. 9). Several cuts usually have to be made to sever the stem and this action leaves a rougher oblique cut than that made by snowshoe hares. Irregular patches of gnawed bark may appear on the lower bole, low branches, root collar, and roots (Fig. 10). Debarking and girdling of larger seedlings also occurs, which leaves a gnawed surface of exposed sapwood (Fig. 11). Indistinct toothmarks usually average 1.5 mm in width and resemble light scratches or small grooves approximately 8 mm long.

Most species of voles have a 2- to 5-year cyclic fluctuation in abundance (see Fig. 2). Seedlings in grass habitats or areas with a heavy shrub or post-harvest slash cover are particularly vulnerable to vole attack. Such habitats are preferred by voles and result in population build-ups. Factors that make plantations in west-central British Columbia susceptible to attack are summarized in Table 2.

FIGURE 9. Clipping of terminal and lateral shoots of lodgepole pine seedling by voles.

TABLE 2. Summary of factors which make plantations in west-central British Columbia susceptible to vole and lemming attack

Factor	Significant	Not significant
Proximity to alpine	+	
Tree species	+ pine > spruce	
Origin	+ planted > natural	
Stock type	+ (pine)	+ (spruce)
Density planted		+
Age of plantation		+
Time since last disturbance		+
Size of block		+
Forest type	+ (spruce-subalpine fir)	
Aspect	+ (N-NE)	
Elevation	+ (>800 m)	
Site preparation	+ unburned > burned	
Vegetation cover		
– young (1-5 years)		+
– older (> 5 years)	+	
Structural complexity of post-harvest debris		
– young	+	
– older	?	

FIGURE 10. Debarking of lower bole of Douglas-fir sapling by voles.

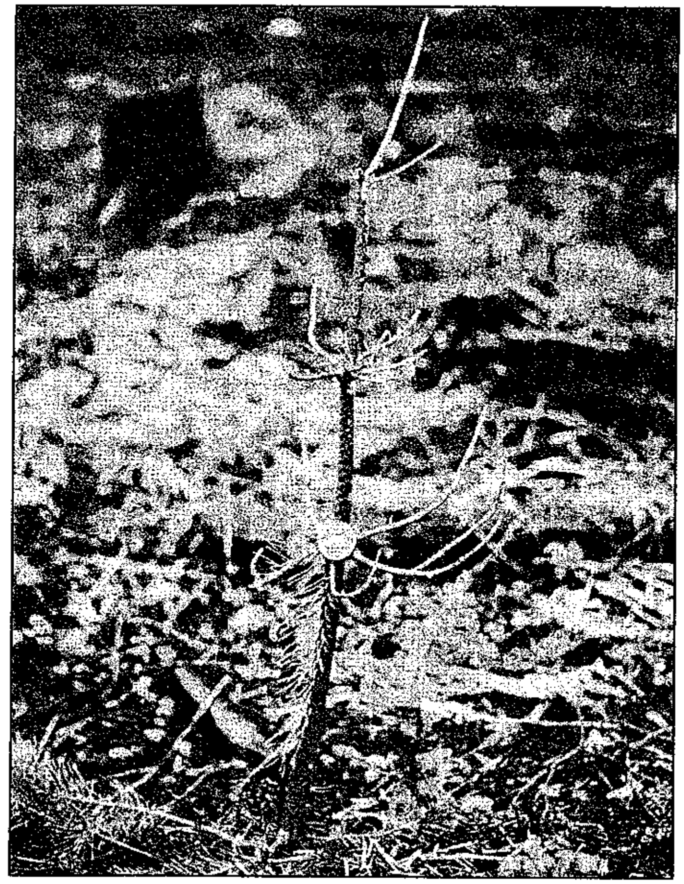

FIGURE 11. Debarking of stem and branches and consumption of needles of lodgepole pine by voles.

Damage reduction

Potential management recommendations to reduce tree damage from voles include:

1. Identify areas with a **high hazard** (see Table 2 and Fig. 12) before logging (part of PHSP), to adjust harvest plans or prepare to protect future plantations accordingly.
2. Control grasses and associated vegetative cover by using herbicides or scarification to prevent population build-ups.
3. Reduce post-harvest debris wherever possible.
4. Use mechanical protection with tree guards, as described for deer. Tree guards must be installed properly and maintained or voles will still have access to trees.
5. Use predator (marten) enhancement by providing habitat diversity for cover, perching, and access to prey populations.
6. Use synthetic predator odour repellents in controlled-release devices to attract predators and repel voles.

The use of toxicants to reduce vole populations has often been used as a means of control. However, the resiliency or recovery of vole populations during peak periods makes depopulation a futile exercise. In addition, there are serious problems with poor bait acceptance, increased resistance to bait formulations, and the hazard to non-target species.

A forecast model to estimate **when** and **where** outbreaks of vole damage to plantations will occur is illustrated in Fig. 12. Since these rodents tend to fluctuate in abundance every 3-4 years, and peak populations of at least the meadow vole and brown lemming presumably occurred in 1986 and 1987, then populations may peak again in 1990-1991.

Plantations which are >5 years old and do not develop a brush problem should "escape" vole damage since the majority of blocks with observed damage were recently planted (1-5 years old). Those plantations with a high degree of vegetation complexity will likely have chronic vole (and possibly snowshoe hare) damage problems; and, thus, damage reduction techniques and strategies become necessary for young susceptible plantations and older plantations with a brush problem.

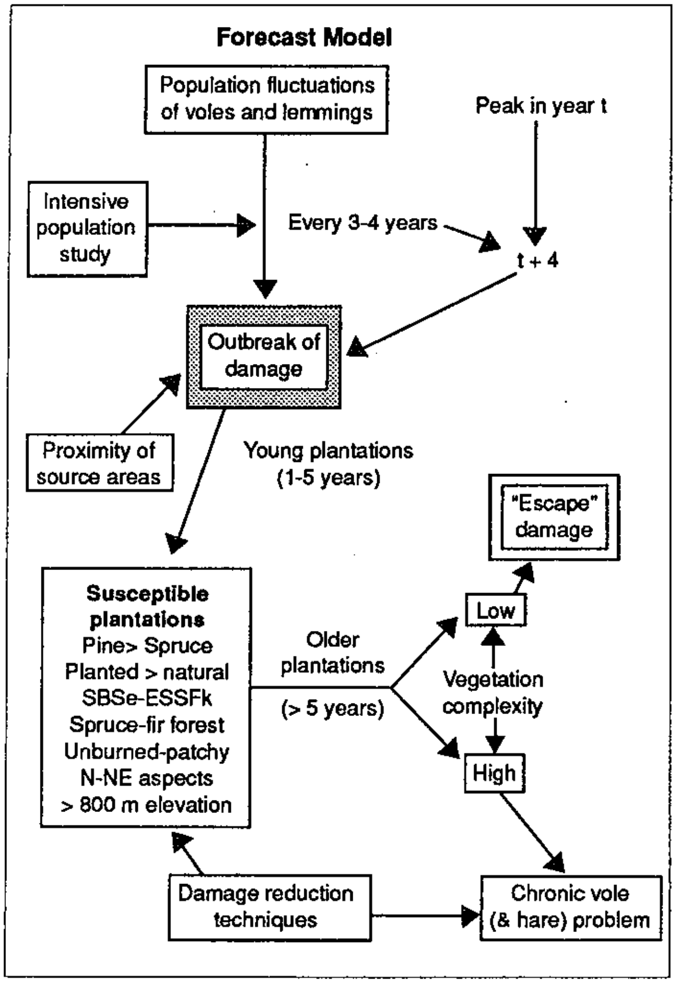

FIGURE 12. Forecast model to predict **when** and **where** outbreaks of vole damage to plantations in west-central British Columbia will occur.

FIGURE 13. Debarking damage to lodgepole pine sapling by snowshoe hare.

JUVENILE STANDS

Snowshoe Hare

Impact of damage

In addition to damaging young seedlings, snowshoe hares remove bark from the base of stems and from low branches of large seedlings and saplings (< 6.0 cm dbh) of lodgepole pine and sometimes Douglas-fir. Trees with dbh > 6.0 cm are not susceptible. Feeding damage may occur higher on the stem and branches depending on snow depth (Fig. 13). The gnawed sapwood has a shaggy or ragged appearance and complete girdling of the stem may occur (Fig. 14). Toothmarks are indistinct, with an average width of 2 mm in a horizontal or diagonal configuration on exposed sapwood. Fecal droppings, slightly flattened circular pellets 10 mm in diameter, are usually present in feeding sites. These barking and girdling injuries occur mainly in winter and early spring (November to April). In general, overstocked pine stands provide optimum winter habitat for snowshoe hares. It is during the peak in abundance every 9-10 years when hares cause serious damage to crop trees in natural and thinned stands of lodgepole pine. Complete girdling of the stem of a crop tree by hare feeding clearly leads to mortality. However, partial girdling (> 50% of stem circumference) also significantly suppresses diameter and height growth of small (< 6.0 cm) stems.

Damage reduction

Recommendations to alleviate damage from snowshoe hares in juvenile stands include:

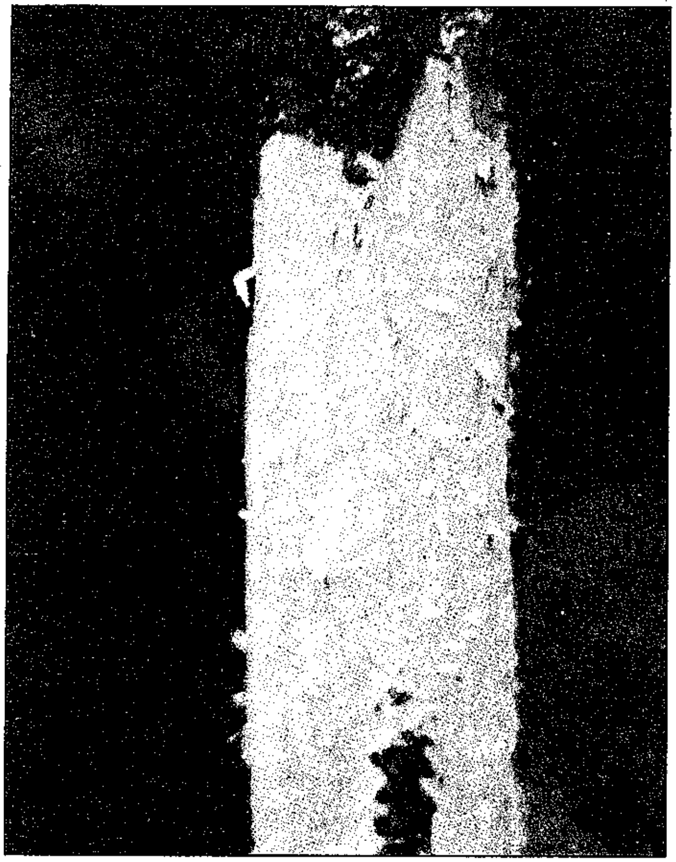

FIGURE 14. Ragged appearance of gnawed sapwood of lodgepole pine from feeding by snowshoe hare.

1. Delay juvenile spacing of overstocked stands of lodgepole pine that are susceptible (> 15 000 stems per hectare) to hare damage until the potential crop trees are > 6.0 cm average diameter. Overstocked stands < 15 000 stems per hectare may be spaced without concern for potential hare damage; since the average dbh > 6.0 cm.
2. Space stands with potential crop trees of average diameter < 6.0 cm during the peak year or first year of the decline in the hare population cycle. One year with minimal damage may follow because the fallen pine foliage acts as an alternative food source. However, crop trees must be of sufficient initial size to reach > 6.0 cm diameter before the next hare population increase.
3. In stands with a wide range of size classes, choose large (> 6.0 cm) diameter crop trees and, if necessary, leave smaller diameter stems as sacrifice food for hares.
4. In terms of area, ensure that spacing operations cover as large an area (> 50 ha) as possible so that the habitat (the spaced stand) is less attractive to hare populations.

These recommendations cannot be applied to spruce plantations.

Red Squirrel

Impact of damage

The red squirrel may also seriously damage crop trees in spaced stands of lodgepole pine. Squirrels strip bark from a stem to feed on the cambium and exposed sapwood (Fig. 15). Identifying characteristics of squirrel barking are the indistinct toothmarks on the sapwood and the presence of bark strips (3 x 8 cm) which accumulate on the ground under the injured tree. These bark strips are often the only evidence which distinguishes squirrel work from similar crown girdling injuries by the porcupine. Squirrels can damage any part of a tree (Fig. 16), whereas hares feed near the snow surface. Most damage by squirrels occurs in spring and early summer (May and June), during the early part of the growing season. Damaged stems are usually > 6.0 cm dbh.

Squirrel damage to lodgepole pine is locally present in most Forest Regions within British Columbia. Squirrels consistently attack spaced stands in the Prince George, Cariboo, and Kamloops Forest Regions. In general, these rodents damage larger crop trees and remove greater amounts of bark per feeding than do hares. Squirrel population fluctuations tend to coincide with cone crops (Fig. 17). Squirrel abundance in a mature stand peaks in the year after a substantial cone crop, with a surplus of squirrels appearing in juvenile stands in subsequent years. The incidence of damage and feeding intensity tends to be associated with high densities of squirrels, although local exceptions to this pattern may occur.

The red squirrel population cycle does not have consistent long-term periodicity.

Damage reduction

Potential management recommendations to reduce tree damage from squirrels include:

1. Identify areas with a high hazard, according to the model and decision-making profile (Figs. 18 and 19).
2. Maximize area (> 100 ha) of spacing within overall juvenile stand. Avoid leaving small blocks of unspaced stands within extensive areas of spacing.

3. Remove brush mechanically or chemically.
4. Maintain patches (> 50 ha) of mature forest adjacent or nearby.
5. Introduce predators (e.g., marten and weasels).
6. Use alternative foods (sunflower seeds) during the May-June damage period. This technique is under study.

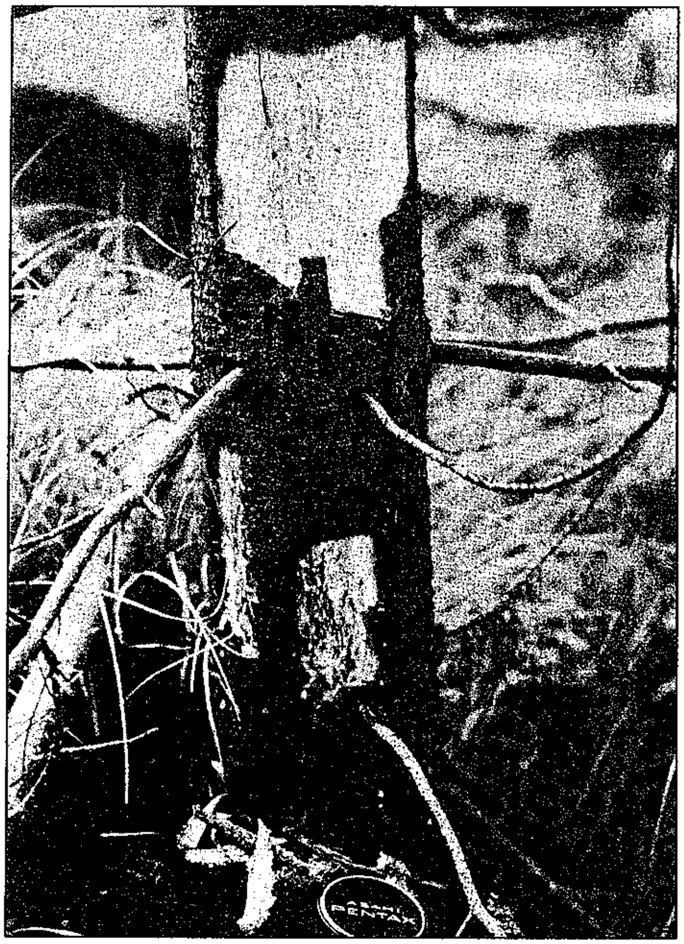

FIGURE 15. Debarking damage to lodgepole pine sapling by red squirrel.

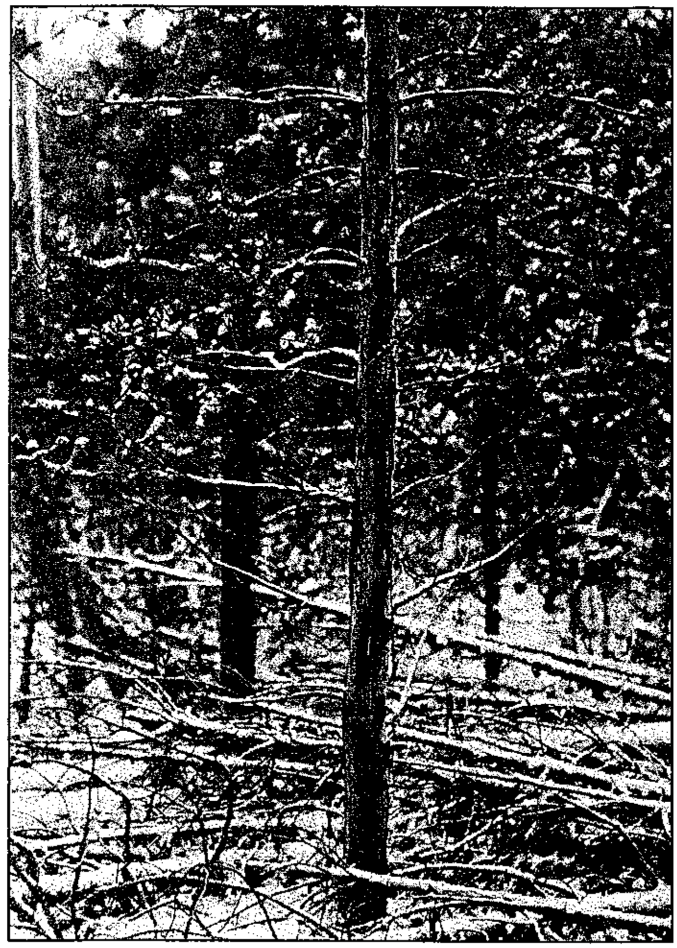

FIGURE 16. Extensive damage to stem of lodgepole pine by red squirrel.

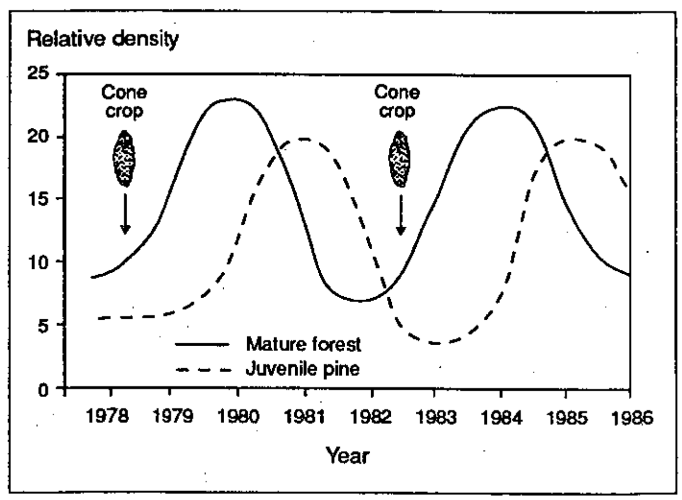

FIGURE 17. Population cycle of red squirrels in mature forest and juvenile lodgepole pine stands.

A forecast model to predict when and where squirrel damage will occur is illustrated in Figure 18. The two major factors are: 1) an extensive (> 1000 ha) fire-origin or post-harvest stand or mosaic of stands with limited areas of mature forest; and 2) the frequency of interior spruce and Douglas-fir cone crops leading to subsequent squirrel population increases in stands of juvenile pine. Fire-origin stands tend to have high densities of stems which leave a great accumulation of slash after spacing. This slash load presumably provides good cover for squirrels. Susceptible stands have average diameters > 6.0 cm.

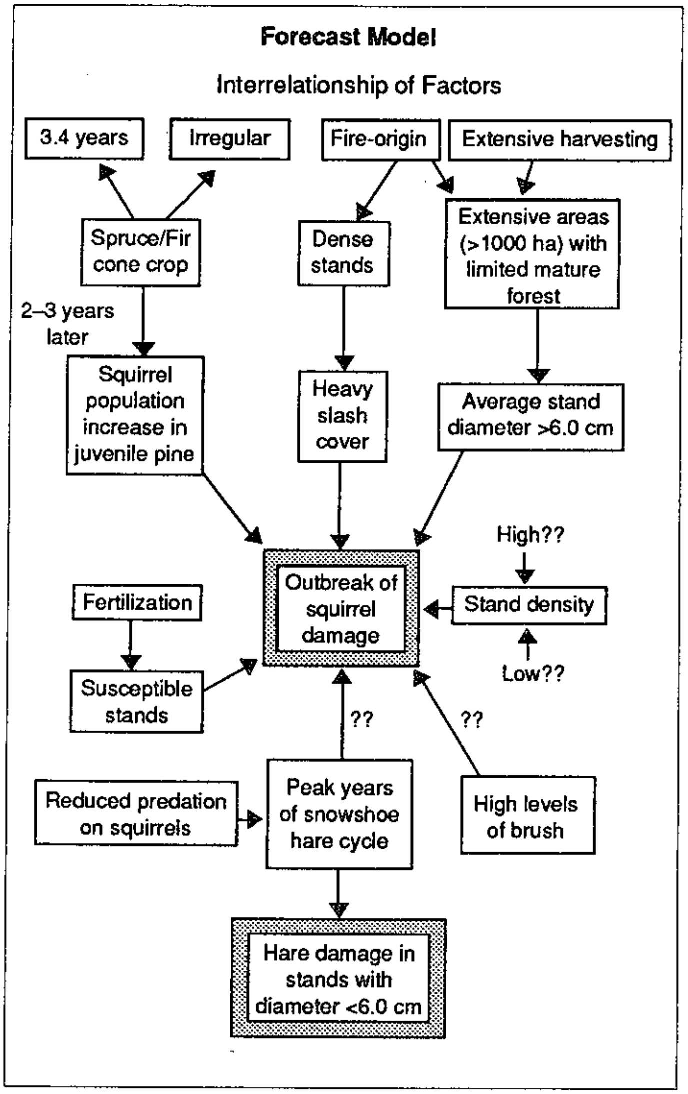

FIGURE 18. Forecast model to predict **when** and **where** outbreaks of squirrel damage will occur in managed stands of lodgepole pine.

Additional factors which may contribute to an outbreak of damage include: 1) a predator switch from squirrels to hares during peak years of the hare cycle; and 2) high levels of brush which provide cover for squirrels.

A decision-making profile (Figure 19) provides an assessment of the risk of squirrel damage when a pre-spacing survey is conducted. Three levels of risk are based on nine factors. Clearly, stands with a high-risk rating should be avoided for stand tending. The investment should be allocated to other stands which have a low risk of squirrel damage. Stands with a moderate risk of attack may still be managed, but this risk may be minimized by brush reduction, slash removal, or no fertilization. The current recommendation is to leave more stems per hectare in the spacing prescription to compensate for future losses to squirrel damage (and to compensate for other stem mortality in the stand). However, a lower density of stems (e.g., < 1000 stems per hectare) might reduce squirrel activity and damage because of a reduction in cover. This latter approach is now being tested on an operational basis in the Penticton, Kamloops, and Vanderhoof Forest Districts, sponsored by Silviculture Branch.

Decision-making Profile → Pre-spacing

Risk Assessment Checklist →

To Avoid Susceptible Stands

When	**Where**
☐ Is there a regular cone crop in nearby mature forest? Spruce / Fir	☐ Extensive stands (>1000 ha)
	☐ Incidence of attack >15% in unspaced stand
☐ Peak years (± 2 years from expected peak) of snowshoe hare cycle (reduced predation on squirrels)	☐ High slash load after spacing
	☐ High levels of brush
☐ Average stand diameter (>6.0 cm dbh)	☐ Fertilization planned
☐ Age classes 1 & 2 (10-40 years)	

Checklist Score (maximum of 9)	**Degree of Risk**
1–2	Low
3–5	Moderate
6–9	High

FIGURE 19. Decision-making profile to assess the risk that a given juvenile stand of lodgepole pine, when operationally spaced, will be attacked by squirrels.

Porcupine

Impact of damage

The porcupine gnaws bark and vascular tissues from stems of coniferous saplings (Fig. 20). Porcupine feeding damage can be identified by the broad (2.5 mm), prominent vertical and diagonal incisor marks on the exposed sapwood (Fig. 21). Basal girdling is common on smaller trees, debarking is common on upper bole and major branches of larger trees (Fig. 22). Top girdling produces a characteristic bushy crown and spike top (Fig. 23). The most widespread incidence of damage is in the Kalum and North Coast Districts of the Prince Rupert Region.

Porcupines appear to be particularly abundant in second-growth western hemlock-Sitka spruce. A survey of stands in Khutzeymateen Inlet showed that western hemlock, which made up 67% of sampled stands, was the most severely (52.7%) damaged species, followed by Sitka spruce with 7.8% of trees attacked. The less abundant amabilis fir and western redcedar had little or no attack. The total percentage of girdled hemlock stems was 30.9%. Significantly more damage wounds were recorded in the middle and upper thirds of hemlock stems than in the lower bole. In general, porcupines preferred large-diameter stems (dominant and co-dominant trees) in their feeding attacks.

FIGURE 20. Debarking of western hemlock stem by porcupine.

FIGURE 21. Toothmarks on gnawed sapwood of western hemlock from porcupine feeding.

Damage reduction

A major method of porcupine control in Washington and Oregon has been the use of strychnine salt blocks. However, this technique has **not** been effective in western U.S. forests. In the absence of definitive research, the following management recommendations are made for reducing porcupine damage:

1. Identify areas with a high hazard, using the forecast model (Fig. 24).
2. In thinning programs, select as leave trees, species which are not readily attacked by porcupine (e.g., amabilis fir, western redcedar); and manipulate stand density (e.g., < 1000 stems per hectare) to make habitat unattractive.
3. Attach sheet metal collars or sleeves (87.5 cm in length) around the lower bole of susceptible trees to prevent porcupine from climbing the stem.
4. Manage fisher (principal predator of porcupine) as a biological control technique to reduce porcupine abundance. This approach must be conducted as a co-operative effort with Wildlife Branch personnel and local fur trappers.

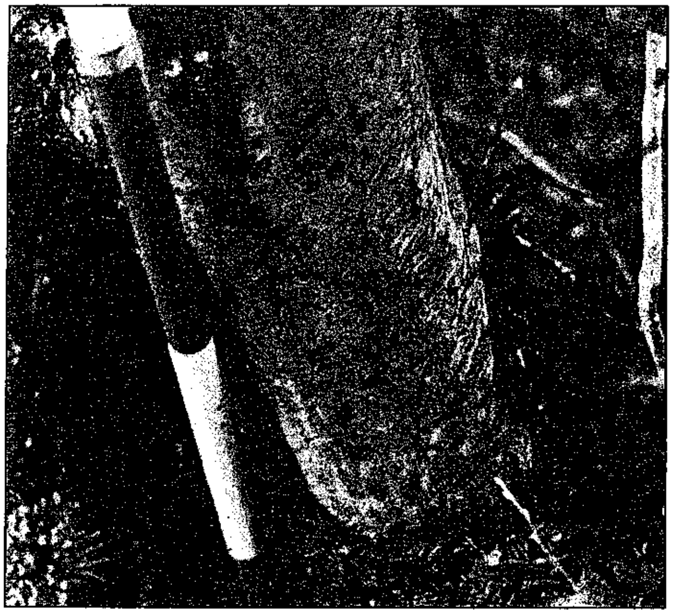

FIGURE 22. Basal girdling of western hemlock by porcupine.

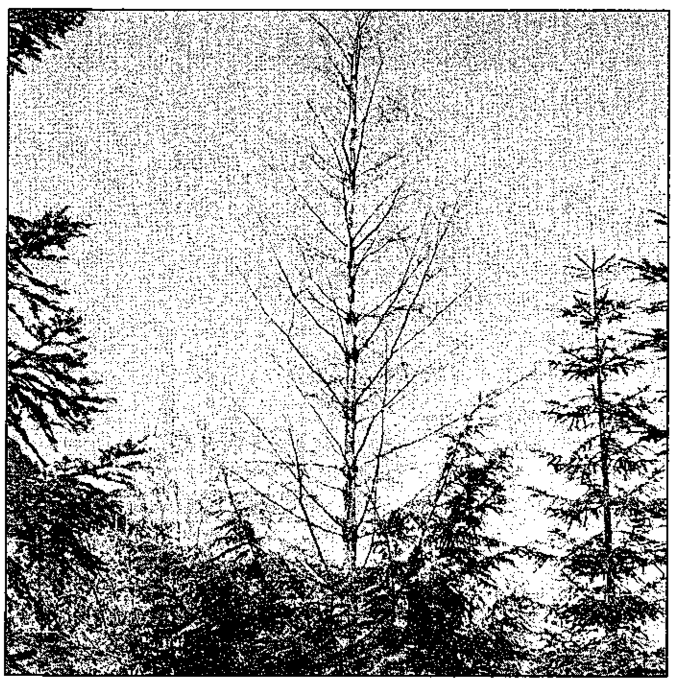

FIGURE 23. Top girdling by porcupine produces spike top.

A first approximation of a forecast model is shown in Fig. 24. The Kalum (CWHws subzone) and North Coast (CWHvm and CWHwm subzones) Districts currently have damage in 15 to 35 year old stands. These stands provide winter feeding areas, and nearby early successional (post-harvest) stages likely provide herbaceous vegetation for summer feeding. Combined with mild winters and a reduction in the predation population, these favourable habitat conditions lead to a porcupine population increase. Such increases appear to occur over decades and may persist indefinitely unless interrupted by catastrophic weather conditions (e.g., severe winter) or a management program.

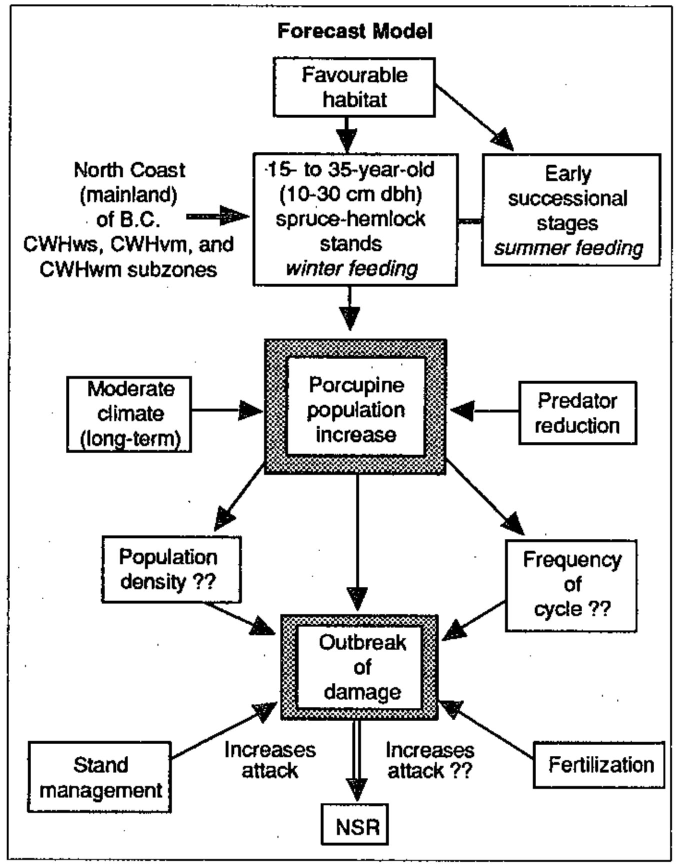

FIGURE 24. Forecast model to predict **when** and **where** outbreaks of porcupine damage will occur.

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