VOLE DAMAGE TO CONIFER TREES ON TEXADA ISLAND

by

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Vole damage to conifer trees on Texada Island

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ABSTRACT

Field observations and snap trapping during spring, 1984 revealed that the Townsend vole, Microtus townsendii (Bachman), was damaging coniferous trees on Texada Island, British Columbia. Damage consisted of the removal of bark and cambium from stems, branches, and roots of Douglas-fir, Pseudotsuga menziesii (Mirbel) Franco, western hemlock, Tsuga heterophylla (Raf.) Sarg., and, rarely, western white pine, Pinus monticola Dougl.

Damage occurred most frequently in spaced (pre-commercially thinned) coniferous stands less than 40 years of age but within this range there was no selection for age, nor was there selection for trees of specific diameters. No trees taller than 16 m were damaged; trees under this height sustained less overall damage with increasing height. However, the degree of damage (low, moderate and severe) was similar in all height and diameter classes.

The extent of vole damage in spaced stands within the susceptible age range was assessed by spot checks through 67 juvenile spacing blocks at Long Beach, Pocahontas Bay, Anderson Bay and Cook Bay. Pockets of localized damage occurred in at least one spaced stand at each location. However, damage to Douglas-fir was most extensive in the Long Beach area.

There were no reductions in volume of annual growth for trees damaged at any level by the voles. Assessment of damage over the short term was not significant; hence, no control

measures are recommended. Monitoring of the damaged areas on Texada Island should be continued and the long term effects evaluated.

ACKNOWLEDGEMENTS

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A. Introduction

The management of B.C.'s forest resource is rapidly being intensified. One aim of intensive forest management is to maintain pest-free stands. Pest damage can lower forest productivity through mortality and growth reduction. Vertebrate pests can kill trees, retard stand establishment, scar basal sections of tree stems and branches, produce slower and irregular growth, and increase a tree's susceptibility to decay and insect depredation (Canutt 1969, Borrecco 1976, Campbell 1976, Sullivan 1984).

Damage by small mammals, apparently voles, has been reported on Vancouver Island in the Malksope Inlet, Port Renfrew, and Cowichan Lake areas. Trees in five to ten year old naturally regenerated stands of western hemlock, *Tsuga heterophylla* (Raf.) Sarg., have been severely debarked, as have 1-0 and 1-2 seedlings and trees in 4-6 year old plantations of grand fir, *Abies grandis* (Dougl.) Lindl., (F. Hamre,[1] pers. comm.; D. McMullen,[2] pers. comm.). Voles have also debarked stems and roots of seedlings in regenerating stands in

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[1]Hamre, F. 1985. Silviculture Crew Coordinator, Ministry of Forests, B.C. Forest Service, Campbell River, British Columbia.

[2]McMullen, D. 1985. Silviculturist, B.C. Forest Products, Crofton, British Columbia.

Washington (J. Rochelle,[3] pers. comm.).

On Texada Island, Townsend voles, Microtus townsendii (Bachman), inflict damage by debarking young, spaced (pre-commercially thinned) plantations of Douglas-fir, Pseudotsuga menziesii (Mirbel) Franco (Howard 1982). Elsewhere on Texada Island, natural stands of spaced Douglas-fir have also been damaged by an unidentified, vertebrate pest. This study examined the pest problem with the following objectives:

1. To identify the pest,

2. To describe the nature of the damage and determine its extent,

3. To determine the relative density of the pest species, and

4. To assess the impact of the damage as a basis for deciding whether or not to implement control measures.

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[3] Rochelle, J. 1984. Manager, Environmental Forestry Research Technology Center, Weyerhaeuser Company, Tacoma, Washington.

B. Methods

I. Study Area

Texada Island (Fig. 1), lies within three biogeoclimatic subzones: the Drier Coastal Western Hemlock, the Drier Coastal Douglas-fir, and the Wetter Coastal Douglas-fir subzones (Klinka et al. 1979). Six study sites were examined in the Long Beach area approximately 30 km southeast of Vananda (Fig. 1). These sites lie between 100 to 350 m elevation within the Wetter Maritime Coastal Douglas-fir subzone. Three sites in separate stands were spaced in early 1982 and three other sites of corresponding age and site characteristics were unspaced.

The study sites were chosen on the basis of accessibility, site quality, age, diameter and height classes, as well as knowledge of pest damage. All stands were naturally regenerated with Douglas-fir as the dominant conifer species. The stands ranged in site quality from medium to good; in age from 8-33 years; in height from 3-18 m; in diameter at breast height (DBH) from 2-14 cm; and in slash level (for spaced stands A, D, and F) from low to high (Table 1). For unspaced stands (A', D', and F') there were 10,571, 10,735 and 15,515 stems/ha. These stands were similar to their paired, spaced stands but no site evaluations

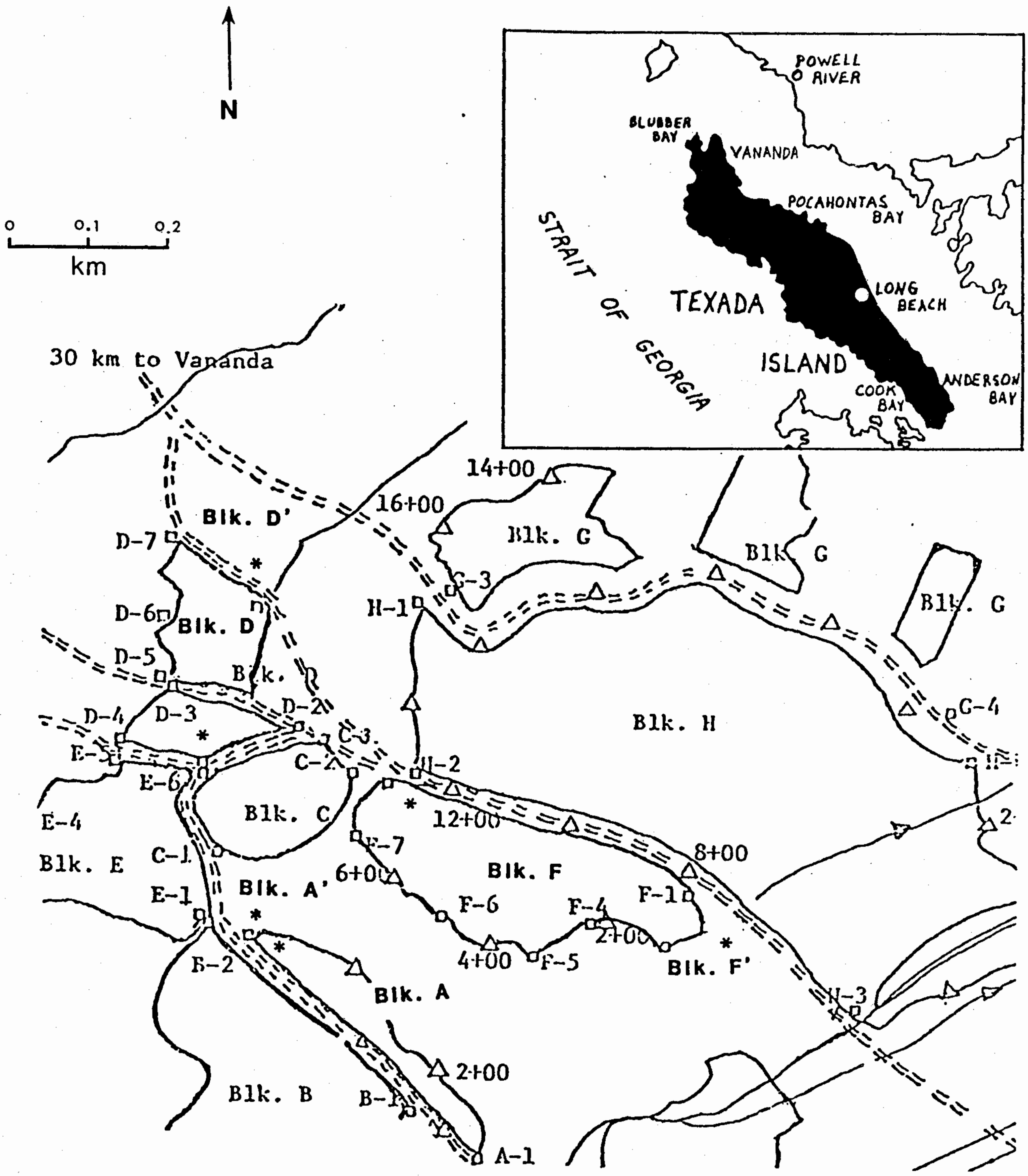

Fig. 1. Texada Island and locations(*) of study sites at Long Beach. Forest blocks are indicated.

Table 1: Selected stand characteristics for the spaced study sites (A, D, and F) at Long Beach on Texada Island. For species composition: F=Douglas-fir H=hemlock O=other species.

Unit Name	A	D	F
Stems/ha	1200	1225	625
Origin of Stand	Natural	Natural	Natural
Species Comp. (%)	F80 H10 O10	F70 H10 O20	F80 H20
Age Range (yrs)	10-22	8-15	18-33
Height Range (m)	4-20	3-5	9-18
DBH Range (cm)	3-13	2-6	10-14
Site Quality	Good	Medium	Medium
Soil	Sandy Loam	Sandy Loam	Gravelly Sandy Loam
Size Treated (ha)	2.3	4.3	7.0
Hygrotope	Submesic	Submesic	Submesic
Average Slope (%)	10	26	36
Slope Position	Mid	Mid	Mid
Slash Class	Low	Low	Moderate-High
Elevation (m)	320-350	260-310	100-150
Aspect	East	East	North-East
Topography	Rolling	Rolling	Even Slope
Brush level (coverage)	Low	Low	None

were available. Stands A, D and F were spaced in 1982. With the exception of mosses and lichen, site F was devoid of understory vegetation, possibly due to a heavy slash level remaining after thinning. Gaultheria shallon (Pursh.) and Ribes spp. formed a sparse understory in sites A and D where there was less slash.

II. Experimental Design

In early spring 1984, a trapping grid was established within each of the 3 spaced and 3 unspaced stands. Each grid was 18 X 18 m with 100 single Museum Special snap traps placed at 2 m intervals. Traps were baited with oatmeal and peanut butter and set on day 1, checked and reset on day 2 and collected day 3, for a total of 200 trap nights on each site. Captured animals were weighed with a Pesola spring scale to the nearest gram, sexed, and the lengths of body, tail, ear and right hind foot were measured to the nearest mm. Townsend voles were classified as adults (>42 g), subadults (30 to 42 g), or juveniles (<30 g) (Boonstra and Krebs 1978). Population estimates for the Townsend vole were determined by comparing the total number caught in the grid with estimates reported in literature for this species (Krebs et al. 1978, Krebs 1979).

The nature and severity of damage was determined by measuring the percent of the bark circumference removed from the base of the boles (percent debarked) of 35 to 50 conifers in each trap grid. Each tree was then assigned to one of the following injury classes: 0, 1-25% (low), 26-70% (moderate), or >70% (severe). The condition of each tree was also classified as: leaning, dying, chlorotic (yellow foliage, shedding leaves), weak or no observable symptoms, to determine if the degree of damage was associated with physical characteristics. The amount of exposed cambium on the roots was classified as: none, low, moderate or severe. Tree height, DBH, maximum length and width of wound and circumference at each wound were recorded. Attempts were made in the field to classify whether damage was old (prior to spring 1984) or new (since spring 1984); however, most damaged trees had both old and new scars or were very hard to classify.

To determine whether damage in the study sites was representative of all stands of similar age on Texada Island, four other spacing blocks were sampled. All trees were assessed within circular plots (4.0 m radius) established every 25 or 50 m along a 400 m transect. The proportion of trees that fell within each injury class was tabulated and combined with data from the study sites.

The dispersion of damage in stands A, D and F was determined from belt transects of 1x100 m extending along a bearing from the center of each study site into the surrounding stand. Every Douglas-fir tree within the 1 m belt was assessed for damage.

The extent of vole damage was also assessed in each of 67 juvenile spacing blocks at Long Beach, Pocahontas Bay, Anderson

Bay, and Cook Bay. Spot checks were conducted at each spacing block and the percent of debarking was estimated for at least 100 trees.

Forty Douglas-fir trees (mean age 27 years) were felled and the incremental height and basal radial growth (for the last 10 years) were measured to determine the impact of vole damage on tree growth. Ten of the trees were in unspaced stands and were undamaged. The remaining 30 trees were in spaced stands but 10 were undamaged, 10 moderately damaged and 10 were severely damaged. The incremental volume was calculated by:

$$\text{Volume} = \text{Basal Area} \times \text{Height}$$

Calculations accounting for taper were also made and gave similar results. Volume measurements were converted to a growth percentage (Avery 1967) for two years preceding spacing and vole damage (1980-81) and compared with the growth percentage for the two years following (1982-83). Signs of damage first occurred in 1982, and that appeared to be the year of greatest vole damage.

C. Results

Observations of debarking scars on damaged trees, the occurrence of runways through low vegetation, and trap captures revealed that the Townsend vole was the species inflicting the damage. A maximum density of 62 adult animals/ha was estimated, and a sex ratio of 3 males to 1 female was found. This density of voles in the forest habitat falls well within the lower range reported in literature for densities of voles in old field habitats (Krebs et al. 1978, Krebs 1979).

Damage consisted of injuries to the bark and cambium of stems, branches and roots (Fig. 2) of Douglas-fir, western hemlock, and rarely western white pine, *Pinus monticola* Dougl. Usually the stem collar was damaged to about 15 cm above ground, but occasionally low branches allowed voles to climb and inflict damage higher up the stem. The severity of damage was variable and not correlated with the physical appearance of the tree (r_s $=0.21$, $p>0.05$). Some trees that were completely girdled showed no observable symptoms of damage whereas others that were <10% damaged appeared chlorotic. In 2 of the 3 paired, study sites, there was a significantly higher incidence of damage in the spaced stands than in the unspaced stands (Fig. 3).

The height of trees in the study sites ranged from 0.8 to 18.1 m. No trees taller than 16 m were damaged by voles. For trees less than this height, incidence of damage decreased

Fig. 2. a. Severely girdled Douglas-fir tree with bark removal on main stem and roots.

b. Dead Douglas-fir tree which had severe basal girdling by voles.

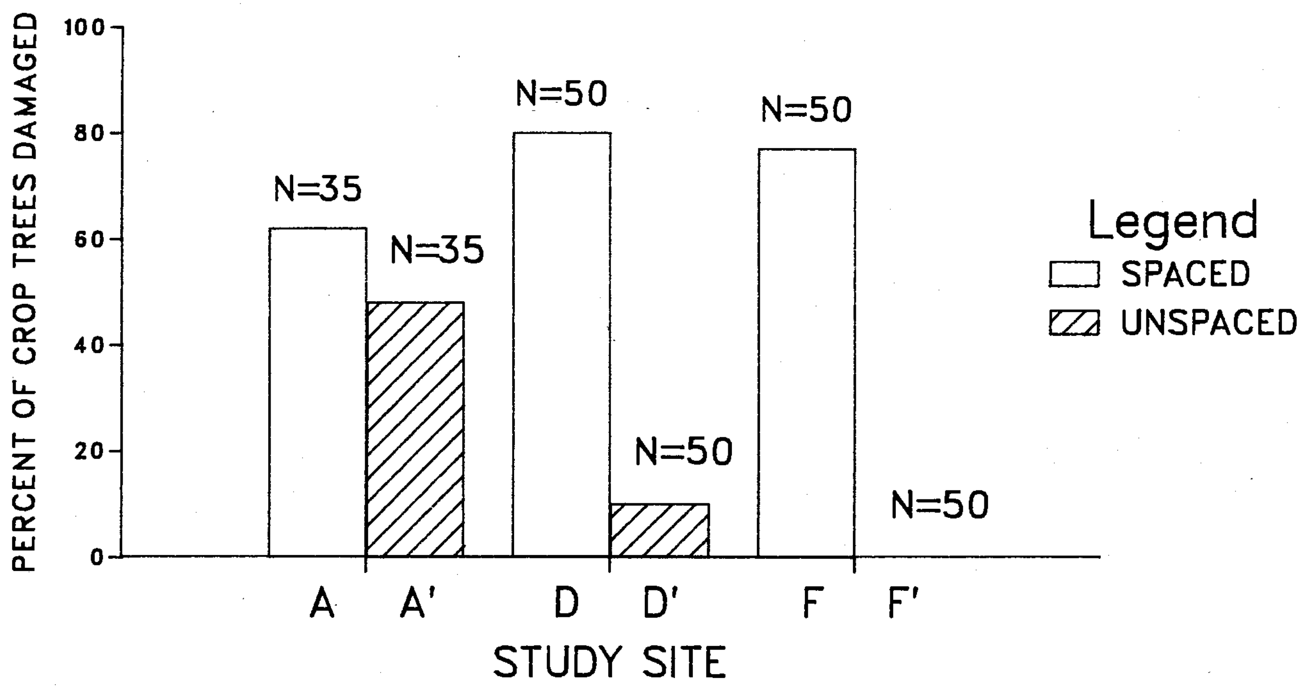

Fig. 3. Severity of vole damage in spaced and unspaced stands. Differences in damage between stands D and D' and F and F' are significant, X^2test, $p<0.05$.

significantly with increasing height (X^2 test, $p<0.05$) (Fig. 4). However, the severity of damage, although significantly different among height classes (X^2 test, $p<0.05$) showed no strong trend. Trees with diameters up to 19 cm DBH were damaged by voles (Fig. 5). The percentage debarked did not differ among the DBH classes (X^2 test, $p>0.05$), indicating that the Townsend vole did not attack specific sizes of trees within this DBH range.

Severity of vole damage was similar in stands of three different ages (Fig. 6), indicating that within this age range (<40 years) there was no selection for tree age.

The total incidence and severity of damage did not decline significantly with distance from the center of study sites A and F, but did decline at site D (X^2 test, $p<0.05$) (Fig. 7). Therefore, it appears that the high level of damage in study sites A and F was representative of the entire stand of trees whereas site D represented a small pocket of high vole damage relative to the entire stand. Alternatively, decreasing damage at site D could result from the change in habitat at the stand boundary.

Douglas-fir and western hemlock were damaged with equal frequency in the Long Beach area. Damage to western hemlock existed in localized pockets at each of the other 3 locations (Fig. 8), but Douglas-fir were not damaged. Therefore, voles selected western hemlock in preference to Douglas-fir trees in these areas.

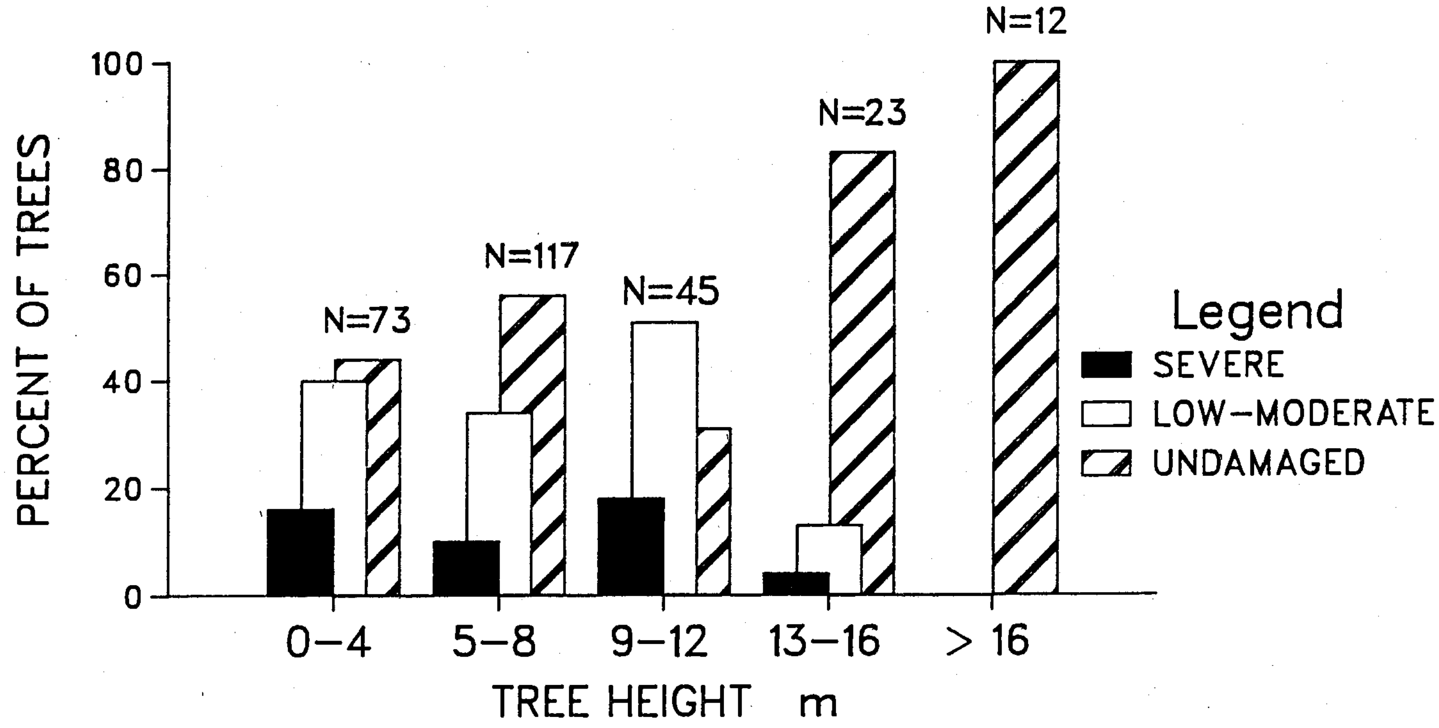

Fig. 4. Severity of vole damage and tree height.

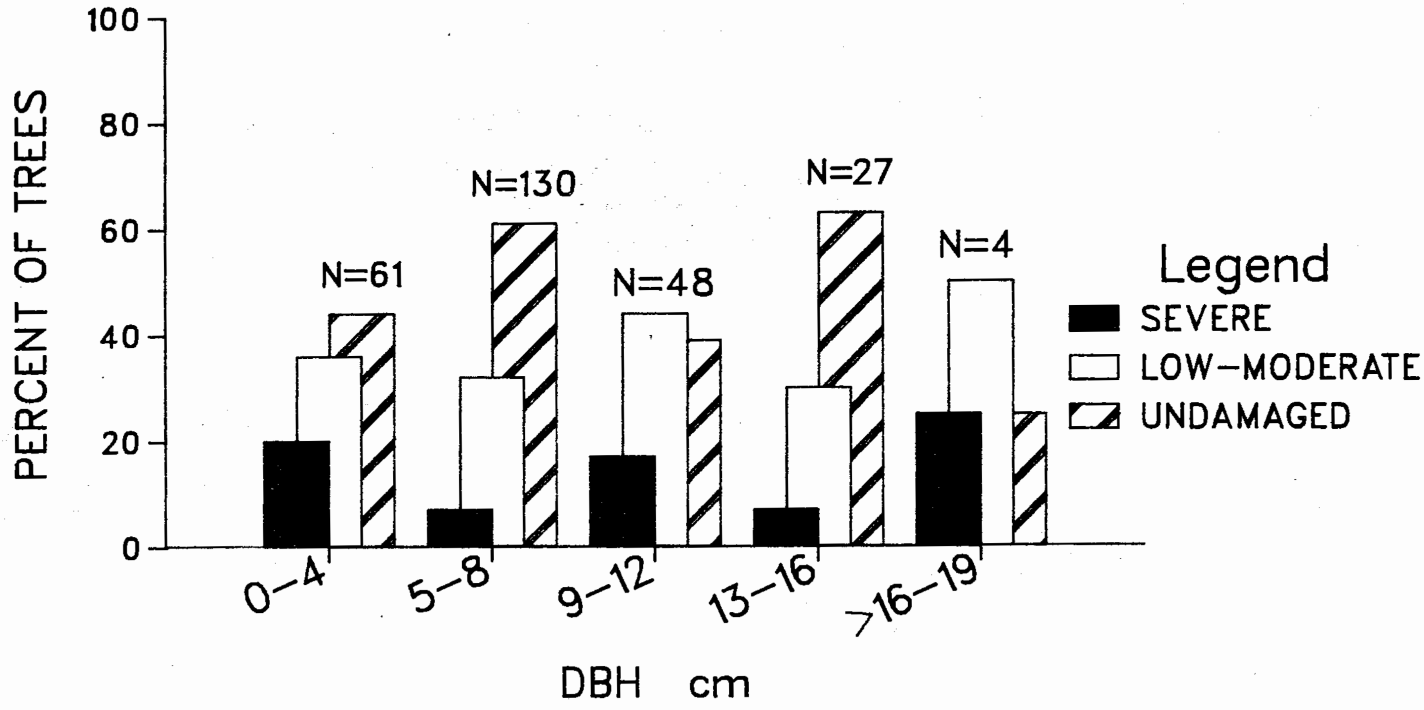

Fig. 5. Severity of vole damage and diameter at breast height.

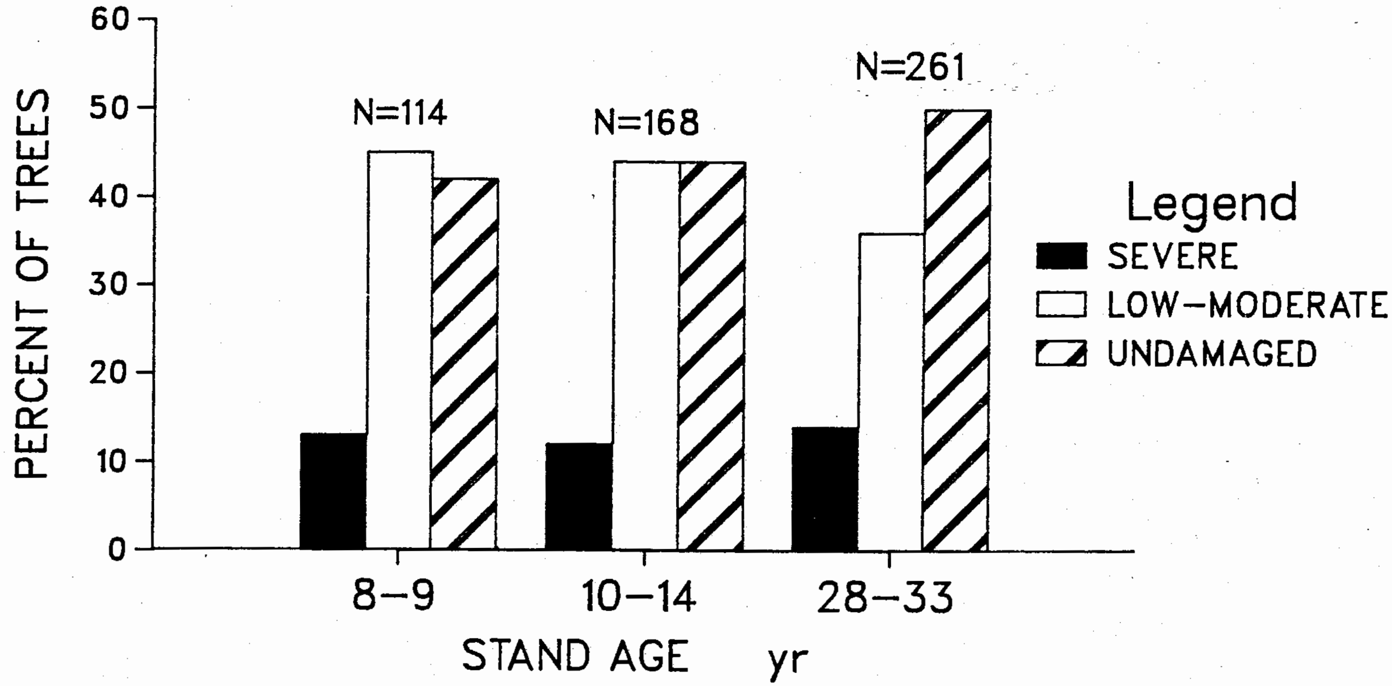

Fig. 6. Severity of vole damage and stand age.

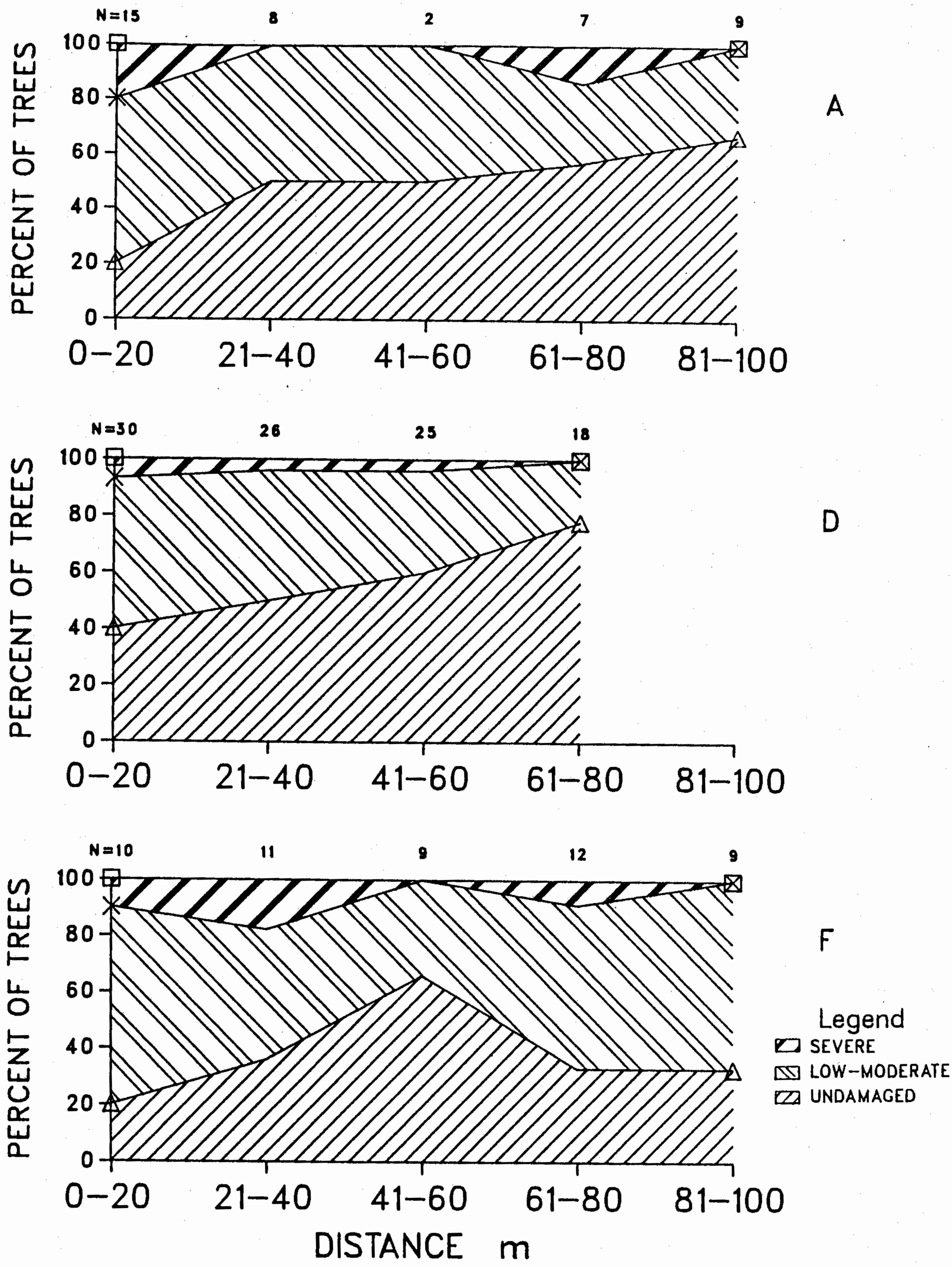

Fig. 7. Severity of vole damage and distance out from the center of sites A, D, and F.

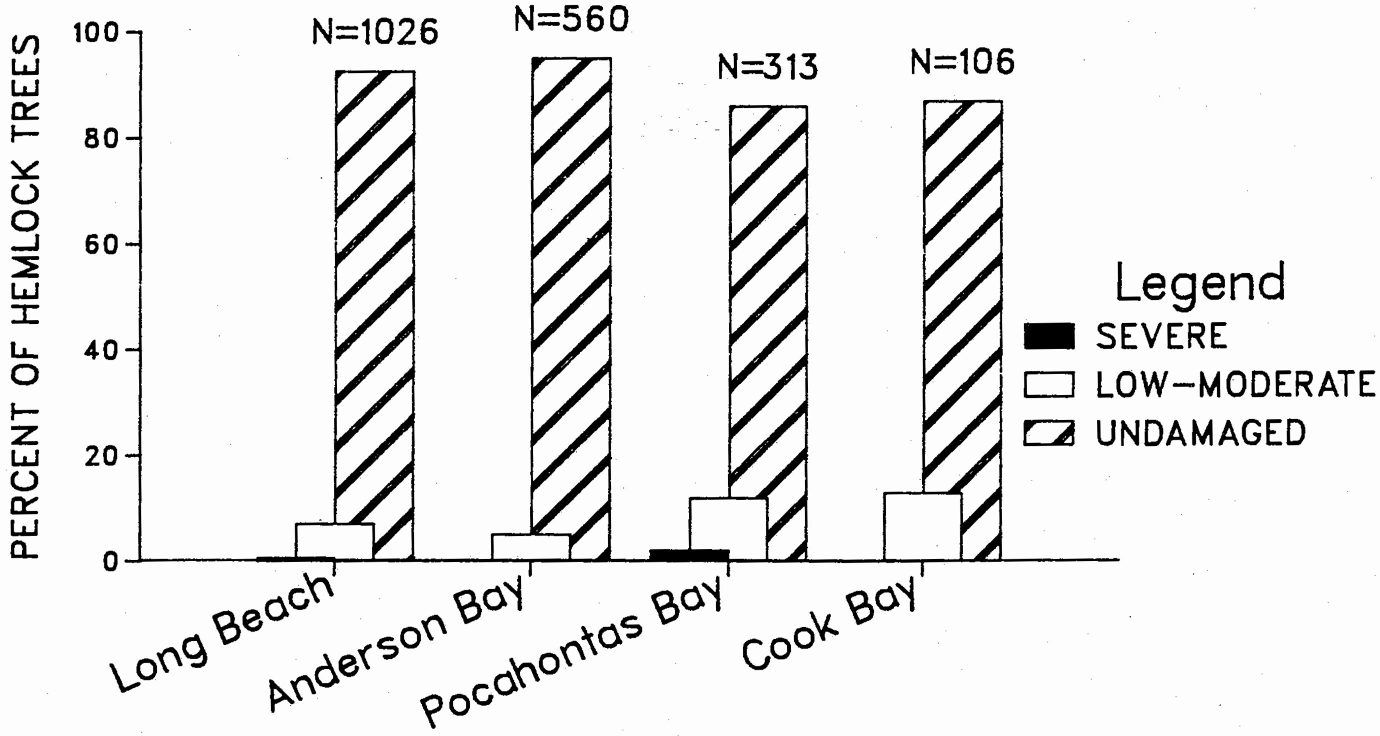

Fig. 8. Extent and severity of vole damage to western hemlock trees on Texada Island.

There were no significant differences between growth rates before and after spacing and vole damage occurred (Table 2). This apparent lack of an adverse effect must be treated cautiously since the impact of injury on growth may not be apparent for several years. Correspondingly, the beneficial effect of spacing on growth of undamaged trees had also not become evident.

Table 2. The average growth rates of Douglas-fir trees with varying degrees of damage. Mann-Whitney U test revealed no significant differences ($p>0.05$) between growth rates before and after spacing for any stand.

		Average Growth Rate (%) ± SD	
Damage Class & Stand Condition	N	1980-1981 (before spacing)	1982-1983 (after spacing)
Undamaged, unspaced	10	5.0± 1.8	5.3±1.5
Undamaged, spaced	10	20.0± 3.7	20.5±6.1
Moderate, spaced	10	24.1± 3.8	22.9±2.1
Severe, spaced	10	22.3±10.5	20.5±3.8

D. Discussion

On Texada Island the presence of debarking scars on pre-commercially thinned Douglas-fir concerned forestry personnel. Low densities of Townsend voles in the Long Beach area indicated that the damage may not be the result of a population irruption but rather a result of preferential feeding by small populations of voles on trees in spaced stands. This preference may have resulted from increased amounts of cover and, in some cases, decreased amounts of food in spaced stands.

Spacing results in various amounts of slash depending upon the type of thinning and age of trees. Current Ministry of Forests standards call for spacing at 12-17 years, in trees with at least 30% of their height in live crown (J.B. Nyberg,[1] pers. comm.). In some areas on Texada Island, where 25-35 year old Douglas-fir stands were spaced, heavy layers of slash occupy the understory. Voles living in habitats such as this with suitable cover, are less vulnerable to various forms of mortality such as predation (Birney _et al_. 1976). Death due to intraspecific encounters may also be reduced because individuals are less likely to make contact when cover is dense (Warnock 1965). During winter, the slash promotes higher temperatures or moderates the thermal regime closer to the ground and prevents

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[1]Nyberg, J.B. 1985. Research Wildlife Ecologist, Ministry of Forests, B.C. Forest Service, Burnaby, B.C.

packing of snow (M.C. Feller,[2] pers. comm.) which may reduce the natural winter mortality of vole populations. Besides reducing mortality, cover may also allow more activity during the day thereby increasing time available to voles for foraging. However, in these forest habitats the food normally used by voles is reduced because the accummulated slash inhibits forage production (USDA Forest Service 1968). Green (1978) concludes that debarking by small mammals indicates nutritional stress. It appears then, that the Townsend vole is debarking conifers for food since preferred vegetation is scarce.

Trees up to 16 m in height and 19 cm DBH are susceptible to vole damage (Figs. 4 and 5). Below these size thresholds the severity of damage was not strongly associated with any particular size of tree. Stands of trees up to 40 years of age were damaged by voles, however, the level of damage was similar in all ages of stands studied (Fig. 6). This range of susceptible ages is important when considering implications of vole damage to forestry. Where damage is economically significant, these small, young trees may need protection until they grow beyond the susceptible ages and sizes.

The Townsend vole is not presently causing a significant impact on forest regeneration or productivity on Texada Island. This assessment is based on the distribution of the damage, the tree species preference and undetectable growth reductions.

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[2]Feller, M.C. 1984. Faculty of Forestry, University of British Columbia, Vancouver, B.C.

Damage in spaced stands within the suceptible age range was not extensive on Texada Island. There were pockets of localized damage on Douglas-fir only in the Long Beach area, whereas low to moderate damage on western hemlock existed in at least one spaced block at each of Pocahontas Bay, Anderson Bay and Cook Bay.

Voles preferentially feed on different species of trees. In southern Ontario hardwood stands, white ash was preferred over white spruce, white pine and basswood (von Althen 1983). Scotch pine and red pine were preferred over jack pine and white spruce in forests in the Canadian mid-west (Buckner 1972). On Texada Island, Townsend voles prefer western hemlock over Douglas-fir trees and may actually assist silviculture in the area. The voles may act as a natural thinning mechanism by removing hemlocks and leaving growing sites for the desired crop, Douglas-fir.

Douglas-fir trees debarked by voles did not exhibit differences in two-year average growth rates when comparing the periods 1980-1981 and 1982-1983 or show any differences among severely, moderately and undamaged trees (Table 2). For an economic loss to be estimated reductions in volume must be evident. Observations of vole feeding scars are insufficient to conclude that damage is economically significant. The impact of feeding by voles on trees may not be evident for several growing seasons. On Texada Island there is some tree mortality (Fig. 2) but it is difficult to determine when these trees were damaged and what level of debarking was inflicted to cause mortality or growth abnormalities. Another consideration in the evaluation of long term impacts of vole damage is secondary pests which may compound the problem and promote mortality. The debarking scars initiated by voles may serve as entry ports for disease organisms or cause mortality by weakening the trees' resistance to "blow down" and "snow press". Decay resulting from wounds due to logging, fire and thinning is economically significant (Molnar and McMinn 1960, Aho 1977, Etheridge 1978, Harrington *et al*. 1983). Therefore, vole damage, although not significant yet, may reduce growth, form and longevity of the conifers when compounded with secondary pests.

On Texada Island secondary damage from organisms facilitated through girdling scars may add enough stress to eventually kill the trees. Trees severely debarked or girlded by voles are expected to die (MacMillan 1984). However, field observations presently fail to confirm this assumption. In anticipation of delayed impacts, the study sites should be reexamined in 5-10 years to determine if reductions in volume are evident and if they represent an economic loss over the long term. Also, spot checks through juvenile spacing blocks on the Island should be repeated annually to detect new or enlarging pockets of damage. Since no economic loss to forest productivity is presently evident control measures are currently unneccessary.

If vole damage becomes significant there are alternative strategies of control which may be considered for implementation. Reductions of vole damage may be attempted by the use of mechanical and chemical protection of vulnerable trees. Also, attempts at reducing vole populations through habitat manipulation, antifertility drugs and poisonous chemicals could be made.

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APPENDIX A

VOLE SURVEY IN JUVENILE SPACING BLOCKS ON TEXADA ISLAND.

For degree of damage:
N=no damage, L=low damage, M=moderate damage, S=severe damage.

	Project No.	Block	Species & Degree of Damage	
			Douglas-Fir	Hemlock
Long Beach:				
	ST92F9-17JS	A	M-S	M-S
		A'	M	M
		B	L-M	L-M
		C	M-S	M-S
		D	S	S
		D'	L	L
		E	M-S	M-S
		F	S	S
		F'	N	N
		G	L	L
		H	L	M
	ST92F9-14JS	G	L	M
	ST92F9-7JS	A	N	L
	ST92F9-16JS	P	N	L
	ST92F9-6JS	A	N	N
		B	N	N
		C	N	N
		D	N	N
		E	N	N
		F	N	N
	ST82V05-02JS	J	L	L
		K	N	N
		L	L	L
		M	N	N
		N	N	N
		O	N	L
		Q	N	L
		R	L	L

	S	N	L
ST82V05-04JS	A	N	N
	B	N	N
	C	N	N
	D	N	N
	E	N	N
ST83V05-05JS	1	N	N
	2	N	N
ST83V05-02JS	?	N	N
ST83V05-03JS	?	N	N

Project No.	Block	Species & Degree of Damage	
		Douglas-Fir	Hemlock

Anderson Bay:

ST92F9-13JS	A	N	N
	B	N	N
	C	N	N
	D	N	N
	E	N	N
	F	N	N
	G	N	N
	H	N	N
	I	N	N
	J	N	N
	K	N	N
ST92F9-10JS	A	N	N
	B	N	N
ST92F9-1JS	?	0	L
ST92F9-2JS	?	0	0

Project No.	Block	Species & Degree of Damage	
		Douglas-fir	Hemlock

Pocahontas Bay:

ST83V05-04JS	A	N	M
	B	N	L
ST83V05-01JS	A	N	N
ST82V05-06JS	A	N	L
	B	N	N
	C	N	N
	E	N	N
	F	N	N

Project No.	Block	Species & Degree of Damage	
		Douglas-fir	Hemlock

Cook Bay:

ST92F9-11	A	N	N
	B	N	N
ST92F9-12	A	N	N
	B	N	N
ST92F9-3	A	N	L
ST92F9-4	A	N	N