A REVIEW AND PRELIMINARY ASSESSMENT OF THE SPRUCE BEETLE TRAP TREE PROGRAM IN THE PRINCE GEORGE FOREST REGION OF B.C. 1978 - 1980

by

R. S. Hodgkinson

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Province of British Columbia
Ministry of Forests

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(The contents of this report may not be cited in whole or in part without the written approval of the Regional Manager, Ministry of Forests, 1011 - 4th Avenue, Prince George, B.C., V2L 3H9)

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A PRELIMINARY ASSESSMENT OF THE SPRUCE BEETLE TRAP TREE PROGRAM IN THE PRINCE GEORGE FOREST REGION OF B.C.

I. INTRODUCTION

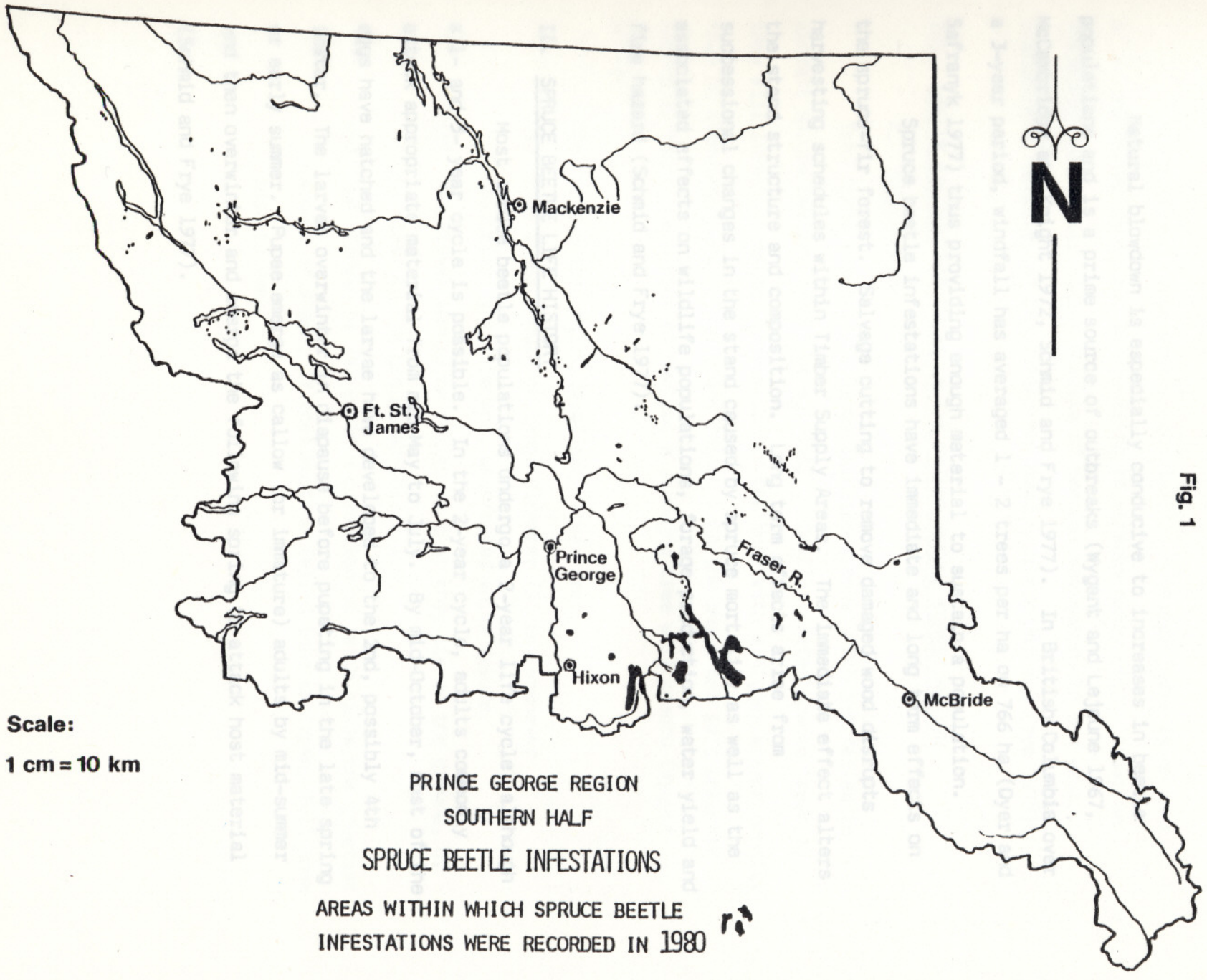
The spruce beetle, Dendroctonus rufipennis (Kirby), is one of the most destructive forest beetles in western North America ranging from New Mexico to the Cook Inlet in Alaska (Schmid and Frye 1977). The beetles' tree killing potential has been well documented during the last 100 years, and in British Columbia since 1962, a series of outbreaks have killed more than 3 billion fbm[1] of Picea species (Schmid and Beckwith 1971).

In the Prince George Forest Region of B.C., more than 63 000 ha of spruce are currently infested (Fig. 1). The most serious infestation is located southeast of Prince George centered around the Bowron River drainage and the Big Valley Forest. There are scattered attack areas in the Crooked River Pulp Harvesting Forest north of Summit Lake and spot infestations to the west of Fort St. James.

In scattered attack areas, annual mortality is difficult to determine because much of the mortality originates from single or small groups of trees. Outbreaks in living trees result from overmature and/or stressed host trees, and beetle population buildups in favorable weather and habitat conditions (Dyer and Hodgkinson 1981). All known major outbreaks have originated from stand disruptions caused by natural blowdown, reserve-strip blowdown or residual logging debris (Wygant and Lejeune 1967).

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1. 18.2 million m^3



PRINCE GEORGE REGION

SOUTHERN HALF

SPRUCE BEETLE INFESTATIONS

AREAS WITHIN WHICH SPRUCE BEETLE INFESTATIONS WERE RECORDED IN 1980

Fig. 1

Natural blowdown is especially conducive to increases in beetle populations and is a prime source of outbreaks (Wygant and Lejeune 1967, McCambridge and Knight 1972, Schmid and Frye 1977). In British Columbia over a 3-year period, windfall has averaged 1 - 2 trees per ha on 766 ha (Dyer and Safranyk 1977) thus providing enough material to sustain a population.

Spruce beetle infestations have immediate and long term effects on the spruce-fir forest. Salvage cutting to remove damaged wood disrupts harvesting schedules within Timber Supply Areas. The immediate effect alters the stand structure and composition. Long term effects arise from successional changes in the stand caused by spruce mortality as well as the associated effects on wildlife populations, forage production, water yield and fire hazard (Schmid and Frye 1977).

II. SPRUCE BEETLE LIFE HISTORY

Most spruce beetle populations undergo a 2-year life cycle, although a 1- and 3- year cycle is possible. In the 2-year cycle, adults commonly attack appropriate material from mid-May to July. By mid-October, most of the eggs have hatched and the larvae have developed to the 2nd, possibly 4th instar. The larvae overwinter in diapause before pupating in the late spring or early summer. Pupae emerge as callow (or immature) adults by mid-summer and then overwinter and emerge the following spring to attack host material (Schmid and Frye 1977).

(d) Trap trees should not be bucked or delimbed; leaving the branches on increases trap tree shading thereby favouring spruce beetle attack and discouraging competition from Ips sp.

(e) Trap trees should be cut so that the stumps are as low as possible. There must be no fresh blowdown near trap trees.

(f) Trap trees should be felled as close to the infestation as possible.

(g) All trap tree sites should be clearly flagged, numbered and mapped.

in part from Fiddick (1978)

The number of trap trees felled depends on the size of the selected traps, the number of standing infested trees, and the amount of windfall or slash nearby. Nagel et al. (1957) recommended 1 trap tree for every 4 - 5 standing trees, while Wygant (1960) advised the following ratios: 1:10 for static infestations and 1:2 for increasing infestations. However, under field conditions trap trees are normally dropped in truck-loads of 15 - 25 trees to facilitate skidding and hauling.

Trap trees seem to effectively attract beetles up to 1/4 mile; less effectively up to 1/2 mile (Nagel et al. 1957). Once the trap tree is infested, it can be hauled to the mill, burned, peeled or chemically treated.

In developing the trap tree strategy, few studies have focused on trap effectiveness in reducing infestation levels in surrounding live spruce. Nagel et al. (1957) established rectangular blocks 40.3 m wide and 305 m long in undisturbed spruce surrounding felled trap tree plots. The blocks were subdivided into 10, 30.5 m areas as they progressed away from the center trap trees. Unfortunately, the heavy spruce beetle population exceeded the capacity of the trap trees. Therefore, no correlation was found between attack density or infestation frequency in standing timber and distance from the trap trees.

The only other investigation was an operational trap tree program conducted by the U.S. Forest Service using Nagel's guidelines (Nagel et al. 1957). Examination of timber surrounding felled trap tree groups revealed that 11 of the 13 trap tree groups seemed to provide protection extending 0.4 to 0.8 km into the standing green trees. Beyond 0.8 km, standing infested trees were usually found. However, no check plots of timber (isolated from the influence of trap trees) were examined, and the results were therefore inconclusive.

In all these studies, it has been difficult to remove or isolate the many variables for making a proper assessment. Nagel et al. (1957) lists these prominent variables as:

- abundance of trap trees
- spruce beetle population density
- trap tree diameters
- amount of trap tree shading (possible Ips competition in sunlit trap trees)
- abundance of adjacent slash and/or blowdown

Some of these variables are discussed in Sect. C 2. (i).

B. Summary of Regional Trap Tree Projects from 1978 - 1980

Conventional trap trees have been used for the past 3 years in the Prince George Forest Region in problem areas delineated from provincial, federal and industrial ground surveys and aerial reconnaissance. Unfortunately, in most earlier programs only visual inspections were made of trap tree success. Where quantitative data was gathered, some statistical analyses and interpretations are lacking.

Table 1 summarizes trap tree programs from 1978 - 1980. Within this Table, some trap tree locations and quantitative data are referenced to additional Figures, Tables and Appendices.

Table 1

Summary of Felled Trap Trees Used Against Spruce Beetle in the Prince George Forest Region 1978 - 1980

Trap Tree Felling Date	Forest District	Trap Tree Location	Number of Trap Trees	Spacing Between Trap Tree Groups	Assessment		Disposal Technique	Remarks
					Visual Inspection Only	Quantitative Data Collected		
March 1979	Ft. St. James	C.P. "U"	10 groups of 5 traps/group	0.02-0.04 km	--	--	Skidded	--
Jan-Feb 1979	Prince George West	see Append. 1	67 groups of 3-4 traps/ group	0.4-3.2 km	x	--	Skidded or Piled & Burnt	--
Feb. 1979	Prince George East	see Append. 2	16 groups of 3-4 traps/ group	0.2 km	--	see Append 3, 4 and Sect. III c.(1)	Skidded	Operational research
March 1980	Ft. St. James	Takla PSYU C.P. "AA"	2 groups of 200(400) traps	0.4 km	x	--	Skidded	--
		C.P. "V"	200 scattered traps	various	x	--	Skidded	--
		C.P. 64	200 scattered traps	various	x	--	Skidded	--
Jan-Feb 1980	Prince George West	see Append. 1						
		Parsnip-Missinka (801-A,B) C.P. 52	2 groups of 3 traps/group	1.6 km	--	see Append. 5	Piled & Burnt	some ambrosia beetles in traps & stumps
		Whiskers Cr. Rd (802) C.P. 40	1 group of 10-12 traps	--	--	see Append. 5	Skidded	light/ moderate shading
		McLeod Lake-Mt. Rd. (803-A,B,C,) C.P. 126	3 groups of 10-12 traps/ group	less than .06 km	--	see Append. 5	Skidded	well shaded sites
		Parsnip-Powerline (804) C.P. 66	1 group of 10-12 traps	--	--	see Append. 5	Skidded	no ambrosia beetles
		Weedon (805-A,B) 1400 Rd.	2 groups of 3 traps/group	1.6 km	--	see Append. 5	Piled & Burnt	well shaded. Much ambrosia beetle activity
Dec 1979 - March 1980	Prince George East	Table 2 Fig. 2	190 groups of 15-25 traps/ group	Approx. 0.4 km	--	Appendices 6, 7, 8, 9	Skidded	see sect. III c. 2(a)

C. Review of Trap Tree Projects in the Prince George East Forest District

1. 1978 - 1979

In February 1979, 16 trap tree groups consisting of approximately 10 trees per plot were felled by West Fraser Mills Ltd. along 2.4 km of road between the southwest corner of C.P. #3, Block "A" and the northwest corner of C.P. #8 (Append. 2). Plots were located within 2 chains south of the road and spaced approximately 10 chains apart.

Trap trees and stumps in each group were treated with various substances (Append. 3, 4) to study the effect on attracting and/or fumigating spruce beetle. Pheromone capsules were attached to selected trap trees before beetle flight (Table 2). Diesel oil was sprayed to the drip point on certain stumps after beetle flight to test the substances fumigation properties.

During the first 2 weeks of October, 1979, 3 trap trees per group were sampled according to procedures in Append. 10. Six 23 cm x 20 cm samples were cut from each log below the midline in the following configuration: no closer than 3 m to the butt end of the log, at the midpoint of the log and at the point where the log narrowed to a 20 cm diameter.

Stumps were sampled 3 to a plot with two 15 cm x 15 cm samples taken off the lower portion of each stump, one on the sunny side and one on the shaded side. Appendices 3 and 4 show the number of surviving spruce beetle per 225 sq. cm. of bark on trap trees and stumps after application of pheromone and/or diesel oil.

Unfortunately, no statistical analysis was undertaken by B.C. Forest Service personnel involved in this project, and the raw data could not be located by the author for such an analysis. In regard to Append. 3, it is unfortunate that no tally was made of the number of successful adult entrance holes/galleries, as this would have been a definite indicator of trap tree attractiveness. Ips species and ambrosia beetles were observed in bark samples from the above trial but their numbers were not recorded.

2. 1979 - 1980

From December 1979 to March 1980, 190 trap tree groups (each group containing approx. 15-25 traps) were felled in the Prince George East Forest District in the logging interest areas outlined in Table 2 and illustrated in Fig. 2.

Adjacent to each trap tree group, two 200 meter probe lines were run with ribbons at right angles to one another as shown in Fig. 3 and assessed prior to beetle flight in May 1980. Trees within 2 meters of the probe line which were attacked in 1979 were tallied and numbered with spray paint for later identification. A visual assessment was made of trees outside the 2 meter strip and any attack was recorded in the comments section of the cruise card.

Table 2

Trap Tree Locations in Prince George East Forest District 1979-1980

Logging Interest Area	Logging Company	Number of Trap Tree Groups
Willow River Pulp Harvesting Forest	Carrier Lumber	62
	N.O.M.	15
Big Valley Forests	N.O.M.	40
	West Fraser	12
	Dunkley	11
	Carrier	4
Naver Pulp Harvesting Forest	N.O.M.	10
North Purden Forest	Rustad Bros.	8
South Purden Forest	Northwood	28
	TOTAL	190

Fig. 2

Trap Tree Locations in Prince George East, 1979-80

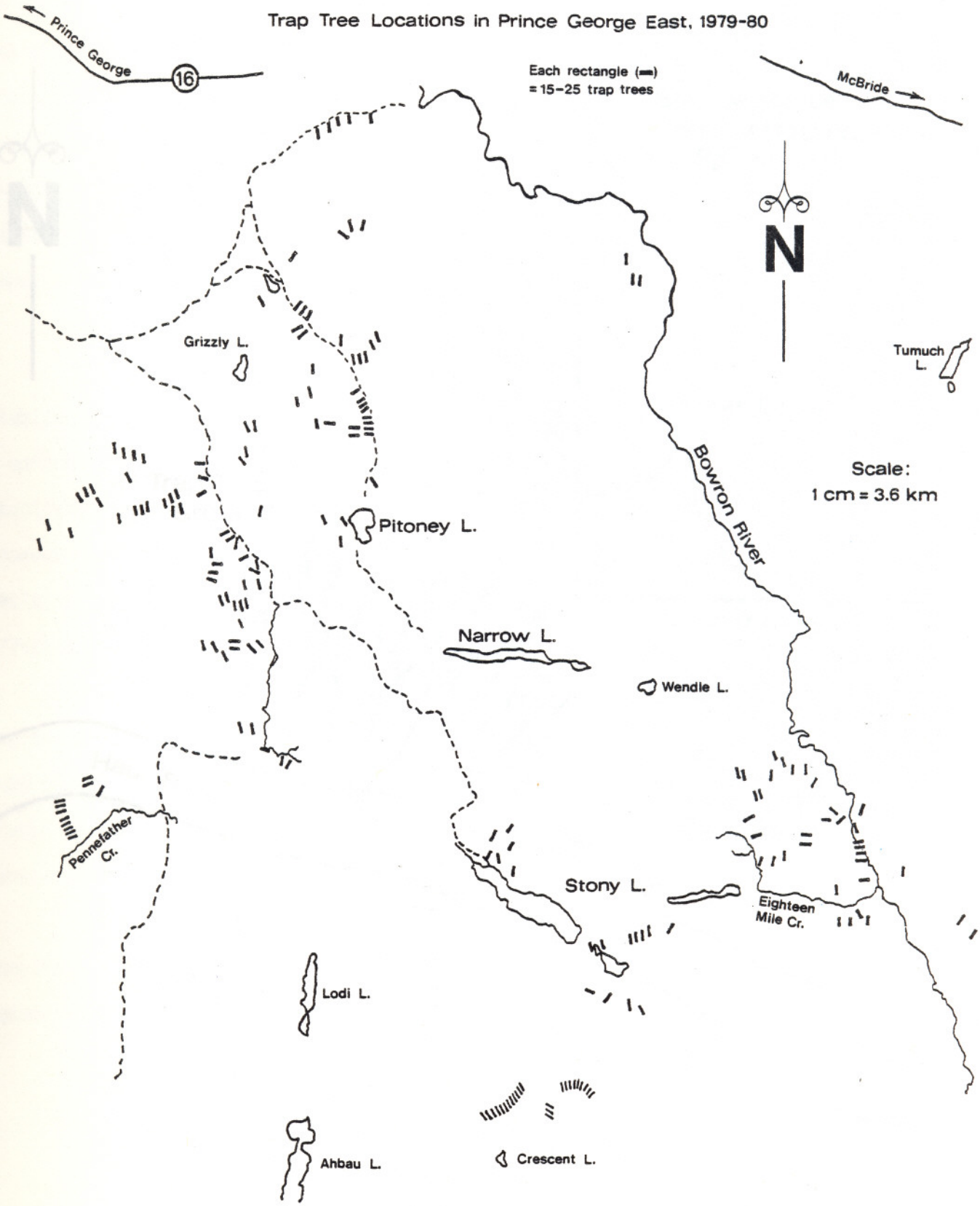
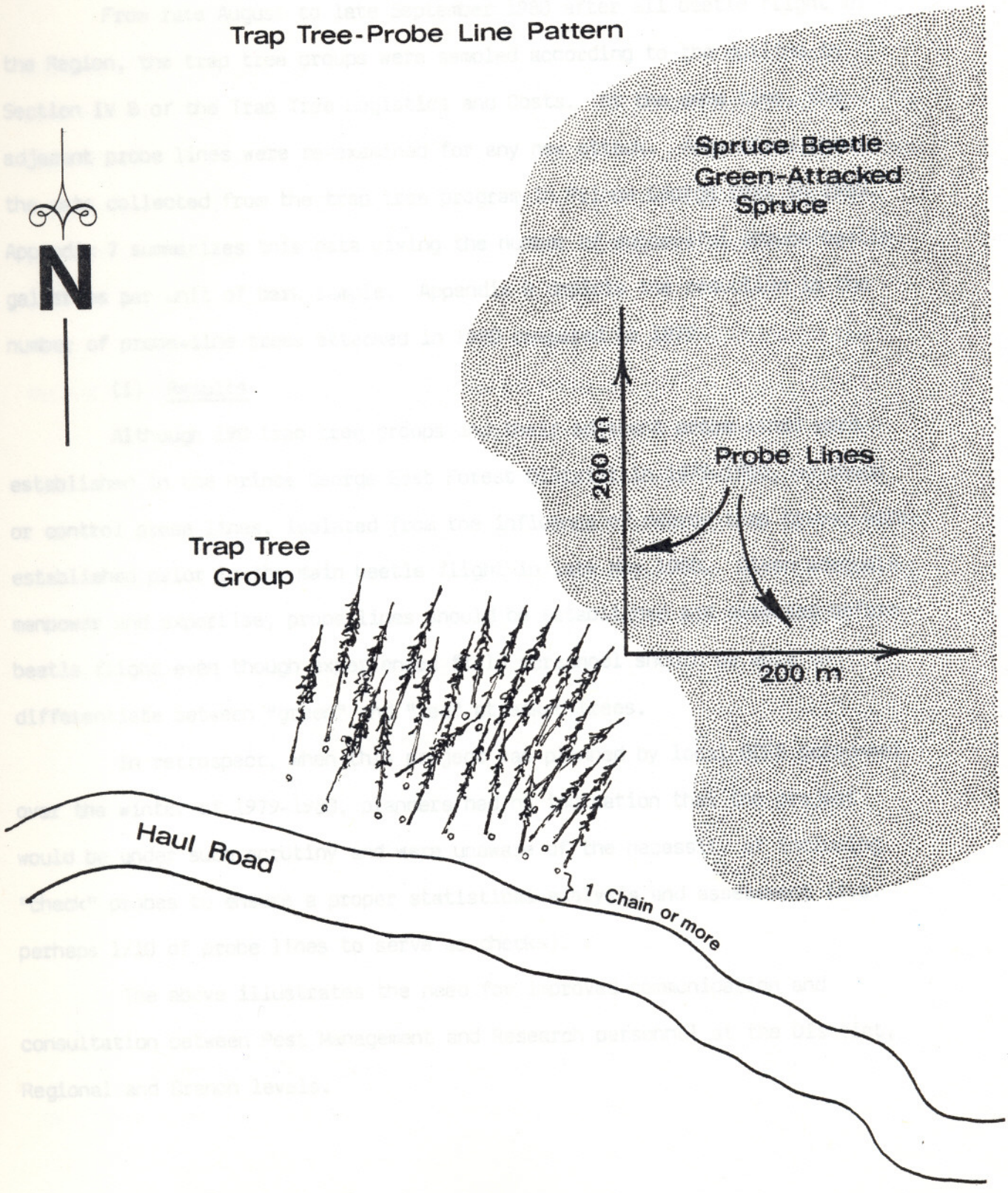


Fig. 3


Trap Tree-Probe Line Pattern
N
Spruce Beetle
Green-Attacked
Spruce
200 m
Probe Lines
200 m
Trap Tree
Group
Haul Road
1 Chain or more

Following the reorganization of the Ministry of Forests, it is expected that the newly appointed Pest Management staff in Victoria and in each Forest Region will have the time, expertise and communication network for improved planning of operational research programs. At press time, the Prince George East Forest District (the epicenter of B.C.'s worst spruce beetle infestation) is critically understaffed in Pest Management because of a lack of funding.

Despite exclusion of check probe lines, some observations on the Prince George East trap tree program are warranted.

1. According to Appendix 7, 79% of trap trees attacked by spruce beetle had from 2-5 successful galleries per 400 cm^2 of trap tree bark surface. While giving proper consideration to the many factors influencing the number of successful galleries (see list by Nagel et al. 1957 on page 7), an index of spruce beetle population density in trap trees can be tentatively established:

Avg. No. of Successful Spruce Beetle Galleries per 400 cm^2 of Trap Tree Bark Surface	Trap Tree Population Density
0 - 1.99	light
2 - 3.99	moderate
4 - 5.99	heavy
6 - 7.99	severe

However, we must be aware that crowded or "severe" population densities often have lower brood survival levels than more moderate population densities. Dyer (person. commun.) reports that the optimum density for spruce beetle brood survival is 3-4 attacks per 400 cm^2 of bark surface.

Several parameters determine the effectiveness of trap trees in absorbing spruce beetle. They may include: the number of trap trees and their shading and proximity to a certain spruce beetle population, amount and proximity of natural blowdown, and the number of Ips sp. which colonize the trap before or during spruce beetle flight.

Although spruce beetle prefer the cooler and darker underside of traps, and Ips sp. prefer the warmer upper surfaces, given high populations of both insects, Ips sp. may encroach on spruce beetle habitat on the flank or sample region of traps (Append. 6) (Nagel et al. 1957, Schmid and Frye 1977, Mitchell 1981). Indeed, Denton (1950) discovered that when Ips perturbatus colonized felled spruce, they competed with and destroyed broods of the spruce beetle.

Appendix 9 illustrates the highly significant inverse correlation between the number of successful spruce beetle and Ips sp. galleries in bark samples. That is, the more Ips sp. that invade bark, the less room for spruce beetle. However, this correlation only explains about 6% of the variability in the number of spruce beetle attacks, and is only one parameter amongst other unresearched factors which influence attack densities.

Trap tree diameter is another factor influencing the number of spruce beetle a trap can absorb. The average diameter of trap trees felled in Prince George East in 1980 was 57.14 cm (Append. 6). According to a table by McComb (1953), a 57 cm trap will absorb a mean of 10,981 spruce beetles, depending on the external variables previously listed (mainly shading).

In data presented by Knight (1960 a) and Frye et al. (1977), a mean of 644 spruce beetle attacks and 1289 spruce beetles are required to kill a healthy standing spruce of 57 cm diameter. Since a 57 cm trap tree will absorb a mean of 10,981 beetles (McComb 1953), and it takes a mean of 1289 beetles to kill a 57 cm standing spruce,

$$10{,}981 - 1{,}289 = 8.5 \text{ trees}$$

Therefore, 1 trap will absorb enough beetles to save an average of 8.5 standing trees of comparable diameter from attack and mortality.

Since a 57 cm spruce contains a mean of 200 bd. ft. (0.78 m^3) of wood, 1980/81 valuation cost = approx. \$40/tree (includes Lumber Recovery Factor)[2].

$$8.5 \times \$40.00 = \$340.00$$

Therefore, 1 trap tree is currently worth an average of \$340.00 in protecting standing spruce of comparable diameter from attack and mortality.

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[2]A. Medynski, Appraisals Co-ordinator, B.C. Ministry of Forests, Prince George Forest Region.

2. Appendix 8 reveals that 59% of the probe lines adjacent to trap trees showed no increase or decrease in attack in 1980 compared to 1979. Probe lines showing an increase in attack = 17.50%, those showing a decrease in attack = 23.85%. The 6.35% overall reduction in attack might have been a partial or direct result of the influence of adjacent trap trees, but without check or control probe lines, a proper interpretation was not possible. Unfortunately, because of manpower and time limitations, some spring probe lines were not established until the beetle flight was underway.

IV. TRAP TREE PROGRAM LOGISTICS AND COSTS

A. Trap Tree Felling

In the opinion of spokesmen from several forest industries and a B.C. Forest Service faller in Prince George, it was concluded that 1 faller could drop approx. 80-100 trap trees (in appropriate groupings) in a 5-6 hour day under reasonable access conditions.

The standard falling rate is presently $26.16/hr. based on a 6 1/2 hour day. Therefore, it would cost approx. $176.00 for a faller to drop 4 patches of 20 trap trees (4 x 20 trees) per day. All of these costs are usually recoverable when the traps are hauled to the mill and processed.

B. Trap Tree Sampling

At present there is no published sampling standard on an international, national or provincial level for assessing the effectiveness of trap trees in "absorbing" spruce beetle. The Forest Insect and Disease Survey's[3] General Instructions Manual (1977) outlines a procedure for measuring spruce beetle "productivity index" and "development index" on windfall. Renwick's (1981)[4] productivity index for assessing spruce beetle hazard in windfall in the Nelson Forest Region of B.C. is borrowed from the federal guidelines.

The only proposed sampling procedure for trap tree assessment in the Prince George Forest Region was outlined in a memo dated August 2, 1980 from H. Spence, Hixon Field Office, to D. Hutcheson, Prince George Regional Office (Append. 10). In this procedure, 6 (20 cm x 23 cm) bark patches were cut from each of the 3 trap trees per trap tree group. The 3 bark patches from each side of the tree were sampled below the midline (a) no closer than 3 m to the butt end of the log, (b) at the midpoint of the log, and (c) at a point of minimum diameter of 20 cm.

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[3]Canadian Forestry Service, Pacific Forest Research Center, Victoria, B.C.

[4]Unpublished manual from Nelson Forest Region.

From personal field testing of the above procedure it was noted that the patches obtained at the 20 cm diameter end, if taken on opposite sides, overlapped on the underside of the log; in most cases time consuming labour was spent axing away heavy branching from this point.

A decision was made Regional and District staff to sample all 190 trap tree sites to establish baseline data for the Bowron-Willow drainages in the first year of a continuing program.

Preliminary sampling was undertaken to determine if 1 pair of bark samples taken on opposite sides of the tree below the midline at the bole's midpoint, would be a precise and cost-efficient representation of the tree's population density.[5]

Appendix 11 illustrates the mean number of spruce beetle galleries per 400 cm^2 of trap tree bark surface found on paired samples taken at 9 m and 16 m from the butt end. A t-test for paired data (Snedecor and Cochran 1972) revealed that there was no significant difference between the number of galleries at the 9 or 16 m sampling distance. This result seemed to support findings by McComb (1953) and Nagel et al. (1957). Therefore, 1 paired set of bark samples taken at the 1/3 or 1/2 point on the bole was chosen as the sampling unit (Append. 12).

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[5] A Development index can be obtained by counting the number of larvae, pupae and adults.

In the sampling procedure, a hatchet was used to clear any branches near the sample point and then the blunt end was used to drive a 2 3/8" wide wood chisel (Craftsman 90025, Sears Ltd.) into the log to outline and remove the patch (Append. 13).

After the bark sample was carefully removed, the number of successful spruce beetle (and Ips sp. or other beetle) galleries was tallied (Append. 12). The trap tree d.b.h. and the relative degree of trap tree shading was also recorded. Under typical field conditions, a two person crew could sample and record the information from a trap tree site in approximately 20-25 minutes. An additional 20 minutes was required for the probe line examination.

C. Trap Tree Treatment or Removal

Trap trees deployed against spruce beetle are normally felled from November 1st to March 31st preceding the spruce beetle flight. After absorbing attacking beetles, these traps must be removed or treated within 1 year during the interval between late August and early April to prevent beetle emergence.

At press time, field reconnaissance by Regional personnel has revealed that several logging companies have failed to remove all of their trap trees felled from December 1979 to March 1980.[6] In some cases, road conditions and communication problems between logging companies and Forest Service District staff have hindered trap tree retrieval.

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[6]As outlined in memo to Prince George Regional Manager from author on August 6, 1981.

Costs of mechanically removing trap tree patches based on 1980 valuations from the appraisal manual are:

- 2 Skidders and Operators (medium sized machines, i.e. Clark 667) @ $40.50/hr. x 10 hrs./day x 2 =	$ 810.00/day
- 1 Bucker (Faller) $19.08/hr. x 10 =	$ 190.80/day
1 Loader and Operator (standard machine - Cat 966) $51.00/hr. x 10 =	$ 510.00/day
(Hauling costs not included) Total Cost =	$1,510.80/day

As with other trap tree costs, extraction expenses over and above normal logging costs are usually recoverable by the forest industry under Section 88.

In typical trap tree areas, the above crew could extract approximately 100 trees, or 4-5 trap tree patches per day.[7] Infested trap trees which cannot be removed must be peeled, burnt or chemically treated to destroy the immature brood.

1. Peeling several long bark strips from the trap tree with a draw knife causes the remaining bark to eventually check and crack away from the cambium; the bark is eventually exposed to the elements. This technique, however, is extremely labour intensive and is, therefore, beyond the scope of operational consideration.

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[7] K. Burnett, Resource Officer-Timber, B.C.F.S., Prince George East Forest District, B.C.

O. Slavic, Forester, Netherlands Overseas Mills, Prince George, B.C.

2. Burning has been attempted on a limited scale for destroying trap tree broods before spring breakup (Summit Lake, Winter 1979). Trap tree groups (3-4 traps each) have been delimbed, bucked and rolled together with a peavey overtop combustible "fines". Chainsaw gas has been used as an aid in ignition. Although reasonably effective, the process has also been extremely labour intensive and cannot be endorsed for more than limited "mop-up".

3. Chemical Treatment No chemical insecticides are presently registered for use against spruce beetle in trap trees in Canada.[8] In 1978 and 1979, operational research permits were obtained for using the insecticides Dursban 2E^{R} and Sevimol-4^{R} on trap trees in the Prince Rupert Region (Waters 1979).

Commencing May 31, 1978, the boles of 28 trap trees (felled February 1978) were sprayed with Dursban 2E^{R} (2.4 lbs./gal.) to the drip point at a rate of 2 stems/gal. (1 part insecticide to 10 parts water). Because of numerous obstructive branches on the traps, it took 12 hours for one applicator to treat the 28 stems with a garden type compression sprayer. All traps were baited with pheromone capsules, and 8 of these had plastic sheets placed under portions of the bole in an attempt to collect dead beetles (Moore 1978)

Although no check (or untreated) traps were used, and no quantitative data was collected, subsequent visual examinations of the traps revealed the applications were not completely effective as live beetle broods were found. The beetles which survived had either attacked the traps prior to treatment or

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[8]Minor-use registration pending for MSMA (monosodium methanearsonate) for use against mountain pine beetle, Dendroctonus ponderosae.

had not contacted the chemical when they entered the traps. As the scaly nature of the bark made complete chemical coverage almost impossible, some of the adults were able to bore into the phloem by crawling under bark scales without contacting the chemical.

Branches on trap trees which had to be retained for shading, greatly impeded spraying of the entire bark surface. The plastic sheets placed under trap trees collected excessive rainwater and forest debris thereby impeding assessment of adult mortality (Moore 1978).

While the idea of using a chemical to produce a lethal trap tree has merit, an external spray application does not appear practical on an operational basis.[9] For this reason the injection of a chemical such as MSMA into trees before they are felled is being tested and considered as an alternative to an insecticide spray.

V. LETHAL TRAP TREES

The lethal trap tree strategy for spruce beetle control is a recent modification of the conventional trap tree method of Nagel et al. (1957). A lethal trap tree may be created by:

(a) applying an insecticide to the bark of a felled or standing spruce before or after spruce beetle attack;[10]

(b) injecting a translocating herbicide into the root collar of a standing spruce; the tree is then left standing or felled.[10]

---

[9] However, insecticides may be the most cost-effective treatment for brood reduction in stumps. A research project should be planned to explore this strategy.

[10] Additional use of spruce beetle attracting synthetic pheromone is being researched.

From reviews by Lister et al. (1976) and Heath (1980), the most effective lethal trap tree has been one injected with 1/2-strength MSMA and felled 2 weeks later. In this procedure, a basal axe-frill is cut into the cambium around the circumference of a selected large diameter standing spruce. Into the frill is placed a small amount of the arboricide MSMA (Glowon^{R}) which then translocates through the xylem tissue in about 2 weeks, thereby killing the tree. The trap tree is then felled, and when attacked by spruce beetle, the subsequent brood fails to survive (Lister et al. 1976).

Trap trees can be injected with MSMA during two periods, in the fall before the trees' physiological processes cease, or in mid-April when vascular conduction begins. Whereas 1/2-strength formulations of MSMA have adequately destroyed spruce beetle broods, full-strength formulations may repel attacking adults (Lister et al. 1976, Heath 1980, Mitchell 1981). Lethal traps are felled approx. 2 weeks after MSMA injection. Since lethal traps need not be removed or subsequently treated, they can be used in remote or inaccessible areas where protection values warrant helicopter time.

In 1979-80, an operational research program using 62 lethal trap trees was conducted at Smithers Landing in the Prince Rupert Forest Region. In this study, the use of full-strength MSMA caused significant mortality of spruce beetle adults and broods, but was somewhat repellent to attacking adults in the lower 2/3 of the trap trees (Mitchell 1981). For 1980-81, additional lethal trap tree programs are planned for the Prince George and Nelson Forest Regions.

VI. CONCLUSIONS

Trap trees have been used in the Prince George Forest Region in various configurations and strategies since the winter of 1978-79. In many cases the traps have been felled without benefits of adequate shading, resulting in a marginal habitat for spruce beetle yet an attractive niche for Ips sp. Competition from Ips sp. has reduced the number of breeding sites available for spruce beetle on such traps. In some instances, several logging companies have failed to remove all of their trap trees before March 31st of the year following their felling.

While no one seriously questions the usefulness of trap trees in certain well defined circumstances, their effectiveness has been often assessed visually with no quantitative or comparative data recorded. The quantity of beetles in trap trees must be correlated with changes in beetle attacks in adjacent standing trees (probe lines). Furthermore, an appropriate number of check probe lines, isolated from the influence of adjacent trap trees, must be routinely established amidst a series of operational trap trees.

A crude estimate revealed that a trap tree of 57 cm d.b.h. was worth approx. $340.00 in protecting adjacent standing spruce of comparable diameter from spruce beetle attack and mortality. However, only when more information is available on important variables mentioned above, can a true cost/benefit analysis be performed.

Although chemical insecticides have some use, at present the only feasible lethal trap trees for operational use are those treated with MSMA. This strategy offers considerable promise for spruce beetle management in inaccessible or isolated high value stands prior to road pre-development. It is hoped that MSMA will receive minor-use registration for lethal trap trees in control of spruce beetle in the near future.

Research and operational trials to date have provided the foundation for designing effective trap tree strategies for use against spruce beetle in B.C. With increased planning, communication, and standardization of assessment techniques within and between Forest Regions, data on the cost-effectiveness of this method can be obtained.

VII. RECOMMENDATIONS

1. The deployment of conventional, lethal, and "decked" trap trees should become a routine practice for spruce beetle management in B.C. as refinements in cost/benefit analysis should ultimately prove.
2. Decking of logs should be encouraged whenever feasible during pre-development of logging areas in susceptible type. Log piles of 3 truckloads or more, spaced no farther than 1/2 mile apart, could be left over a summer to absorb attacking adults.
3. A provincial workshop is necessary to standarize procedures in B.C. for sampling spruce beetle populations in trap trees (conventional, lethal and "decked"), and in standing trees, blowdown, stumps and slash.
4. All trap tree groups that are sampled should have adjacent probe lines so that changes in beetle activity in standing trees can be correlated to attack densities in trap trees. The latter can only be achieved when an appropriate number of check probe lines, isolated by at least 1/4 mile from adjacent traps, are established amidst a series of operational trap trees, preferably at several locations in the infestation.
5. To supplement operational trap tree programs in B.C., field research trials to measure trap tree influence on beetle populations in adjacent standing timber are highly recommended for 1981 and beyond.

6. Forest Districts that are critically understaffed for spruce beetle reconnaissance and trap tree assessment should have increased funding and/or a re-alignment of responsibilities for permanent and auxiliary staff.

7. Regional training seminars are required to educate District field personnel in:

   (a) the identification of spruce beetle, associated beetles and tree damage;

   (b) the selection and felling of conventional, lethal and "decked" trap trees;

   (c) the axe-frilling of lethal trap trees and subsequent application of MSMA (specialized training);

   (d) the techniques of trap tree sampling and assessment; and

   (e) the principles of probe-line establishment and sampling.

8. The minor use registration of MSMA for lethal trap trees to control spruce beetle should be obtained as soon as possible.

9. Further small field research trials are recommended to properly test the toxicity of diesel oil and 1 or more chemical insecticides (ie. Dursban 2E^{R}, Sevimol-4^{R}, methoxychlor) against spruce beetle in stumps, windfalls and unmilled or non-injected trap trees.

10. An additional field study is necessary to compare the effectiveness of pheromone-baited, felled trap trees against non-baited traps trees.

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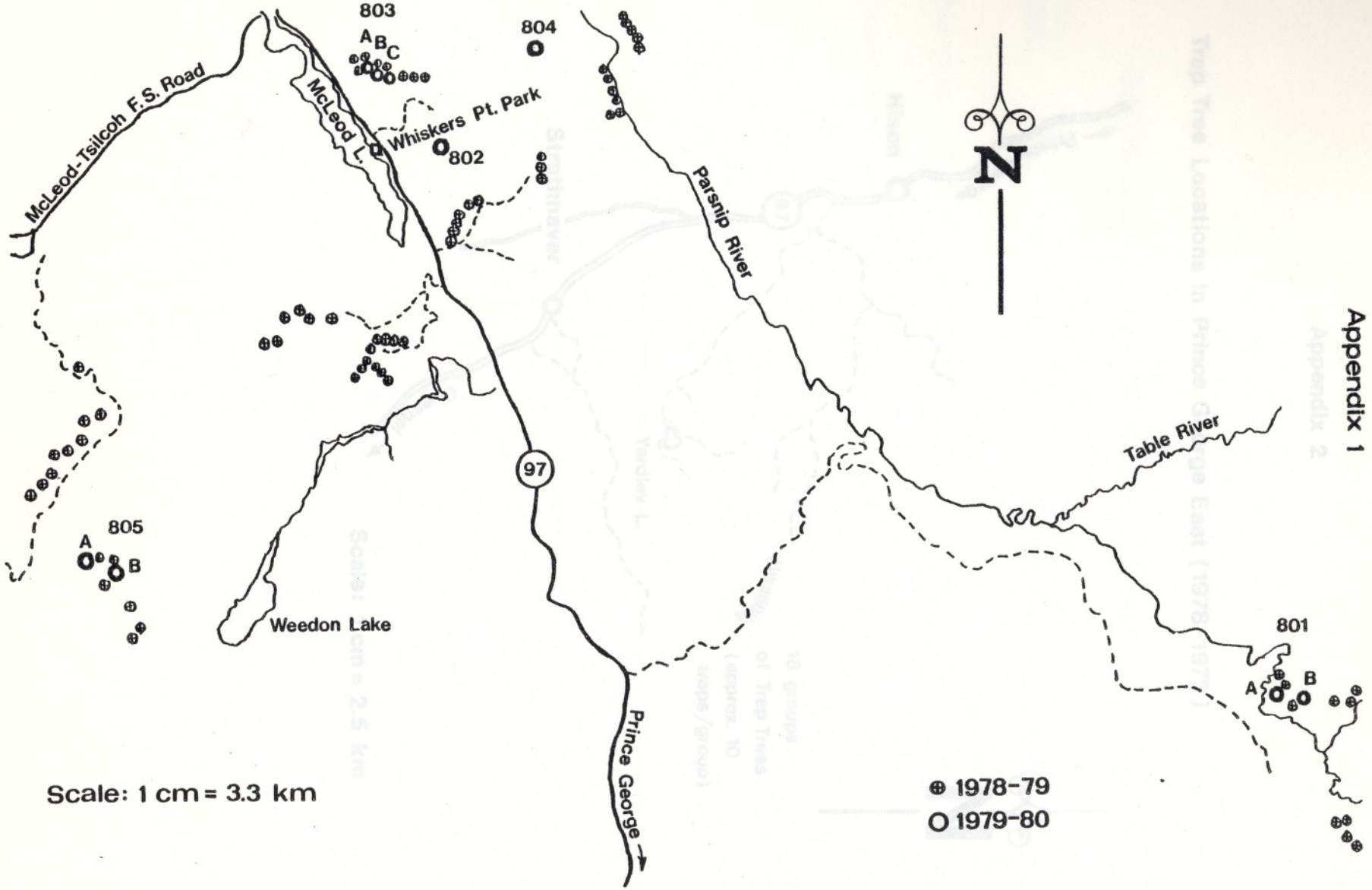
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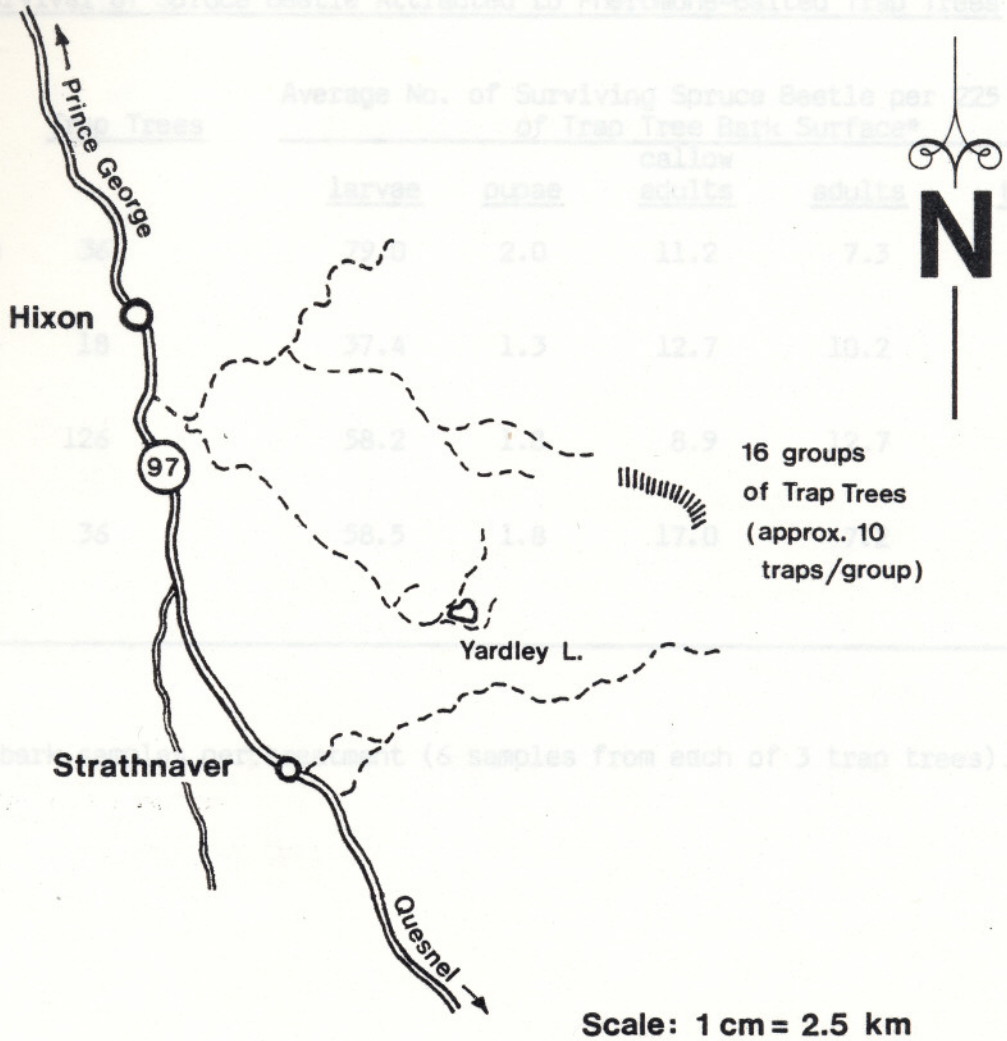
Appendix 1

Trap Tree Locations in Prince George West (Summit Lake) 1978-79, 1979-80



Appendix 2

Trap Tree Locations in Prince George East (1978-1979)



Appendix 3

Survival of Spruce Beetle Attracted to Pheromone-Baited Trap Trees

Trap Tree Treatment	Trap Trees	Average No. of Surviving Spruce Beetle per 225 sq. cm. of Trap Tree Bark Surface*				
		larvae	pupae	callow adults	adults	total
A. Pheromone	36	79.0	2.0	11.2	7.3	99.5
B. Pheromone	18	37.4	1.3	12.7	10.2	61.6
C. Check	126	58.2	1.8	8.9	12.7	81.6
D. Check	36	58.5	1.8	17.0	7.2	84.5

*Based on 18 bark samples per treatment (6 samples from each of 3 trap trees).

Appendix 4

Survival of Spruce Beetle in Stumps after Application of Diesel Oil

Stump Treatment	No. of Stumps	Average No. of Surviving Spruce Beetle per 225 sq. cm. of Stump Bark Surface after Application of Diesel Oil*				
		larvae	pupae	callow adults	adults	total
A. Diesel	42	38.0	2.5	7.4	13.2	61.6
B. Diesel[1]	12	25.0	0	3.0	20.0	48.0
C. Check[2]	6	26.0	0	2.0	8.0	36.0
D. Check	12	27.0	2.0	24.0	23.0	76.0

*Based on 6 bark samples per treatment (2 samples from each of 3 stumps).

[1,2]Pheromone on adjacent trap trees.

Appendix 5

Spruce Beetle Gallery Count in Trap Trees - Summit Lake, July 1980

Location		Avg. No. of Successful Spruce Beetle Galleries per 225 cm^2 of Bark Surface per Location	
		Stump	Log
Parsnip-Missinka	801 A	4.50	5.44
	801 B	10.68	5.28
Whiskers	802	4.68	2.15
McLeod Lake-Mtn. Rd.	803 A	5.25	4.50
	803 B	7.50	1.11
	803 C	0	3.61
Parsnip-Powerline	804	7.29	2.14
Weedon	805 A	7.50	2.33
	805 B	6.00	3.67

*The Gallery counts were derived from the average of 36 bark samples per area (6 trees from each trap tree group - except 803 B and 805 A, B which had 3 trees per location).

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Rustad Bros. Co.

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	*Ips* sp. or other beetles		1979 Attack	1980 Attack	no Attack	
1.	Traps removed before sampling.							
2.	57.50	2.00	19.50	Moderate	0	0	30	0
3.	37.00	4.50	18.75	Moderate	3	2	52	-1
4.	44.50	3.25	26.25	Low	0	0	35	0
5.	58.50	2.50	25.75	Low	0	0	40	0
6.	48.50	4.00	18.75	Moderate	0	0	31	0
7.	53.00	2.25	22.50	Moderate	0	0	15	0
8.	47.00	2.50	17.50	Moderate	0	0	73	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Carrier Lumber

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
1.	65.50	4.75	7.25	Heavy	0	0	24	0
2.	69.50	3.50	12.50	Low	-	-	-	-
3.	61.25	2.50	18.75	Heavy	-	-	-	-
4.	63.00	3.00	18.00	Low	1	0	24	-1
5.	48.00	3.75	13.25	Low	-	-	-	-
6.	62.00	3.00	10.25	Low	-	-	-	-
7.	55.00	2.25	11.50	Low	-	-	-	-
8.	65.00	3.00	11.50	Low	3	1	65	-2
9.	logged							
10.	57.00	4.00	15.00	Low	1	4	34	+3
11.	82.00	7.00	13.50	Poor	1	2	50	+1
12.	49.00	5.00	12.50	Low	0	0	22	0
13.	77.00	5.00	13.50	Low	0	0	80	0
14.	51.00	4.00	8.25	Low				
15-17	logged							
18.	47.55	2.50	5.00	Low	4	0	52	-4
19.	35.25	3.50	18.50	Poor	0	1	20	+1
20.	58.25	2.25	5.00	Low	0	1	21	+1
21.	58.00	4.25	20.00	Low	0	0	19	0
23.	42.50	3.50	18.50	Low	0	0	0	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Carrier Lumber

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
24.	38.00	1.25	11.00	Low	0	1	10	+1
25.	43.50	3.25	31.75	Poor	0	0	35	0
26.	44.00	4.75	23.75	Heavy	0	0	22	0
27.	49.00	2.50	22.50	Low	0	0	28	0
28.	-	-	-	-	4	0	16	-4
29.	46.50	1.25	26.25	Poor	0	0	28	0
30.	54.00	4.00	13.75	Low	0	0	30	0
31.	67.00	4.00	21.75	Poor	4	4	34	0
32.	64.50	4.00	10.00	Moderate	0	2	28	+2
33.	-	-	-	-	1	0	38	-1
34.	86.00	4.25	16.50	Moderate	0	0	29	0
35.	70.00	6.25	8.75	Low	-	-	-	-
36.	71.00	3.25	15.00	Heavy	-	-	-	-
37.	55.50	4.00	11.75	Heavy	0	3	21	+3
38.	60.75	5.00	9.25	Heavy	0	1	17	+1
39.	53.50	3.25	12.50	Moderate	0	0	49	0
40.								
41.	41.00	2.75	2.75	Poor	0	0	30	0
42.	53.00	4.50	15.75	Poor	-	-	-	-
43.	42.00	4.00	13.25	Low	1	0	44	-1

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Carrier Lumber

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
44.	61.00	2.50	31.75	Low	2	1	39	-1
45.	54.00	2.50	28.75	Poor	0	0	79	0
46.	60.50	3.75	30.00	Poor	0	0	69	0
47.	34.50	2.25	22.50	Moderate	0	0	60	0
48.	41.50	2.75	18.75	Poor	0	0	25	0
49-53	deleted							
54.	73.00	4.75	23.75	Moderate	0	0	20	0
55.	51.50	4.50	21.25	Low	1	0	24	-1
56.	71.50	3.25	20.00	Low	-	-	-	-
57.	48.50	4.25	32.50	Low	6	3	28	-3
58-60	logged							
61.	59.50	3.50	13.75	Moderate	0	0	30	0
62.	53.25	1.00	25.00	Heavy	0	0	29	0
63.	52.00	1.25	16.75	Low	0	0	30	0
64-65	not felled.							
66.	64.00	2.25	2.50	Heavy	0	0	50	0
67.	75.00	3.25	10.00	Heavy	4	0	61	-4
68.	63.50	3.00	8.75	Heavy	0	0	60	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Southwest N.O.M. (Hixon I)

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
3800 RD (3830)								
1.	79.50	4.00	14.25	Heavy	0	0	35	0
2.	74.50	4.50	11.25	Moderate	-	-	-	-
3.	68.00	4.25	16.25	Moderate	2	1	25	-1
3800 RD (3828)								
1.	102.00	3.75	15.00	Heavy	0	0	30	0
2.	-	6.25	10.00	Heavy	0	0	17	0
3.	90.00	6.25	10.00	Heavy	0	0	29	0
4.	78.00	4.00	10.00	Medium	0	0	31	0
5.	74.00	4.75	8.75	Low	0	0	27	0
6.	69.00	4.25	20.00	Moderate	0	0	33	0
7.								
8.								

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Dunkley - West Fraser (Hixon II)

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
2400 Rd								
1.	57.00	3.75	15.00	Heavy	0	0	33	0
2.	57.50	5.50	8.50	Moderate	-	-	-	-
3.	55.00	3.25	10.00	Low	2	2	56	0
4.	66.50	4.00	12.50	Low	-	-	-	-
5.	67.50	6.75	3.75	Moderate	0	0	10	0
6.	64.50	6.75	8.75	Moderate	1	0	16	-1
7.	68.50	4.00	11.75	Moderate	2	1	32	-1
8.	67.00	5.50	8.75	Moderate	0	0	28	0
9.	59.50	4.25	8.75	Moderate	0	0	29	0
2437 Km								
1.	78.50	3.00	12.50	Heavy	0	0	31	0
2.	54.50	2.00	13.75	Moderate	0	0	54	0
3.	68.50	4.50	10.00	-	-	-	-	-

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Dunkley - West Fraser (Hixon II)

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
24c Rd								
1.	Logged							
2.	78.00	4.75	17.50	Heavy	Logged	-	-	-
3.	Logged							
4.	71.50	2.25	11.75	Heavy	1	0	40	-1
5.	59.50	1.25	12.50	Low	0	1	28	+1
6.	74.50	2.25	16.00	Moderate	2	5	27	+3
7.	56.00	2.00	9.50	Heavy	4	3	38	-1
8.	64.00	2.75	9.50	Heavy	0	0	45	0
9.	52.50	2.25	13.75	Moderate	1	1	29	0
10.	54.00	2.75	15.50	Heavy	0	0	32	0
11.	46.00	2.75	21.50	Heavy	0	2	31	+2

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Northwood

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
a) 64km	54.50	1.50	20.00	Poor	0	4	29	+4
b) 66km	57.50	4.50	17.50	Low	0	5	33	+5
c) 68km	71.00	2.25	14.00	Moderate	2	1	41	-1
d) 70km	55.00	4.00	16.25	Moderate	0	0	48	0
3.	54.50	3.00	26.25	Poor	-	-	-	-
5.	45.50	2.50	22.50	Poor	-	-	-	-
6.	41.50	4.00	25.00	Low	-	-	-	-
7.	62.50	6.25	11.75	Poor	12	1	37	-11
8-11	logged							
12.	25.50	2.25	16.75	Poor	0	0	32	0
13-15	deleted							
16.	55.50	3.50	23.75	Low	0	0	33	0
17.	42.50	2.75	22.50	Low	0	0	21	0
18.	49.00	2.00	23.50	Poor	5	5	15	0
19.	19.00	0.25	25.50	Poor-Mod.	3	2	3	-1
20.	52.00	2.25	9.25	Poor	4	11	26	+7
21.	42.00	1.50	1.50	Poor	2	5	43	+3
22.	59.00	1.75	20.00	Poor	18	10	7	-8
23.								
24.	52.50	3.25	18.75	Poor	2	0	22	-2
25.	42.00	4.00	26.25	Low	6	5	17	-1

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: Northwood

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	*Ips* sp. or other beetles		1979 Attack	1980 Attack	no Attack	
26.	59.00	3.25	31.25	Poor	6	23	8	+17
29.	57.50	3.75	13.00	Low	5	0	18	-5
30.	57.50	2.75	20.00	Low	-	-	-	-
31.	59.00	4.00	22.50	Low	-	-	-	-
32.	32.50	1.75	31.25	Poor	-	-	-	-
33.	61.50	3.50	13.00	Poor	-	-	-	-

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: N.O.M.

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
1.	56.00	2.30	16.00	Moderate	-	-	-	-
2.	90.00	0.50	13.50	Poor	0	0	5	0
3.	53.33	2.80	12.70	Heavy	1	0	10	-1
4.	63.33	4.10	20.10	Low	0	0	4	0
5.	67.00	4.25	11.50	Low	0	0	190	0
6.	64.33	5.00	13.75	Low	1	1	18	0
7.	-	-	-	-	0	0	40	0
8.								
9.	73.75	4.50	13.75	Moderate	0	0	57	0
10.	75.00	6.50	16.25	Low	0	0	34	0
11.	69.00	5.25	7.50	Low	-	-	-	-
12.	25.50	2.25	16.50	Poor	-	-	-	-
13.	59.50	3.00	3.25	-	0	0	27	0
14.	53.00	2.25	20.50	-	0	0	27	0
15.	60.00	2.75	21.75	-	1	0	35	-1
16.	50.00	2.25	17.50	-	6	0	31	-6
17.	68.15	4.25	12.00	-	0	0	32	0
18.								
19.								
20.	68.15	3.25	13.75	-	0	0	35	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: N.O.M.

Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
1.	56.00	2.30	16.00	Moderate	-	-	-	-
2.	90.00	0.50	13.50	Poor	0	0	5	0
3.	53.33	2.80	12.70	Heavy	1	0	10	-1
4.	63.33	4.10	20.10	Low	0	0	4	0
5.	67.00	4.25	11.50	Low	0	0	190	0
6.	64.33	5.00	13.75	Low	1	1	18	0
7.	-	-	-	-	0	0	40	0
8.								
9.	73.75	4.50	13.75	Moderate	0	0	57	0
10.	75.00	6.50	16.25	Low	0	0	34	0
11.	69.00	5.25	7.50	Low	-	-	-	-
12.	25.50	2.25	16.50	Poor	-	-	-	-
13.	59.50	3.00	3.25	-	0	0	27	0
14.	53.00	2.25	20.50	-	0	0	27	0
15.	60.00	2.75	21.75	-	1	0	35	-1
16.	50.00	2.25	17.50	-	6	0	31	-6
17.	68.15	4.25	12.00	-	0	0	32	0
18.								
19.								
20.	68.15	3.25	13.75	-	0	0	35	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: N.O.M.

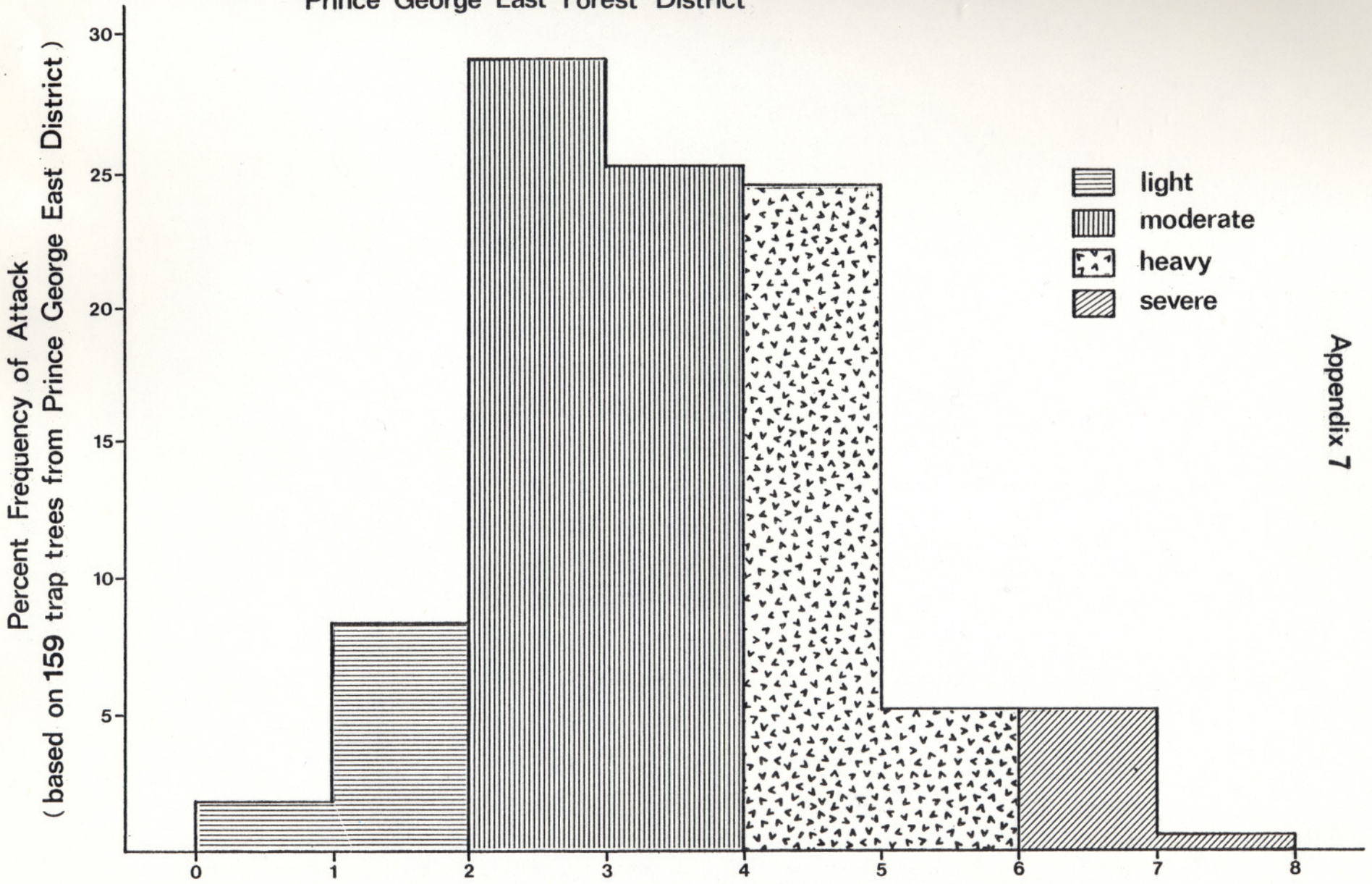
Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
21.	53.50	2.75	14.50	Moderate	0	0	27	0
22.	51.50	3.75	18.25	Low	1	0	54	-1
23.	52.75	3.10	11.40	-	7	1	34	-6
24.	63.67	5.50	24.00	Moderate	6	7	28	+1
25.	57.00	3.00	10.75	Moderate	4	0	16	-4
26.	69.75	4.50	11.25	Moderate	3	0	28	-3
27.	67.00	2.50	12.00	-	0	0	26	0
28.	65.25	4.00	5.00	Poor	0	0	24	0
29.	47.50	2.00	23.75	Low	2	13	12	+11
30.	55.00	2.00	28.50	Poor	0	10	18	+10
31.	38.00	2.50	26.75	Poor	4	7	14	+3
32.	48.50	1.25	26.25	Moderate	1	8	12	+7
33.	44.00							
34.	48.50	4.50	18.75	Low	1	3	0	+2
35.	62.00	2.00	28.00	Low	0	0	19	0
36.	43.00	6.25	12.50	Heavy	0	1	28	+1
37.	Trap Trees not dropped.							
38.	63.00	3.12	26.50	Low	3	0	22	-3
39.	44.75	1.00	17.88	Low	2	0	49	-2
40.	51.25	3.25	16.63	Moderate	0	0	19	0

SPRUCE BEETLE TRAP TREE ASSESSMENT - PRINCE GEORGE EAST - 1980

Company Interest Area: N.O.M.

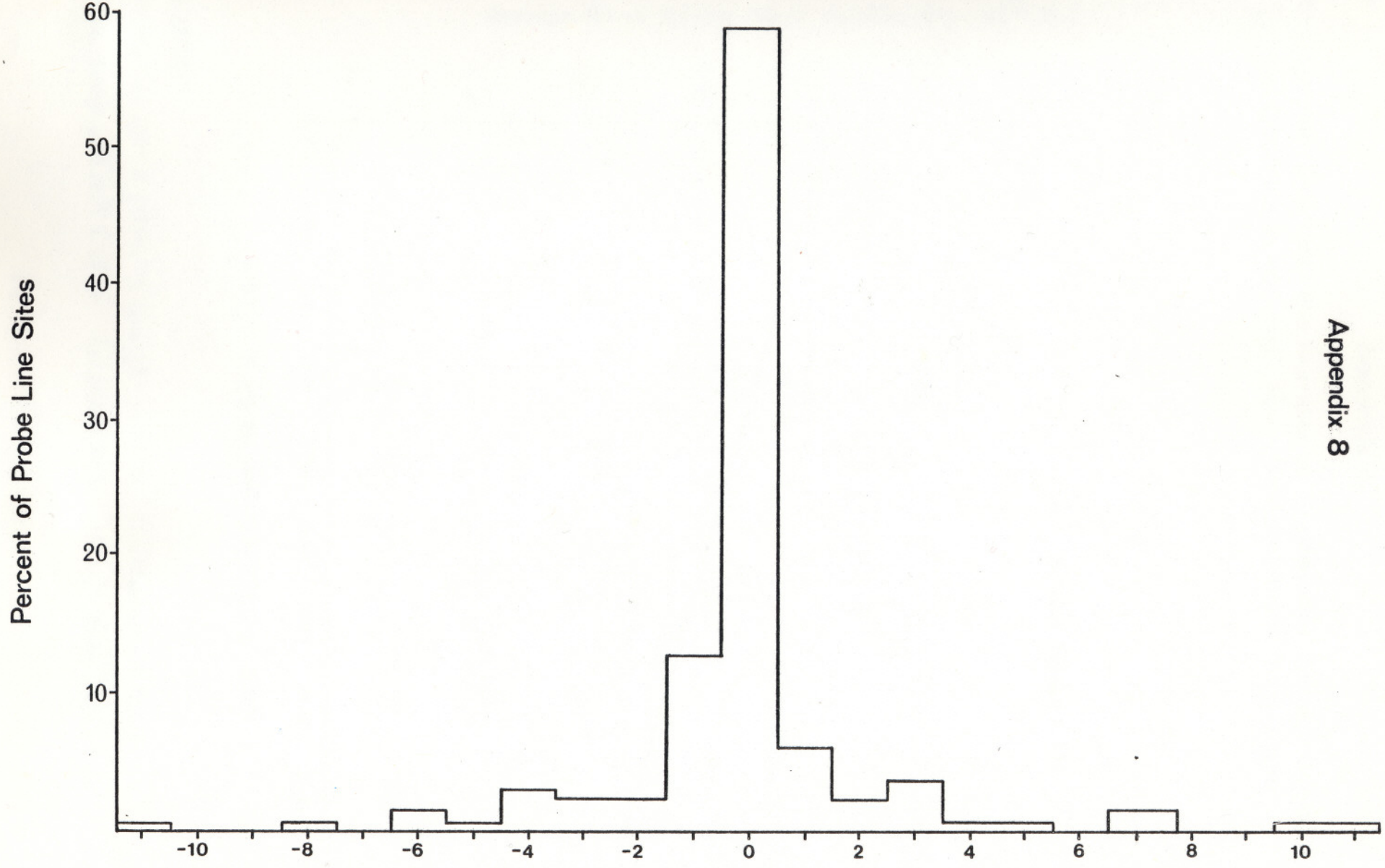
Site No.	Trap Tree d.b.h. in cm.	Avg. No. of Successful Galleries per 400 cm^2 of Trap Tree Bark Surface		Trap Tree Shading	No. of Standing Probe-Line Trees Attacked by Spruce Beetle			Increase or Decrease in Beetle Attack
		Spruce Beetle	Ips sp. or other beetles		1979 Attack	1980 Attack	no Attack	
41.	57.00	3.50	22.50	Low	-	-	-	-
42.	62.50	3.50	12.67	Moderate	2	2	45	0
43.	52.00	3.00	21.25	Poor	-	-	-	-
44.	63.00	2.25	7.50	Moderate	0	0	23	0
45.	29.50	1.00	20.00	-	-	-	-	-
46.	36.50	0	11.75	-	0	0	23	0
47.	39.75	2.25	17.75	Heavy	0	0	35	0
48.	Logged							
49.	43.00	1.25	12.50	Heavy	0	0	15	0
50.	54.00	3.75	7.50	Heavy	0	0	30	0
51.	49.75	2.25	30.00	Heavy	0	0	9	0
52.	73.75	5.25	10.00	-	0	0	22	0
53.	56.60	3.00	15.00	Moderate	1	1	24	0
54.	36.50	3.00	27.50	Heavy	0	0	22	0
55.	60.00	3.25	25.00	-	0	0	23	0

Spruce Beetle Infestation Levels in Trap Trees During 1980.
Prince George East Forest District



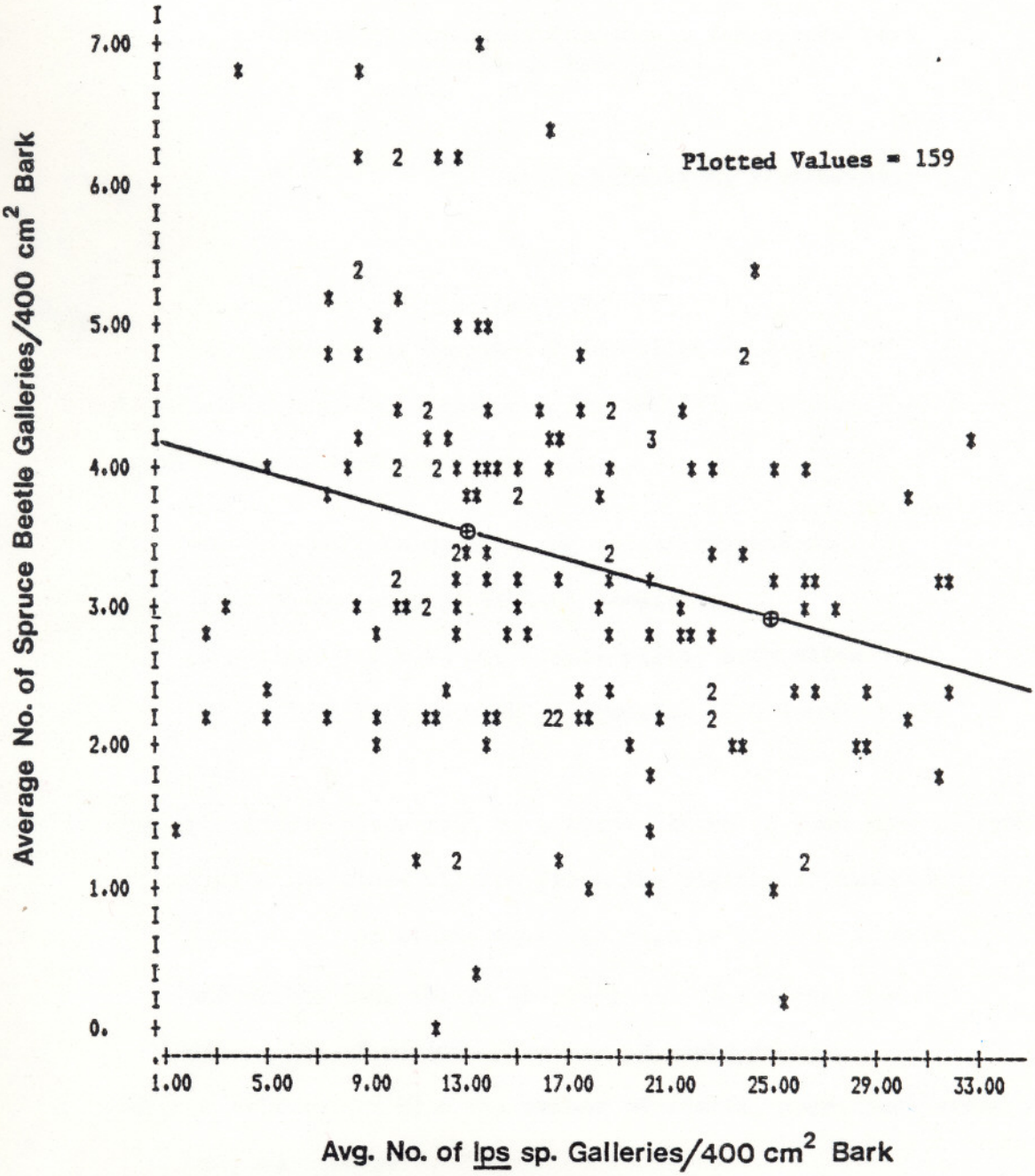
Appendix 7

Distribution of Changes in the Number of Spruce Beetle-Attacked Spruce on Probe Lines adjacent to Trap Tree Sites in Prince George East (1979-80)



Appendix 9

Relationship Between the Number of Successful Spruce Beetle & Ips sp. Galleries in 400 cm^2 Bark Samples from Trap Trees



Statistics:

Correlation (R)= 0.25249, R Squared= 0.06375, Significance= 0.00066

Stand. Error of Est.= 1.31130, Intercept (A)= 4.16434, Slope (B)= -0.04976

FOREST SERVICE
Province of British Columbia

Appendix 10

DATE: August 2, 1979

FILE NO. Pest Management Sup.

SUBJECT: Sampling Procedures for Spruce Bark Beetle in Trap Trees.

ATTENTION OF: Dennis Hutcheson, Protection.

RKS:

The following is for your information to assist in formulating sampling procedures for the Prince George Region in Spruce Trap Tree Plots.

(1) Sampling will be done in August and September.

(2) Three trees per plot will be sampled.

(3) Each tree will have six sample plots, each being ½ square foot in area with a dimension of 8 inches by 9 inches.

(4) The sample plots will be situated three to each side of the tree. The plots will be below the midline of the tree, located (a) no closer than ten feet to the cut or butt end of the log, (b) at the midpoint of the log, and (c) at a point of minimum diameter of eight inches.

(5) At each sample plot the number of adults, pupae and larvae will be counted.

(6) The butt diameter of the log and the distance to the eight inch diameter point will be measured to establish the number of attacks per square foot and the number of larvae.

(7) Stumps will be sampled three to a plot. Two sample plots

per stump on the lower portion of the stump, one on the sunny side and one on the shaded side. The sample plots will be 6 inches by 6 inches.

These sampling procedures were developed with the assistance of Jack Monts, F.I.D.S. Canadian Forest Service.

Herb Spence
Acting Ranger.

Appendix 11

Comparison of the Mean Number of Spruce Beetle Galleries at Two Sampling Locations on Felled Trap Trees

Trap Tree No.	Mean No. of Spruce Beetle Galleries per 400 sq. cm. of Trap Tree Bark Surface	
	At 9 m*	At 16 m*
1	2.0	1.0
2	3.5	3.5
3	2.5	0.5
4	5.0	3.0
5	1.5	0.5
6	3.0	4.0
7	2.5	4.0
8	5.5	7.5
9	5.0	1.5
10	2.5	4.5
11	4.0	5.5
12	5.5	3.5
13	6.5	11.0
14	4.5	6.5
15	6.5	6.0
16	2.0	0
17	3.0	1.5
18	2.5	1.0
	$\bar{x}$ = 3.75**	$\bar{x}$ = 3.61**

*No. of meters from the butt end.

**No significant difference at $p < 0.05$ ($t = 0.29$, d.f. = 17)

Appendix 12

SPRUCE BEETLE
TRAP TREE ASSESSMENT

Date : _____ Location : _____

Location of 400 cm^2 bark patch.	Number of Successful Beetle Galleries per 400 cm^2 of Trap Tree Bark Surface			
	Trap Tree No.			
	1. Dbh = ___ cm		2. Dbh = ___ cm	
$\frac{1}{3}$-$\frac{1}{2}$ up bole.	Spruce Beetle	Other	Spruce Beetle	Other
Sunny Side				
Shaded Side				
Total	a.	c	b	d

Avg. No. Spruce Beetle Galleries / 400 cm^2 Bark Patch = $\frac{a+b}{4}$ = ___

Avg. No. Ips (or other) Galleries / 400 cm^2 Bark Patch = $\frac{c+d}{4}$ = ___

Comments : (Shading, etc...) _____

Appendix 13

Trap Tree Sampling

