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Ministry of
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FOREST INSECT & DISEASE IMPACTS IN TIMBER SUPPLY AREAS

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Victoria, B.C.

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PEST MANAGEMENT REPORT NUMBER 6

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ESTIMATES OF FOREST INSECT AND DISEASE IMPACTS IN BRITISH COLUMBIA TIMBER SUPPLY AREAS

Coordinated by

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Protection Branch

British Columbia Forest Service

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TABLE OF CONTENTS

		Page
	LETTER OF TRANSMITTAL	iv
	FOREWARD	v
1.	INTRODUCTION	1
2.	METHODS	3
3.	PROVINCIAL SUMMARY	9
4.	FOREST REGION AND TIMBER SUPPLY AREA SUMMARIES	15
4.1.	CARIBOO	15
4.1.1.	QUESNEL	21
4.1.2.	WILLIAMS LAKE	28
4.1.3.	100 MILE	34
4.2.	KAMLOOPS	40
4.2.1.	KAMLOOPS	46
4.2.2.	LILLOOET	51
4.2.3.	MERRITT	56
4.2.4.	OKANAGAN	61
4.3.	NELSON	66
4.3.1.	ARROW	71
4.3.2.	BOUNDARY	77
4.3.3.	CRANBROOK	82
4.3.4.	GOLDEN	88
4.3.5.	INVERMERE	94
4.3.6.	KOOTENAY LAKE	100
4.3.7.	REVELSTOKE	106
4.4.	PRINCE GEORGE	111
4.4.1.	FORT NELSON	117
4.4.2.	MACKENZIE	122
4.4.3.	McBRIDE	128
4.4.4.	PEACE	134
4.4.5.	PRINCE GEORGE	140

TABLE OF CONTENTS (continued)

		Page
4.5.	PRINCE RUPERT	146
4.5.1.	BULKLEY	151
4.5.2.	CASSIAR	156
4.5.3.	KALUM	160
4.5.4.	KISPIOX	165
4.5.5.	LAKES	170
4.5.6.	MORICE	175
4.5.7.	NORTH COAST	180
4.5.8.	QUEEN CHARLOTTES	185
4.6.	VANCOUVER	189
4.6.1.	FRASER	194
4.6.2.	KINGCOME	200
4.6.3.	MID COAST	206
4.6.4.	NOOTKA	212
4.6.5.	QUADRA	218
4.6.6.	SOO	224
5.	ACKNOWLEDGMENTS	230
6.	REFERENCES	231
7.	APPENDICES	233
7.1.	DETAILED METHODS FOR CALCULATING PEST LOSSES	234
7.1.1.	BARK BEETLES	234
7.1.1.1.	CARIBOO APPROACH	235
7.1.1.2.	NON-CARIBOO APPROACH	237
7.1.2.	DOUGLAS-FIR TUSSOCK MOTH	239
7.1.2.1.	GROWTH LOSSES	239
7.1.2.2.	MORTALITY LOSSES	241
7.1.3.	ROOT DISEASES	241
7.1.3.1.	LAMINATED ROOT ROT AND ARMILLARIA ROOT DISEASE	241
7.1.3.2.	TOMENTOSUS ROOT ROT	243

TABLE OF CONTENTS (continued)

		Page
7.1.4.	DWARF MISTLETOES	243
7.1.5.	WHITE PINE WEEVIL	244
7.1.6.	WESTERN SPRUCE AND 2-YEAR-CYCLE BUDWORMS	246
7.1.6.1.	GROWTH LOSSES	246
7.1.6.2.	MORTALITY LOSSES	248
7.1.7.	PORCUPINE	250
7.1.8.	SPRUCE APHID	250
7.1.9.	REGENERATION DELAY LOSSES	251
7.2.	GLOSSARY	252

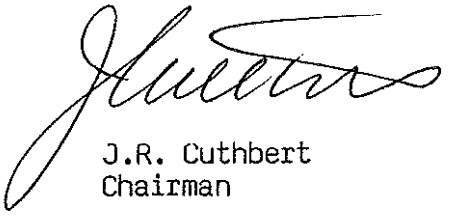
FOREST PEST REVIEW COMMITTEE of BRITISH COLUMBIA

In 1983, W. Young, Chief Forester for British Columbia and founding Chairman of the Forest Pest Review Committee, requested a tabulation of pest impact data for each Timber Supply Area (TSA) in the Province. The Committee was aware that forest pests in several TSA's were greatly influencing timber harvesting and forest management plans. However, pest-caused impacts, i.e., mortality, growth and yield losses and other effects, had yet to be specified in TSA plans. These data were required to assess pest effects on short-term supplies of mature timber and on long-term forest productivity represented by immature stands, and to show where pest effects were either unavoidable or manageable.

The data for this report were provided by, or derived from, Canadian Forestry Service research studies and surveys, and by B.C. Forest Service operational surveys, particularly for bark beetles and root diseases. Where data were lacking, results were extrapolated from other regions or estimated from expert and local opinions.

BCFS Pest Management and Planning and Inventory staff at Victoria and at regional offices developed a format for data expected to be the most useful for planning purposes and for supplementing calculations of yields and allowable annual cuts. However, because several major assumptions have been made, e.g., some pest effects already have been incorporated into volume-overage curves based on natural stands, future revisions - both to format and data - are expected for this report.

This compilation represents current, best estimate of pest-caused forest losses in B.C. Although many of the data are tentative, they should be valuable for planning and pest management specialists in industry and government, for management teams and for TSA steering committees. Readers of this report are encouraged to comment and provide suggestions. The FPRC will ensure that the report, along with future amendments based on new information, remains current and relevant.



J.R. Cuthbert
Chairman

4 March 1986

FOREWARD

This report, "Forest Insect and Disease Impacts in Timber Supply Areas," requires suggestions and comments from users to assist planning and pest management personnel to improve future issues.

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1. INTRODUCTION

Insects, diseases, weeds and other organisms cause a variety of detrimental effects ranging from growth loss and deformity to tree mortality. There is growing concern regarding the effects of pests in British Columbia's forests, and attempts are being taken to reduce them. The provincial government, for example, has allocated several million dollars annually to reduce the impact of bark beetles, on provincial forests. Although many forest pests have been identified and assessed, adequate information is not readily available for management purposes in all cases.

This report is a supporting document for Timber Supply Area (T.S.A.) and pest-management planning. It provides estimates of timber volume losses due to pests for each T.S.A. in British Columbia based on available survey data, extrapolation of research results and professional opinion.

The objectives of the report are:

- to annually estimate the respective losses of forest pests and summarize them provincially, regionally[a], and by each T.S.A. These summaries include mortality losses, salvage estimates, growth losses, and regeneration delays.

- to review current damage appraisal and survey information to arrive at estimates of the incidence, impact, and affected area.

Forest protection, including control and management of fires and pests, has been recognized and included in forestry operations but has not, until recently, been adequately represented in long term timber supply planning. One of the major impediments to incorporating pest impacts in this planning process has been the lack of reliable data regarding the impact of pests on timber growing stock. Recent bark beetle surveys carried out in the Interior pine and spruce forests, and root disease surveys in coastal second growth

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[a] Two page colors, green and orange, are used in this document to differentiate between regional and T.S.A. summaries, respectively.

Douglas-fir stands are examples of attempts to rectify some of these data gaps. Information from these surveys is already being used; for instance, recent timber supply analyses for the Quadra T.S.A. have used managed stand yield tables developed from the Vancouver Region root disease survey.

Allied to the task of collecting and recording pest management data is the work now underway to improve upon the incorporation of pest impact data in the procedures used to assess impacts on future timber supplies and other elements of the forest resource base. Currently, to account for catastrophic losses from fires, insects and disease, a total volume loss deduction is made to the estimated long run sustained yield capacity of the T.S.A. Recently, Reed and Errico (1985) have shown that incorporation of fire losses of 1% per year in a dynamic forest yield model results in a 40-60% reduction of the expected long run sustained yield. Efforts by these researchers to develop a model to determine the effect of insects and disease continue.

This report represents the current best estimate of pest losses. It will be revised annually based on new data and current estimation techniques.

3. METHODS

The methods used deal with three major types of impacts (mortality, growth and regeneration delay) for each pest group and must be uniformly applied to all T.S.A.'s (see Table 1). Survey information used to deduce these losses is provided from either British Columbia Forest Service (B.C.F.S.) or Canadian Forestry Service (C.F.S.) surveys. If duplicate survey data exist, then the Regional Pest Management Coordinator determines which information is best suited for inclusion into the loss calculations.

All losses are calculated for the Crown forest gross and net operable land bases (Appendix 7.2, glossary). Losses are not generally calculated for Tree Farm Licence (T.F.L.) lands. Both these land bases are obtained from two different data sources. The first is obtained from the Inventory and Planning Branch's area or volume reports (Statistical Analysis System[a] (S.A.S.) Reports, glossary) and the second from pest surveys. If T.F.L. and private lands have been included in surveys, it should be footnoted as such, or else assumed that only crown forest lands outside T.F.L.'s were surveyed.

Mortality losses (glossary) are based on current survey data and produce short-term (1 year) salvage estimates and current year impact figures. Although the bulk of mortality losses occur on mature timber types, some mortality occurs in immature timber types. Thus, the terms "Mortality Losses" and "Mature Pest Losses" are not synonymous. Included in this category is mortality from bark beetles (mountain pine beetle[b], spruce beetle,

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a Assistance in obtaining S.A.S. reports can be obtained from the Regional Planning Officer or the Headquarter's Systems Development Forester (Planning Branch).

b Common pest names are found in Benoit (1985) and Hawksworth *et al.* (1985).

Table I Summary of major pests accounted or not accounted for in volume estimates, based on category of loss[a]

	Not Accounted for in Current Volume Estimations (V.A.C. s/A.V.L. s)	Accounted for in Current Volume Estimations (V.A.C. s/A.V.L. s)
Mortality Losses	mountain pine beetle (m^3) spruce beetle (m^3) Douglas-fir beetle (m^3) western balsam bark beetle (m^3) Douglas-fir tussock moth (m^3/current year)	western spruce budworm (m^3/current year) decay
Growth Losses	Douglas-fir tussock moth (m^3/current year)	laminated root rot(m^3/year) armillaria root disease (m^3/year) tomentosus root rot (m^3/year) dwarf mistletoes (lodgepole pine, Douglas-fir, hemlock and larch) (m^3/year) western spruce budworm (m^3/current year) 2-year-cycle budworm (m^3/current year) spruce aphid (m^3/current year)
Regeneration Delay Losses	mountain pine beetle (m^3/year) spruce beetle (m^3/year) Douglas-fir beetle (m^3/year) western balsam bark beetle (m^3/year) porcupine (m^3/year) severe white pine weevil infestations (m^3/year)	

a The breakdown presented in this table assumes the use of unmanaged stand yield tables.

Douglas-fir beetle and western balsam bark beetle) and some defoliators (western spruce budworm, 2-year-cycle budworm[a], and Douglas-fir tussock moth)[b]. Root diseases and blisten rusts may also cause mortality in immature stands but this loss is not measured, as mortality assessment techniques are not well developed for these pests.

Current survey data are used to estimate salvage opportunities and to identify non-salvaged losses (glossary) for inventory updating. In addition, estimates of losses over the total crown land base (gross estimates) are calculated for comparison with previous estimates (i.e. C.F.S. or B.C.F.S.).

An alternative approach, which was rejected, was to average mortality due to pest actions over the previous 5-10 year period to produce an average annual mortality estimate. This approach was not feasible as past survey and impact estimates are not sufficiently accurate to make reliable long-term averages.

Growth losses are generally treated as long-term losses on the L.R.S.Y. and are used to calculate pest losses resulting from root diseases and dwarf mistletoes. These losses are based on susceptible areas determined from S.A.S. reports.

This long-term approach assumes that growth responses due to pests will remain constant over future rotations. This assumption is not necessarily true for all pests, but one which is assumed for this exercise.

This approach involves estimating the total susceptible area for pests which cause growth losses and applying a loss figure based on the Maximum Mean Annual Increment (MAX M.A.I., glossary). All M.A.I. figures used in this

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a Note: the western spruce budworm causes both mortality and growth losses, while bark beetles cause both mortality and regeneration delay losses.

b The tussock moth's major impact over an infestation cycle (3-5 years) is mortality but growth losses contribute a smaller, but still significant, portion of the total loss. (Ross and Taylor, 1983).

report come from the Chapman Richard's Equation (glossary, for the appropriate utilization levels). The total susceptible area is used for calculating losses, regardless of the stand's current age, as L.R.S.Y. is effected by losses which occur over the lifetime of a stand.

Exceptions to the long-term growth loss approach are losses resulting from the western spruce budworm, 2-year-cycle budworm, Douglas-fir tussock moth, and spruce aphid, which will be calculated as a loss based on survey data from the current year only. Historic survey information on these pests is not sufficiently accurate to make long-term estimates at this time.

Regeneration delay losses (glossary) are treated as long-term losses to L.R.S.Y. and will be calculated for bark beetle infestations, porcupines, and severe weevil infestations. These impacts are based on areas determined from survey reports. The regeneration delays represented here will only include additional delays directly attributable to their respective pests. To arrive at the total regeneration delay, an additional time span must be added to allow for normal crop establishment. Light to moderate weevil infestations are not considered to have a significant impact on timber losses and will not be calculated until better assessment techniques are available. Losses to the lodgepole terminal and Warren's root collar weevils will not be calculated until surveys are conducted and better assessment techniques are available.

Once pest losses on trees have been classified according to the three major categories (mortality, growth and regeneration delay) each category must be further subdivided into "Accounted For" versus "Unaccounted For" in regards to the existing growth curves. Table 1 clumps pests into one of six categories based on this dual classification system. Note, it is possible to find pests entered more than once on this table.

"Accounted For" pests usually cause insidious losses as a result of growth reductions. These pests are often hard to identify in forest stands and hence volume-over-age curves (V.A.C., glossary) or average volume lines (A.V.L., glossary) incorporate these impacts.

Pests which are found in the "Not Accounted For" category, have not been accounted for in A.V.L.s or V.A.C.s. These pests usually cause sudden noticeable mortality or growth losses in infested stands and their impact on future harvests is harder to determine than the "Accounted For" category. The impact of pests in this category on future harvests, depends upon the stand's current age-class distribution. A large loss as a result of the mountain pine beetle in the 80 to 120 year age classes, may have a minimal impact on future harvests if stands in these age classes occur in relative abundance.

Decay is found in the "Accounted For versus Mortality" category in table I. Decay has not been calculated for two reasons; M.A.I.'s used in calculating pest losses are net decay, meaning that decay has already been deducted; secondly, in the future, managed stands will contain less mature and overmature timber and it is assumed that the decay component of younger timber will be negligible.

Detailed methods for calculating pest losses are found in Appendix 7.1.

Provincial, Regional, and T.S.A. tables usually consist of three, two, and four tables respectively. These tables are entitiled:

Provincial Tables

- P. 1 Summary of pest losses for British Columbia
- P. 2 Estimated mortality losses caused by current pest activity
- P. 3 Estimated growth and regeneration delay losses (losses to the long run sustained yield) caused by current pest activity

Regional Tables

- C. 1 Summary of pest losses for the Cariboo Forest Region
- C. 2 Characterisitics of susceptible stands used to generate inventory area reports - Cariboo Forest Region

T.S.A. Tables

- C. - Q. 1 Estimated mortality losses caused by current pest activity
- C. - Q. 2 Estimated growth and regeneration delay losses (losses to the long run sustained yield) caused by current pest activity

C. - Q. 3 Summary of information used to determine pest losses

C. - Q. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

Tables are ordered by using the first letter of the region's or T.S.A.'s name, followed by a numeral. The exceptions are:

- Prince George Region (P.G.), Prince Rupert Region (P.R.), Mackenzie T.S.A. (P.G. - Mc.), McBride T.S.A. (P.G. - Mb.), Peace T.S.A. (P.G. - Pe.), Prince George T.S.A. (P.G. - Pr.), Kalum T.S.A. (P.R. - Ka.), and Kispiox T.S.A. (P.R. - Ki.)

3. PROVINCIAL SUMMARY

CONCERNS

The pests of primary concern in British Columbia are the bark beetles which caused a gross loss for 1984 of 11 995 200 m^3. This loss is comprised of mountain pine beetle, spruce beetle, western balsam bark beetle, and Douglas-fir beetle impacts which account for 76.5%, 23%, 0.3% and 0.2% respectively, of the gross total. Two other important bark beetle numbers are: the non-salvable loss (4 510 600 m^3 for 1984) and salvage (2 518 500 m^3 for 1984). These figures probably underestimate the importance of the western balsam bark and Douglas-fir beetles as survey information on them is lacking in a number of T.S.A.'s.

Dwarf mistletoes ranked second in British Columbia causing losses to the net land base of 1 641 700 m^3/year (3.2% of the Annual Allowable Cut[a] (A.A.C.)). Lodgepole pine, hemlock, larch and Douglas-fir dwarf mistletoes were jointly responsible for this loss, each contributing 63%, 34%, 2.5%, and 0.5% respectively to the total.

Root diseases caused projected annual net losses of 1 366 100 m^3/year (2.7% of the A.A.C.). Armillaria root disease, tomentosus root rot and laminated root rot contribute to this total causing 43%, 31% and 26% respectively.

Weevils have also been identified as important pests in most forest regions. Refer to table P. 1 for a provincial summary of pest losses.

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a The A.A.C. referred to here is for crown forest land, excluding T.F.L.'s, as T.F.L. lands were not included in these pest calculations.

NECESSARY ACTIVITIES

Necessary activities supplemental to current practises include additional survey and damage appraisal work on the western balsam bark beetle, all dwarf mistletoes, and interior root diseases. Specifics include:

(1) Western balsam bark beetle surveys in the following forest regions; Prince Rupert, Kamloops, and Nelson. It has been identified as a concern in these regions but accurate survey information is not available.

(2) Dwarf mistletoe information is lacking on the following species:

(2.1) Lodgepole pine dwarf mistletoe incidence and impact information needs improvement, as the incidence figure for the Province is based on a 1972 C.F.S. 1 100 km roadside survey in the Cariboo Forest Region. Impact information is based on the Provincial Pathologist's interpolation of U.S. data. Due to the importance of this pest, impact and incidence surveys are required in the following forest regions, Kamloops, Nelson, Prince George, and Prince Rupert, while in the Cariboo Forest Region impact work is required.

(2.2) Hemlock dwarf mistletoe incidence and impact figures in the Prince Rupert Forest Region are based on a study done in the Vancouver Forest Region near Woss Lake. Prince Rupert's impacts are assumed equal in magnitude to those in Vancouver but localized Prince Rupert studies appear to be required.

(2.3) Larch and Douglas-fir dwarf mistletoe incidence and impact information is lacking and is based on the Canadian Forestry Service and Provincial Pathologist estimations. Due to the minor nature of these impacts in comparison to other pests, this survey work is not considered a priority, but localized studies in specific T.S.A.'s in the Nelson and Kamloops Forest

Regions should be considered.

(3) Tomentosus root rot incidence and impact estimates are based on small scale studies conducted by H. Merler (Van Der Kamp and Merler 1984) in the Prince George Forest Region. This information was then used to calculate losses in the Cariboo, Prince George and Prince Rupert Forest Regions. It is estimated that this pest accounts for 30% of the provincial root disease losses and it is therefore extremely important that these surveys be repeated on a larger scale in these forest regions.

(4) Provincial armillaria root disease and laminated root rot estimates are based on the Vancouver Forest Region surveys. Additional armillaria root disease surveys are required in the Cariboo, Kamloops, Nelson, Prince Rupert, and Prince George Forest Regions, while additional laminated root rot surveys are required in the Kamloops, Nelson, and Prince Rupert Forest Regions.

(5) Many other pests require additional survey and damage appraisal work including weevils (white pine, lodgepole terminal and Warren's root collar) and porcupines, but these are not considered a priority due to the lower magnitude of their losses. The western blackheaded budworm in the Vancouver Forest Region is an exception, and immediate studies are required to determine the growth and mortality effects of this pest.

Table P. 1 Summary of pest losses for British Columbia (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short term losses to the beetles

Pests (and loss duration)[a]	Type of loss[b]	Forest Regions (m^3/yr or m^3/1984)						
		Cariboo	Kamloops	Nelson	Prince George	Prince Rupert	Vancouver	Totals
Bark beetles	Short Term							
	Gross	4 594 361	2 263 809	1 224 131	889 701	2 994 598	28 606	11 995 206
	Non-salvable Loss	1 952 704	1 052 389	365 827	163 773	956 326	19 506	4 510 647
	Salvage	478 416	569 924	458 391	224 361	785 322	2 103	2 518 517
	Long-term							
	Regen delay							
	Gross	80 206	25 367	7 291	20 641	8 572	859	142 926
	Net	38 911	15 618	3 471	4 110	4 219	624	66 953
Dwarf mistletoes	Long-term							
	Gross	511 501	294 588	133 565	309 123	642 531	513 604	2 404 912
	Net	349 798	260 223	98 093	262 484	315 753	355 388	1 641 739
Root diseases	Long-term							
	Gross	250 498	254 678	74 514	713 053	154 500	293 912	1 741 153
	Net	220 974	223 620	58 022	529 248	72 669	261 535	1 366 068
White pine weevil	Long-term							
	Regen delay							
	Gross	-[c]	-	-	-	868	2 723	3 591
	Net	-	-	-	-	868	2 723	3 591
Defoliators	Short-term							
	Growth losses							
	Gross	7 717	35 184	-	-	40 745	-	83 646
	Net	6 869	27 813	-	-	2 598	-	37 280
	Mortality Losses							
	Gross	-	1 400	-	-	-	-	1 400
	Net	-	1 148	-	-	-	-	1 148
Spruce aphid	Short-term							
	Gross	-	-	-	-	13 793	-	13 793
	Net	-	-	-	-	8 059	-	8 059
Porcupine	Long-term							
	Gross	-	-	-	-	3 198	-	3 198
	Net	-	-	-	-	3 198	-	3 198

a Loss duration can be described as either short or long-term in nature. (i.e. short-term indicates a loss for 1984 only).

b Gross estimates are based on the gross land area prior to deductions for non-merchantable areas, environmentally sensitive areas and operability. Net estimates are based on the net operable land base.

c Pest activity has not been identified as a major concern in these areas.

Table P. 2 Estimated mortality losses caused by current pest activity[a]

T.S.A.: All
DATE : N/A
RATED BY: N/A

Pest	Losses in m^3				
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)	
	Gross	Non Salvable Loss	Salvage	Gross	Net
mountain pine beetle	9 188 315	3 859 209	1 731 746		
spruce beetle	2 746 277	634 741	771 095		
western balsam bark beetle	34 130	7 610	4 702		
Douglas-fir beetle	26 484	9 087	10 974		
western spruce budworm				1 400	1 148
Total	11 995 206	4 510 647	2 518 517	1 400	1 148

a Mortality losses represent a loss for 1984 only.

Table P. 3 Estimated growth and regeneration delay losses (losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: All
DATE: N/A
RATED BY: N/A

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
lodgepole pine dwarf mistletoe			1 375 690	1 035 431
hemlock dwarf mistletoe			970 167	555 841
larch dwarf mistletoe			49 368	41 907
Douglas-fir dwarf mistletoe			9 687	8 560
armillaria root disease			661 280	581 470
tomentosus root rot			671 027	423 540
laminated root rot			408 056	361 058
white pine weevil regeneration delay	3 591	3 591		
western spruce budworm			41 383[b]	34 474
2-year-cycle budworm			40 794[b]	2 639
Douglas-fir tussock moth	2 869[b]	1 315		
porcupine	3 198	3 198		
spruce aphid			13 793[b]	8 059
mountain pine beetle (regen delay)	142 928	66 953		
spruce beetle (regen delay)	25 665	6 227		
western balsam bark beetle (regen delay)	140	37		
Douglas-fir beetle (regen delay)	336	164		
Total	175 858 2 869[b]	80 170 1 315	4 145 275 94 570[b]	3 007 807 45 172

a Losses to L.R.S.Y. will occur yearly over an extended time frame.
b These losses represent pest activity for 1984 only and cannot be added to the long-term losses in this column.

4. FOREST REGION AND TIMBER SUPPLY AREA SUMMARIES

4.1 CARIBOO FOREST REGION - AN OVERVIEW

CONCERNS

Mountain pine beetle is the major concern in the Cariboo Forest Region. The current infestation spreads over 405 000 ha affecting 4 518 900 m^3 (non-salvable net loss: 1 946 100 m^3). At present the Douglas-fir and spruce beetles are a manageable concern, as both are desirable species required to maintain the large wood profile of the major mills. Spruce beetle infestations invariably result from large areas of blow-down and only one area of blow-down exists at present near Roaring River. It is being monitored and should not cause a major increase in beetle activity. Lodgepole pine dwarf mistletoe causes net annual losses of 349 800 m^3/yr. Root rots and diseases are responsible for at least an additional 221 000 m^3/yr of losses.

Weevils may become important pests of young stands and plantations in this region but survey information is lacking. The impact of these pests will increase as more basic silviculture is practised.

PEST MANAGEMENT OPPORTUNITIES

"Use it or lose it" - this philosophy applies to the current epidemic of mountain pine beetle in the Cariboo. Aggressive harvesting is the main control option available, and as a positive side effect of harvesting, the site is prepared for a new forest. Lodgepole pine dwarf mistletoe losses are accounted for in the current growth estimations, therefore any treatment to remove the infestation will increase the yield in the future. If a high quality of treatment is maintained, the mistletoe infestation can be managed by the next rotation. Strict management of pests in young stands and plantations provide the greatest opportunities for increasing yield.

NECESSARY ACTIVITIES

A comprehensive aerial sketch mapping survey is the most important ingredient for maintaining an effective bark beetle program and must receive support. Aggressive harvesting must be encouraged in the areas of the mountain pine beetle infestation determined to be beyond direct control capabilities. The harvesting must be directed into beetle infested stands only, and only the beetle attacked timber must be removed. Otherwise the beetle will expand from the unharvested infestation. Large scale harvesting of infested stands will result in an earlier falldown in timber supplies so we must ensure it is targeted to areas where maximum beetle control will be achieved. Direct control must be actively pursued in the designated control zones. Pheromones appear to be a tool which will make treatment of small patch infestations and single trees more practical and cost effective. Trap trees are a proven tool and must be deployed in any active Douglas-fir and spruce harvesting areas. Quality control must be maintained over the small business program as it relates to beetle infestations.

Harvesting of lodgepole pine dwarf mistletoe infested stands is the best method for control of this parasite and, if the mistletoe harvesting guidelines are enforced, the new stand will be free of infection. Detection of root diseases before harvesting is necessary before any treatment of the infected areas is done. Spacing crews will require training in recognition of pests of young stands such as rusts, galls, cankers, weevils, and root diseases as intensive forestry increases.

Table C. 1 Summary of pest losses for the Cariboo Forest Region (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short-term losses to the bark beetles)

Pests (and loss duration)[a]	Type of loss[b]	Timber Supply Areas (m^3/year or m^3/1984			
		Williams Lake	Quesnel	100 Mile	Totals
mountain pine beetle	short term				
	gross	4 318 347	123 722	76 853	4 518 922
	non-salvable				
	loss	1 805 351	77 332	63 415	1 946 098
	salvage	388 271	25 768	5 702	419 741
	long term				
	regen delay gross	74 033	4 197	1 709	79 939
	regen delay net	34 008	3 314	1 523	38 845
lodgepole pine dwarf mistletoe	long term				
	gross	282 488	153 471	75 544	511 503
	net	148 909	132 004	68 885	349 798
armillaria root disease	long term				
	gross	73 440	43 002	78 457	194 899
	net	58 444	42 571	71 324	172 339
spruce beetle	short term				
	gross	185	9,425	47 331	56 941
	non-salvable				
	impact	13	455	3 994	4 462
	salvage	117	8 649	40 388	49 154
	long-term				
	regen delay gross	34	31	27	92
	regen delay net	7	18	15	40
tomentosus root rot	long term				
	gross	24 992	30 607	-[c]	55 599
	net	18 560	30 075	-	48 635
Douglas-fir beetle	short term				
	gross	8 962	-	5 106	14 068
	non-salvable				
	loss	354	-	426	780
	salvage	6 728	-	1 705	8 433
	long term				
	regen delay gross	141	-	34	175
	regen delay net	22	-	4	26
western spruce budworm	short term				
	growth losses				
	gross	-	-	7 668	7 668
	net	-	-	6 828	6 828
western balsam bark beetle	short term				
	gross	877	1 348	2 205	4 430
	non-salvable				
	loss	198	638	528	1 364
	salvage	132	425	528	1 085
	long-term				
	regen delay gross	-[d]	-	-	-
	regen delay net	-	-	-	-
2-year-cycle budworm	short term				
	gross	-	49	-	49
	net	-	45	-	45

Table C. 1 continued

	Bark Beetles					Lodgepole Pine Dwarf Mistletoe		Root Diseases		Defoliators	
	Gross	Non Salvable Loss	Salvage	Regen Delay Gross	Regen Delay Net	Gross	Net	Gross	Net	Gross	Net
Total Losses	4 594 361	1 952 704	478 413	80 206	38 911	511 503	349 798	250 498	220 974	7 717	6 873

a Loss duration can be described as either long or short-term in nature (i.e., short-term indicates a loss for 1984 only).

b Gross estimates are based on the gross land area prior to deductions for non-merchantible areas, environmentally sensitive areas and operability. Net estimates are based on the net operable land base.

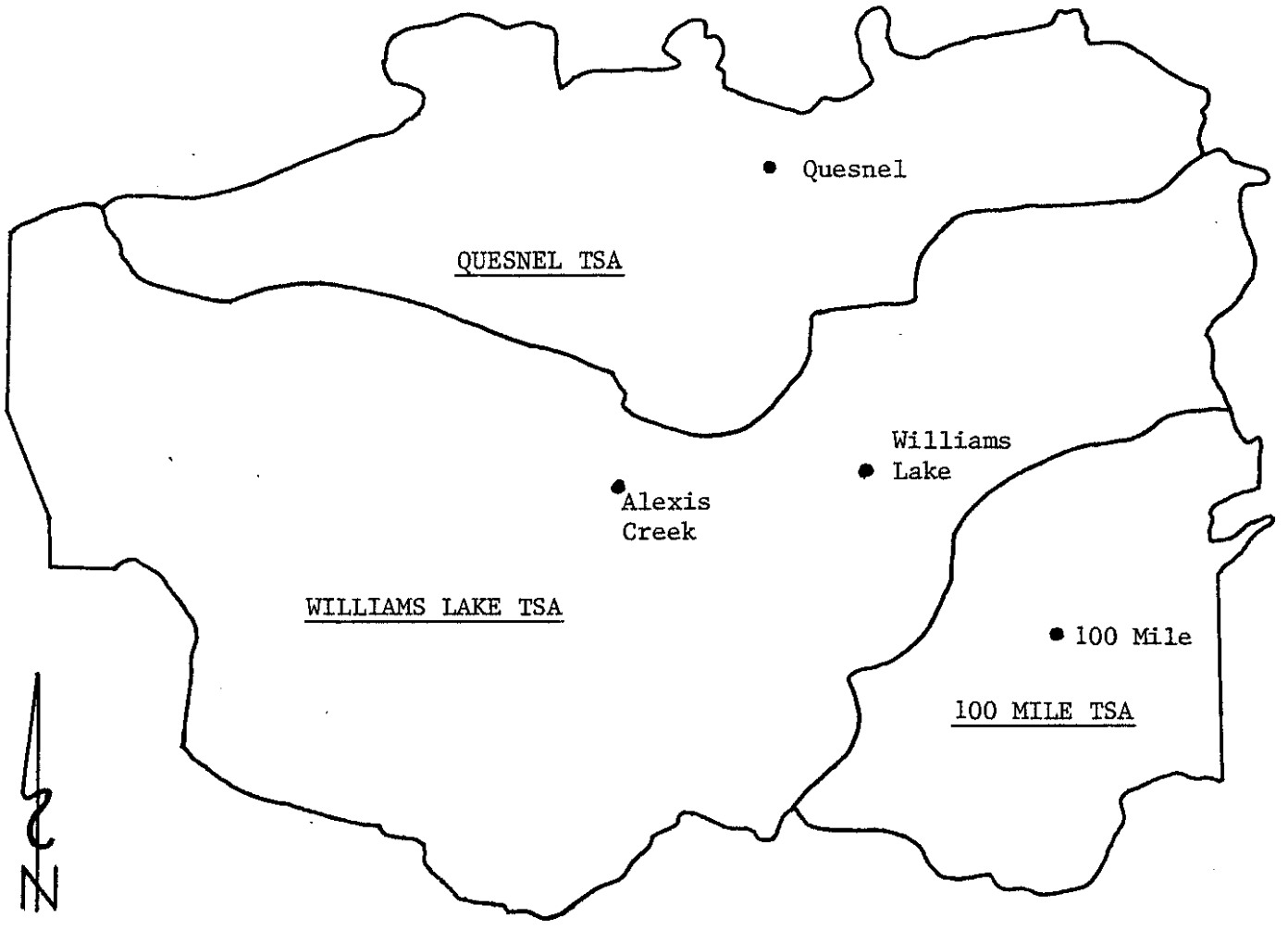
c Pest activity has not been identified as a major concern in these areas.

d Regeneration delay losses were estimated to be negligible for this bark beetle.

Table C. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Cariboo Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (Years)	Sites	Timber Supply Areas Affected:
tomentosus root rot	21-26(S, SF,SH+ SC, SB, SPL, S Decid)	All	All	Williams Lake, Quesnel
armillaria root disease	1(F), 4(FS), 5(FPL), 21-25(S, SF, SH, SC, SB, SPL) 28(PL)+29(PLF) in 100 Mile TSA	All	All	All
spruce beetle	20-22(BS,S,SF), 24(SB), 25(SPL)	121+	All	All
mountain pine beetle	28-31 (PL,PLF,PLS + PlB,Pl Decid)	81+	All	All
western balsam bark beetle	18(B), 20(BS)	81+	All	All
Douglas-fir beetle	1(F), 4-6(FS,FPL, FPy), 8 (F Decid)	121+	All	Williams Lake 100 Mile
lodgepole pine dwarf mistletoe	28(PL)	21+	All	All
western spruce budworm	1(F),5(FPL),6 (FPy)	All	All	100 Mile
2-year-cycle budworm	18(B),20(BS), 21(S), 24(SB)	All	All	Quesnel

a Inventory Area Reports and Statistical Analysis Systems Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.



CARIBOO FOREST REGION

4.1.1. QUESNEL T.S.A. - SUMMARY STATEMENT

CONCERNS

Bark beetles are the primary concern in the Quesnel T.S.A. with the mountain pine beetle having non-salvaged losses in 1984 of 77 300 m^3 (gross loss: 123 700 m^3/1984). Adding to this concern was a large beetle flight in 1984 into non-accessible areas. The spruce beetle is currently at low levels with non-salvable losses of 500 m^3/1984, as currently 95% of attacked spruce beetle volumes are being salvaged. (Salvage 8 600 m^3/1984.) The Douglas-fir beetle problem is generally located in Tree Farm License #5 northwest of Quesnel and as such is not dealt with in this report. However, unless carefully monitored and proper prevention tactics are followed, it could become a serious problem. The western balsam bark beetle has the potential of becoming more important as lodgepole pine and spruce are liquidated and harvesting balsam species becomes more important. Lodgepole pine dwarf mistletoe is another major concern in this T.S.A. with net growth losses of 132 000 m^3/yr (3.6% of the A.A.C.). Current survey information indicates that pine in the western half of the T.S.A. has the highest levels of mistletoe infestation.

Root rots also cause major losses in this T.S.A. and if untreated will cause problems in the new forest. Armillaria root disease has net losses of 42 600 m^3/yr (1.2% of the A.A.C.) and tomentosus root rot causes losses of 30 100 m^3/yr (0.9% of the A.A.C.).

The white pine weevil is currently not a major concern, but its impact will invariably increase as spruce plantations reach susceptible heights. The lodgepole terminal weevil and the Warren's root collar weevil are generally considered insignificant pests but may become more importatnt as lodgepole pole pine becomes intensively managed.

PEST MANAGEMENT OPPORTUNITIES

The non-salvaged losses to the mountain pine beetle can be reduced by aggressive harvesting. Maintaining a non-epidemic situation in spruce stands requires sanitation harvesting of any blow-down, prescribed burning of any logged areas and the enforcement of close-utilization standards. Losses due to lodgepole pine dwarf mistletoe are incorporated in growth curves and any treatments to reduce their impact presumably will result in volume yields greater than those expected from natural stands. Removal of the host tree also eliminates the mistletoe, therefore treatments are practical and easy to implement (i.e. harvesting). Treatment of root diseases before attempting to grow a new forest will also increase yields in the future. Increased pest management activity in young stands and plantations in the future will result in higher volumes available for harvesting in these stands.

NECESSARY ACTIVITIES

In order to optimize removal of beetle-killed wood and beetles, it is critical that harvesting be directed to areas with active infestations and highest priority be given to removing the heaviest infestations first. Activities required to maintain control of spruce and Douglas-fir beetles include the continuation of sanitation harvesting and enforcement of the beetle clauses. Direct control tactics have been very effective against the mountain pine beetle, spruce beetle, and Douglas-fir beetles in localized infestations. Single tree removal should be made more effective by using pheromones to "mop-up" residual beetles left in infested stands after treatment. Douglas-fir beetles are strongly attracted to trap trees, and there should be a continuing trap tree program in all active logging areas. Pheromones could be used to enhance effectiveness of standing lethal Douglas-fir and spruce trees.

Management of lodgepole pine requires that any tree over three meters in height be knocked down. This clause is used to control lodgepole pine dwarf mistletoe in residual stems on a cutblock, thus removing a major infection source. Infected understory over 20 cm in current harvesting areas must be eliminated by hand clipping or by the Marden chopper. Management of pine for mistletoe also includes establishing proper stand boundaries and the use of prescribed fire.

Root rots and root diseases must be detected during initial stand entries, such as during pre-harvest assessment, and the disease centres either eliminated from planting or treated in some manner in order to obtain an optimum productive land base. Pests of plantations must receive a higher priority, at least for assessment surveys, if the new forests are to produce the volumes expected.

Table C. - Q. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Quesnel
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	123 722	77 332	25 768			
spruce beetle	9 425	455	8 649			
western balsam bark beetle	1 348	638	425			
Total	134 495	78 425	34 842			

a Mortality losses represent a loss for 1984 only.

Table C. - Q. 2 Estimated growth and regeneraton delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Quesnel
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			43 002	42 571
tomentosus root rot			30 607	30 075
lodgepole pine dwarf mistletoe			153 471	132 004
2-year-cycle budworm			49[b]	45
mountain pine beetle (regeneration delay)	4 197	3 314		
spruce beetle (regeneration delay)	31	18		
Total	4 228	3 323	227 080 49[b]	204 650 45

a Losses to L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table C. - Q. 3 Summary of information used to determine pest losses

T.S.A.: Quesnel

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.1	0.25	0.35
	Medium	28	2.7	0.25	0.35
	Poor	28	1.5	0.25	0.35
	Low	28	1.125	0.25	0.35
armillaria root disease	Good	1,4,5	4.4	-	0.05
	"	21,22,24	4.1	-	0.05
	"	25	3.8	-	0.05
	"	28	4.5	-	0.05
	"	29	4.2	-	0.05
	Medium	1,4,5,21	2.9	-	0.05
	"	21-24	2.6	-	0.05
	"	25	2.5	-	0.05
	Poor	1,4,5	1.5	-	0.05
	"	21	1.2	-	0.05
	"	22-24	1.4	-	0.05
	"	25	1.1	-	0.05
	Low	5	1.1	-	0.05
	"	21,24,25	0.5	-	0.05
tomentosus root rot	Good	21-24	4.1	0.16	0.25
	"	25,26	3.8	0.16	0.25
	Medium	21	2.9	0.16	0.25
	"	22-24	2.6	0.16	0.25
	"	25,26	2.5	0.16	0.25
	Poor	21	1.2	0.16	0.25
	"	22-24	1.4	0.16	0.25
	"	25,26	1.1	0.16	0.25
	Low	21-26	0.5	0.16	0.25
2-year-cycle budworm	Medium	18,20,21,24	2.6	refer to section 7.1.6.	

a Refer to Table C. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. through 7.1.6. for the derivation of these numbers. Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table C. - Q. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Quesnel

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare[c] (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/yr)
mountain pine beetle	83.3	25	pine medium site	--	2.9	69	199.4
spruce beetle	96.6	95	spruce balsam mixture medium site	--	2.6	87	225.8
western balsam bark beetle	78.9	40	--[d]	--	--[d]	--[d]	--[d]

a Refer to section 7.1.1. for derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.
c An estimate of total volume per hectare was not necessary, was with the Cariboo Approach loss calculations are initiated using gross volumes as inputs.
d Regeneration delay losses were assumed to be negligible for this pest, therefore, these estimates were not required.

4.1.2. WILLIAMS LAKE T.S.A. - SUMMARY STATEMENT

CONCERNS

Accounting for 4.3 million cubic meters of gross timber losses in 1984, the mountain pine beetle is by far the most serious pest in this T.S.A. Douglas-fir beetle, armillaria root disease and lodgepole pine dwarf mistletoe are other pests of concern, but are minor in comparison to the mountain pine beetle. Projected annual net losses due to the armillaria root disease, tomentosus root rot and lodgepole pine dwarf mistletoe are 58 400, 18 600 and 148 900 m^3/yr respectively (gross: 380 920 m^3/yr or a combined net loss of 8.9% of the A.A.C.). The black army cutworm may hamper plantation establishment in the eastern portions of the T.S.A. The western hemlock looper defoliated 5 200 ha in 1984, but is not currently considered a significant pest because of the species it attacks and the normally brief duration of outbreak.

PEST MANAGEMENT OPPORTUNITIES

Incentives to harvest the mountain pine beetle infested stands have made salvage of these stands much more feasible. Pheromone baiting is a method of redirecting beetle populations into areas that are scheduled to be harvested and the technique has potential for use in this T.S.A. The demand for spruce and Douglas-fir means non-salvable losses to spruce and Douglas-fir beetles will be kept at a minimum. Trap tree treatment for these beetles has been effectively used in the past. Net losses to the lodgepole pine dwarf mistletoe should be greatly reduced by logging of the infested stands and sanitation of surrounding areas. This pest management practice will presumably result in a net yield increase because mistletoe is accounted for in the present volume curves.

NECESSARY ACTIVITIES

The regular annual aerial survey of current red attack is not enough; cumulative attack (red and grey) must be surveyed to assess the total impact of the beetle to assist in determining a realistic A.A.C. Such a survey

does not preclude the regular survey; it is necessary to locate specific infestations for operational management. Harvesting of infested stands is of utmost priority, and the infested stands must be prioritized with heavily attacked stands scheduled first for harvest. This is important because the mountain pine beetle infestation is so expansive that it is impossible to address all the infested stands. In the past, logging has taken place in lightly attacked higher volume stands while moderate and heavily attacked marginal volume stands remain untouched. Trap tree disposal and salvage logging in Douglas-fir and spruce should continue.

Lodgepole pine dwarf mistletoe management must include harvesting of infested stands (usually in conjunction with the mountain pine beetle), post-logging treatment and continued sanitation. Survey information is needed to manage the armillaria root disease and tomentosus root rot problems. Defoliator and weevil populations must also be monitored to manage effectively.

Seedlings must not be planted in site specific areas where the black army cutworm is known to be foraging. A practical survey and management system must be developed to assess hazard and treat black army cutworm outbreaks.

Table C. - W. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Williams Lake
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	4 318 347	1 805 351	388 271			
Douglas-fir beetle	8 962	354	6 728			
spruce beetle	185	13	117			
western balsam bark beetle	877	198	132			
Total	4 328 371	1 805 916	395 248			

a Mortality losses represent a loss for 1984 only.

Table C. - W. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Williams Lake
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			73 440	58 444
tomentosus root rot			24 992	18 560
lodgepole pine dwarf mistletoe			282 488	148 909
mountain pine beetle (regeneration delay)	74 033	34 008		
Douglas-fir beetle (regeneration delay)	141	22		
spruce beetle (Regeneration delay)	34	7		
Total	74 208	34 037	380 920	225 913

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table C. - W. 3 Summary of information used to determine pest losses

T.S.A.: Williams Lake

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.1	0.25	0.35
	Medium	28	2.7	0.25	0.35
	Poor	28	1.5	0.25	0.35
armillaria root disease	Good	1	4.3	-	0.05
	"	4	4.6	-	0.05
	"	5	3.6	-	0.05
	"	21-24	4.1	-	0.05
	"	25	4.0	-	0.05
	Medium	1,21-24	2.5	-	0.05
	"	4	2.9	-	0.05
	"	5	2.3	-	0.05
	"	25	2.6	-	0.05
	Poor	1,25	1.4	-	0.05
	"	4	1.8	-	0.05
	"	5	1.3	-	0.05
	"	21-24	1.9	-	0.05
	Low	1,25	1.05	-	0.05
	"	4	1.35	-	0.05
	"	5	0.975	-	0.05
	"	21-24	1.425	-	0.05
tomentosus root rot	Good	21-24	4.1	0.16	0.25
	"	25,26	4.0	0.16	0.25
	Medium	21-24	2.5	0.16	0.25
	"	25,26	2.6	0.16	0.25
	Poor	21-24	1.9	0.16	0.25
	"	25-26	1.4	0.16	0.25
	Low	21,24	1.425	0.16	0.25
	"	25,26	1.05	0.16	0.25

a Refer to Table C. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. through 7.1.5. for the derivation of these numbers. Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table C. - W. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Williams Lake

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/yr)
mountain pine beetle	50.8	17.7	pine poor site	--	1.5	77	118.7
Douglas-fir beetle	79.0	95	fir medium site	--	2.4	79	185.9
spruce beetle	70.2	90	spruce medium site	--	2.5	104	256.1
western balsam bark beetle	37.7	40	--[d]	--	--[d]	--[d]	--[d]

a Refer to section 7.1.1. for derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.
c An estimate of total volume per hectare was not necessary as with the Cariboo Approach loss calculations are initiated using gross volumes as inputs.
d Regeneration delay losses were assumed to be negligible for this pest, therefore, these estimates were not required.

4.1.3. 100 MILE T.S.A. - SUMMARY STATEMENT

CONCERNS

The mountain pine beetle continues to be the biggest problem in the 100 Mile T.S.A. as far as pest management is concerned. (Non-Salvable Loss: 63 400 m^3 for 1984.) Pest loss numbers show larger losses for lodgepole pine dwarf mistletoe, but management difficulties make the mountain pine beetle the most serious pest. The mountain pine beetle infestation is located in the western portion of this T.S.A. Small tree size and poor access make management and salvage of the timber difficult.

The other bark beetles, armillaria root disease, and lodgepole pine dwarf mistletoe are also of concern in this T.S.A. The projected annual losses due to armillaria root disease and lodgepole pine dwarf mistletoe are 71 324 m^3/yr and 68 900 m^3/yr respectively (gross: 78 500 and 75 500 m^3/yr). The western spruce budworm is causing moderate damage to Douglas-fir in the southern end of the T.S.A. and its population is expected to increase in 1985.

The potential of such second growth pests as the weevils may become a serious concern in the coming years. Similarly, the greatest impact of defoliators such as western spruce budworm may be in plantations and second growth stands where top-kill can significantly reduce tree quality.

PEST MANAGEMENT OPPORTUNITIES

The non-salvable losses to spruce beetle will be maintained at current levels or reduced by aggressive salvage and management of infested spruce stands. Relaxed utilization and reduced stumpage have encouraged harvesting in mountain pine beetle infested stands. An aggressive direct control program in the eastern half of the T.S.A. has been successful in minimizing losses to the beetle.

Net losses to lodgepole pine dwarf mistletoe should be substantially reduced through logging and host eradication as a site treatment. Since losses due to lodgepole pine dwarf mistletoe are included in current volume curves, any reduction in impacts would presumably show up as a larger yield than natural stands. Similarly any management of armillaria root disease would presumably improve yields of existing stands.

NECESSARY ACTIVITIES

In addition to detailed aerial survey and ground probe information, bark beetle control plans require single tree disposal, trap tree felling, and harvesting of infested or susceptible stands. The intensity of the infestation must determine layout and size of cutblocks. In areas of light, patchy attack, small timber sales should be awarded. The harvesting of mountain pine beetle attacked stands that have a low portion of susceptible volume (e.g. F(PL) stands) should be avoided if possible. Mistletoe management must include harvesting infested stands, utilizing proper cut boundaries, and removing infested residuals. Surveys are necessary to determine the location and severity of armillaria root disease. Plantation pests and defoliators in older stands must be monitored and then managed if infestations become severe.

Table C. - 100. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: 100 Mile
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Impact	Salvage
mountain pine beetle	76 853	63 415	5 702			
Douglas-fir beetle	5 106	426	1 705			
spruce beetle	47 331	3 994	40 388			
western balsam bark beetle	2 205	528	528			
Total	131 495	68 363	48 323			

a Mortality losses represent a loss for 1984 only.

Table C. - 100. 2 Estimated growth and regeneration delay losses (losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: 100 Mile
DATE: June 20, 1985
RATED BY: D. Doidge, B. Merta, S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			78 457	71 324
lodgepole pine dwarf mistletoe			75 543	68 885
western spruce budworm			7 668[b]	6 828
mountain pine beetle (regeneration delay)	1 708	1 523		
Douglas-fir beetle (regeneration delay)	34	4		
spruce beetle (regeneration delay)	27	15		
Total	1 769	1 542	154 000 7 668[b]	140 209 6 828

a Losses to L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table C. - 100. 3 Summary of information used to determine pest losses

T.S.A.: 100 Mile

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.4	0.25	0.35
	Medium	28	3.1	0.25	0.35
	Poor	28	1.7	0.25	0.35
	Low	28	1.3	0.25	0.35
armillaria root disease	Good	1,25	3.5	-	0.05
	"	4	2.6	-	0.05
	"	5	3.3	-	0.05
	"	21	3.6	-	0.05
	"	22-24	4.0	-	0.05
	"	28	4.4	-	0.05
	"	29	3.9	-	0.05
	Medium	1,5	1.8	-	0.05
	"	4	1.4	-	0.05
	"	21	2.9	-	0.05
	"	22-24	2.3	-	0.05
	"	25	2.4	-	0.05
	"	28	3.1	-	0.05
	"	29	2.8	-	0.05
	Poor	1	0.8	-	0.05
	"	4	1.05	-	0.05
	"	5	1.0	-	0.05
	"	21	2.175	-	0.05
	"	22-24	1.725	-	0.05
	"	25,28,29	1.7	-	0.05
	Low	1	0.6	-	0.05
	"	5	0.3	-	0.05
	"	21,24,25	0.5	-	0.05
	"	28,29	1.275	-	0.05
western spruce budworm	Medium	2,4,8-10,18, 20-26,28-31	1.8	refer to section 7.1.6.	
	"				
	"				

a Refer to Table C. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3., 7.1.4. and 7.1.6. for the derivation of these numbers.

Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table C. - 100. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: 100 Mile

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	89.9	8.25	pine poor site	--	1.7	82	137.5
Douglas-fir beetle	41.7	80	fir medium site	--	1.8	82	144.9
spruce beetle	93.8	91	spruce-balsam medium site	--	2.3	113	264.2
western balsam bark beetle	47.9	50	--[d]	--	--[d]	d	--[d]

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.
c An estimate of total volume per hectare was not necessary as with the Cariboo Approach, loss calculations are initiated using gross volumes as inputs.
d Regeneration delay losses were assumed to be negligible for this pest, therefore, these estimates were not required.

4.2. KAMLOOPS FOREST REGION - AN OVERVIEW

CONCERNS

The pest of primary concern in this region is the mountain pine beetle which caused a gross loss for 1984 of 2 153 900 m^3. However, because of high salvage rates the net non-salvable loss for 1984 was 1 007 000 m^3. The bark beetle problem (mountain pine beetle, spruce beetle, western balsam bark beetle and Douglas-fir beetle) will continue to grow until current outbreaks have run their course. Other pests of prime importance are lodgepole pine dwarf mistletoe, armillaria root disease and laminated root rot which caused a combined net loss of 469 600 m^3/year. (6.7% of the A.A.C.). Refer to Table K. I for a complete listing of the losses and pests of major concern in this region.

PEST MANAGEMENT OPPORTUNITIES

The bark beetles can be managed by priority harvesting and related techniques; Douglas-fir tussock moth can be controlled through the use of biological and chemical insecticides. Plans are underway to purchase a stockpile for Nuclear Polyhedrosis Virus to combat the next outbreak of this moth.

The treatment of root disease at time of harvest by either stumping or planting resistant species may reduce future losses. The use of the residual felling clause at time of harvest along with other basic techniques will control losses to mistletoe. As these two pests are largely accounted for in growth curves (volume-age curves) we will presumably realize gains over the expected natural productivity.

NECESSARY ACTIVITIES

The bark beetles can be managed at current and improved levels through good planning, early detection, pheromone baiting, priority harvest of green infested and susceptable stands, trap trees, good house keeping clause enforcement and other control techniques.

As the combination of various forest pests is causing significant losses to mature and immature stands in terms of mortality or growth loss it is imperative that a complete and intensive assessment of each area be made at the pre-harvest or pre-treatment stage to ensure concerns are correctly identified and correctly prescribed for. This crucial step will set the direction, right or wrong, on each area treated.

Root rots must be identified before harvest and then dealt with through the use of basic root rot strategies.

Mistletoe can also be addressed most effectively at time of harvest or post treatment and correct procedure during stand tending operations will greatly improve the yield on the next rotation.

Managers can consult the Kamloops Region Pest Management Guidelines for detailed methods to deal with specific pest problems.

Table K. 1 Summary of pest losses for the Kamloops Forest Region(Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short-term losses to the bark beetles)

Pests (and loss duration)[a]	Type of impact[b]	Timber Supply Areas m^3/yr. or m^3/1984				
		Kamloops	Lillooet	Merritt	Okanagan	Totals
mountain pine beetle	short-term					
	gross	11 682	1 660 592	120 776	360 828	2 153 878
	non-salvable loss	454	959 938	12 450	34 192	1 007 034
	salvage	8 630	106 660	91 296	307 729	514 315
	long-term					
	regen delay gross	47	24 076	424	623	25 170
	regen delay net	7	14 873	179	401	15 460
lodgepole pine dwarf mistletoe	long-term					
	gross	84 808	28 815	79 320	85 860	278 803
	net	72 492	22 189	69 800	81 533	246 014
armillaria root disease	long-term					
	gross	59 173	11 483	14 557	42 126	127 339
	net	51 912	9 880	13 055	36 963	111 810
laminated root rot	long-term					
	gross	59 173	11 483	14 557	42 126	127 339
	net	51 912	9 880	13 055	36 963	111 810
spruce beetle	short-term					
	gross	19 440	48 904	30 698	10 889	109 931
	non-salvable loss	900	40 003	3 521	931	45 355
	salvage	12 852	8 551	25 824	8 382	55 609
	long-term					
	regen delay gross	25	151	14	7	197
	regen delay net	9	136	10	3	158
western spruce budworm	short-term					
	growth loss					
	gross	32 315	-[c]	-	-	32 315
	net	26 498	-	-	-	26 498
	mortality loss					
	gross	1 400	-	-	-	1 400
	net	1 148	-	-	-	1 148
Douglas-fir dwarf mistletoe	long-term					
	gross	5 358	-	1 408	2 921	9 687
	net	4 557	-	1 270	2 733	8 560
larch dwarf mistletoe	long-term					
	gross	-	-	-	6 098	6 098
	net	-	-	-	5 649	5 649
Douglas-fir tussock moth[d]	short-term					
	growth loss					
	gross	2 041	39	14	775	2 869
	net	936	18	6	355	1 315

Table K. 1 continued

	Bark Beetles					Dwarf Mistletoes		Root Diseases		Defoliators			
	Gross	Non Salvable Losses	Salvage	Regen Delay		Gross	Net	Gross	Net	Growth Losses		Mortality Losses	
				Gross	Net					Gross	Net	Gross	Net
Total	2 263 809	1 052 389	569 924	25 367	15 618	294 588	260 223	254 678	223 620	35 184	27 813	1 400	1 148

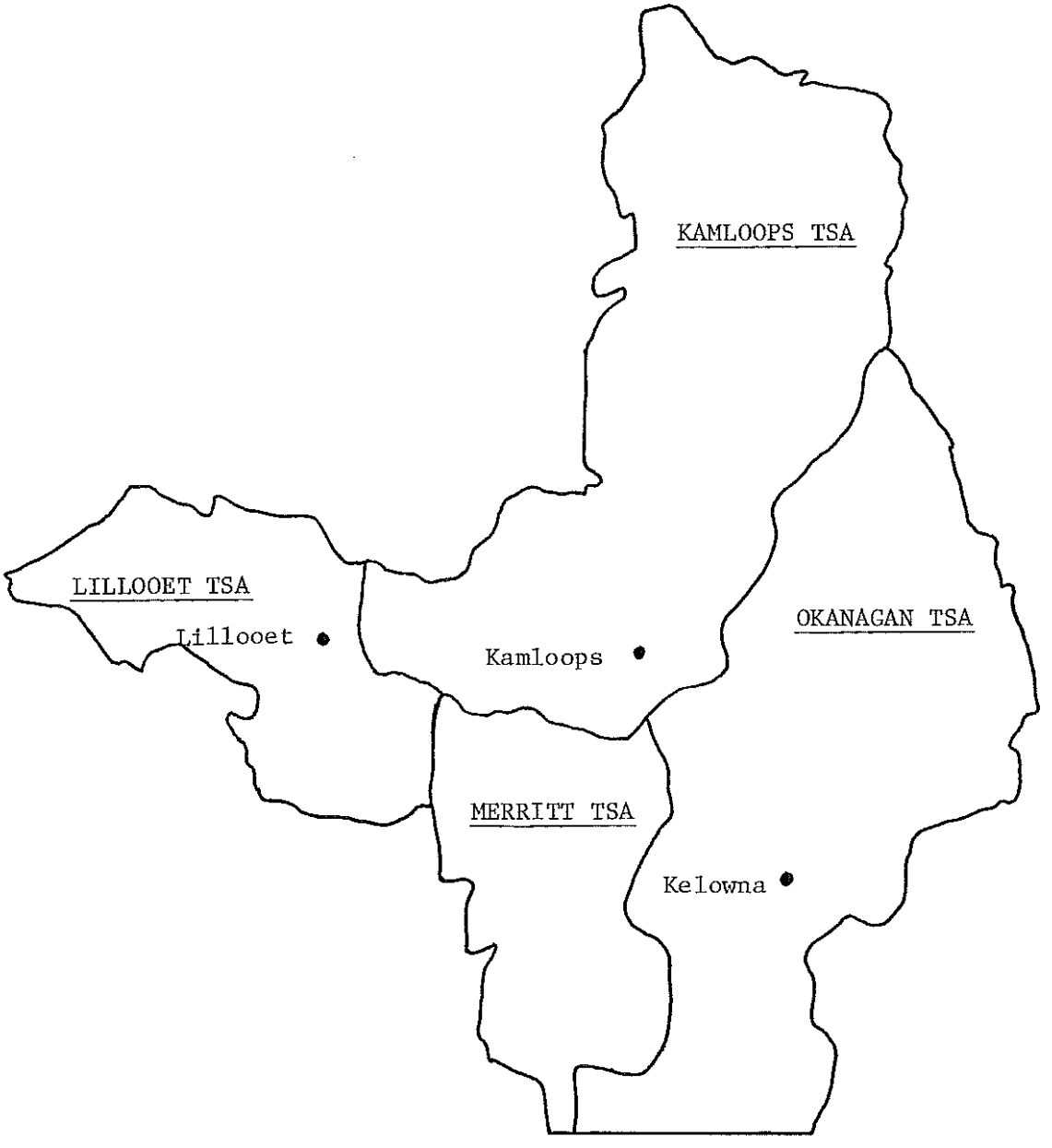
a Loss duration can be described as either long or short-term in nature (i.e. short-term indicates a loss for 1984 only).
b Gross estimates are based on the gross land area prior to deductions for non-merchantible areas, environmentally sensitive areas and operability.
c Pest activity has not been identified as a major concern in these areas.
d Gross losses for the Douglas-fir tussock moth include infestations on crown, private, and indian reserve lands.

Table K. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Kamloops Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (years)	Sites	Timber Supply Areas Affected
spruce beetle	21-26(S, SF, SH + SC, SB, SPL, S Decid)	121+	All	All
mountain pine beetle	28-31(PL, PLF, PLS + PLB, PL Decid)	81+	All	All
armillaria root disease and laminated root rot	1-8(F, FC+ FCy, FH, FS, FPL, FPy, FL, F Decid)	All	All	All
lodgepole pine dwarf mistletoe	28-31(PL, PLF, PLS+PLB, PL Decid)	All	All	All
larch dwarf mistletoe	33(LF),34(L)	All	All	Okanagan
Douglas-fir dwarf mistletoe	1(F),5-8(FPL, FPy, FL, F Decid)	All	All	Okanagan, Merritt, Kamloops
western spruce budworm	1(F),4-6(FS,FPL, FPy),8 (F Decid)	All	All	Kamloops
Douglas-fir tussock moth	1(F),5(FPL), 6(FPy)	All	All	All

a Inventory Area Reports and Statistical Analysis Systems Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.

KAMLOOPS FOREST REGION



4.2.1. KAMLOOPS T.S.A. - SUMMARY STATEMENT

CONCERNS

Forest pests are having a major impact on most stands throughout this T.S.A. Of primary concern are losses due to lodgepole pine dwarf mistletoe, laminated root rot and armillaria root disease causing combined net losses of 176 000 m^3/year (7.5% of A.A.C.). Bark beetles in this T.S.A., primarily the mountain pine beetle and spruce beetle, also cause losses (gross combined losses for 1984 of 31 100 m^3). However, because the beetle salvage rates are high the non-salvable bark beetle losses are only 1 400 m^3. The western balsam bark beetle and Douglas-fir beetle are a concern, but as yet, accurate survey information does not exist to delineate these losses. Defoliators, namely the Douglas-fir tussock moth and western spruce budworm have caused growth losses and mortality through the fir stands in the southern half of this T.S.A. The losses for the Douglas-fir tussock moth in 1984 are minimal, while the western spruce budworm caused net growth losses of 26 500 m^3 in 1984. White pine blister rust is causing losses in this T.S.A. although the extent of the problem has not been identified.

PEST MANAGEMENT OPPORTUNITIES

Western spruce budworm is being monitored until long term strategies are developed.

NECESSARY ACTIVITIES

Accurate surveys are needed to identify the area and volume affected by the western balsam bark and Douglas-fir beetles.

White pine blister rust must be dealt with through pruning of attacked stands and planting of less-susceptible white pine stock to re-establish this valuable species as a viable crop.

Table K. - K. 1 Estimated mortality losses on volume caused by current pest activity[a]

T.S.A.: Kamloops
DATE: June 28,1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3				
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)	
	Gross	Non salvable Impact	Salvage	Gross	Net
mountain pine beetle	11 682	454	8 630		
spruce beetle	19 440	900	12 852		
western spruce budworm				1 400	1 148
Total	31 122	1 354	21 482	1 400	1 148

a Mortality losses represent a loss for 1984 only.

Table K. - K. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Kamloops
Date: June 28, 1985
Rated by: R. Edwards
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
mountain pine beetle (regeneration delay)	47	7		
spruce beetle (regeneration delay)	25	9		
laminated root rot			59 173	51 912
armillaria root disease			59 173	51 912
lodgepole pine dwarf mistletoe			84 808	72 492
Douglas-fir dwarf mistletoe			5 358	4 557
Douglas-fir tussock moth	2 041[b]	936		
western spruce budworm			32 315[b]	26 498
Total	72 2 041[b]	16 936	208 512 32 315[b]	180 873 26 498

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table K. - K. 3 Summary of information used to determine pest losses

T.S.A.: Kamloops

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	5.2	0.35	0.25
	"	29,30	4.2	0.35	0.15
	"	31	3.125	0.35	0.15
	Medium	28	3.2	0.35	0.25
	"	29,30	3.1	0.35	0.15
	"	31	2.5	0.35	0.15
	Poor	28	2.1	0.35	0.25
	"	29,30	1.8	0.35	0.15
	"	31	1.875	0.35	0.15
	Low	28	1.575	0.35	0.25
	"	29,30	1.35	0.35	0.15
	"	31	1.41	0.35	0.15
Douglas-fir dwarf mistletoe	Good	1	4.3	0.03	0.25
	"	5,6,8	3.6	0.03	0.15
	Medium	1	2.9	0.03	0.25
	"	5,6,8	2.3	0.03	0.15
	"	7	2.2	0.03	0.15
	Poor	1	1.4	0.03	0.25
	"	5,6,8	1.3	0.03	0.15
	"	7	2.2	0.03	0.15
	Low	1	1.5	0.03	0.25
	"	5,6,8	0.97	0.03	0.15
Douglas-fir tussock moth	Good Medium Poor Low	1,5,6	0.75[d]	-	0.6 + 0.3
western spruce budworm	Medium	5,6,8	2.3	-	0.2, 0.4, and 0.8
				laminated root rot	armillaria root disease
armillaria root disease and laminated root rot	Good	1	4.3	0.06	0.06
	Good	2-4	4.6	0.06	0.06
	Good	5,6,8	3.6	0.06	0.06
	Medium	1	2.5	0.06	0.06
	Medium	2-4	2.9	0.06	0.06
	Medium	5,6,8	2.3	0.06	0.06
	"	7	3.2	0.06	0.06
	Poor	1	1.4	0.06	0.06
	"	2-4	1.8	0.06	0.06
	"	5,6,8	1.3	0.06	0.06
	"	7	2.7	0.06	0.06

a Refer to Table K. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to section 7.1.2. through 7.1.6 for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

d Ross and Taylor 1983.

Table K. - K. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Kamloops

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	77.8	95	pure pine medium site	220	3.2	66	210
spruce beetle	92.6	95	pure spruce medium site	324	2.5	104	256
western spruce budworm	82	-[c]	taken from Ross, 1983[d]	56	-	-	-

a Refer to sections 7.1.1. and 7.1.6. for the derivation of these numbers.
b This factor is esimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.
c Regeneration delay losses were assumed to be negligible for this pest, therefore, these estimates were not required.
d Ross and Taylor 1983.

4.2.2. LILLOOET T.S.A. - SUMMARY STATEMENT

CONCERNS

Major losses in this T.S.A. are being caused by the mountain pine beetle and the spruce beetle, with gross combined losses for 1984 being 1 709 500 m^3 and due to low salvage rates the combined non-salvable losses are 999 900 m^3. The western balsam bark beetle is also a concern, but currently accurate survey information does not exist. The lodgepole pine dwarf mistletoe, armillaria root disease and laminated root rot cause combined net losses of 41 900 m^3/year (5.2% of A.A.C.). Defoliators, such as Douglas-fir tussock moth and western spruce budworm may cause significant growth reductions in this T.S.A., but at present their losses are considered minimal.

PEST MANAGEMENT OPPORTUNITIES

The western spruce budworm is being monitored until long term strategies are developed.

NECESSARY ACTIVITIES

Accurate surveys are needed to identify the area and volume affected by the western balsam bark beetle.

Table K. - L. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Lillooet
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	1 660 592	959 938	106 660			
spruce beetle	48 904	40 003	8 551			
Total	1 709 496	999 941	115 211			

a Mortality losses represent a loss for 1984 only.

Table K. - L. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] on volume caused by current pest activity

T.S.A.: Lillooet
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
mountain pine beetle (regeneration delay)	24 076	14 873		
spruce beetle (regeneration delay)	151	136		
Douglas-fir tussock moth	39[b]	18		
laminated root rot			11 483	9 880
armillaria root disease			11 483	9 880
lodgepole pine dwarf mistletoe			28 815	22 189
Total	39[b] 24 227	18 15 009	51 781	41 949

a Losses to L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table K. - L. 3 Summary of information used to determine pest losses

T.S.A.: Lillooet

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.4	0.35	0.25
	"	29,30	3.9	0.35	0.15
	Medium	28	3.1	0.35	0.25
	"	29,30	2.8	0.35	0.15
	"	31	2.0	0.35	0.15
	Poor	28	1.7	0.35	0.25
	"	28,30	1.7	0.35	0.15
	"	31	1.5	0.35	0.15
	Low	28	1.275	0.35	0.25
	"	29-31	1.275	0.35	0.15
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1	3.5	0.06	0.06
	"	2,3	3.25	0.06	0.06
	"	4	2.6	0.06	0.06
	"	5,6,8	3.3	0.06	0.06
	Medium	1,5	1.8	0.06	0.06
	"	4	1.4	0.06	0.06
	"	6,8	1.0	0.06	0.06
	"	2,3	2.6	0.06	0.06
	Poor	1	1.4	0.06	0.06
	"	2-4	1.05	0.06	0.06
	"	5,6,8	0.75	0.06	0.06
	Low	1,3,4	1.05	0.06	0.06
	"	5,6	0.75	0.06	0.06
Douglas-fir tussock moth	Good Medium Poor Low	1,5,6	0.75[d]	-	0.6 + 0.3

a Refer to Table K. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.2. through 7.1.5. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

d Ross and Taylor 1983.

Table K. - L. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Lillooet

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	64.2	10	pure pine medium site	197	3.1	74	227
spruce beetle	90.9	10	pure spruce medium site	345	2.9	120	353

a Refer to section 7.1.1. for the derivation of these numbers.
b This salvage factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.2.3 MERRITT T.S.A. - SUMMARY STATEMENT

CONCERNS

Of primary concern in this T.S.A. are losses to dwarf mistletoes (lodgepole pine and Douglas-fir) which caused a combined net loss of 71 100 m^3/year (6.2% of A.A.C.). Root rots, armillaria root disease and laminated root rot caused significant growth losses (net combined loss of 26 100 m^3/year of 2.3% of A.A.C.). The mountain pine beetle and the spruce beetle cause gross losses of 151 500 m^3, but because of high salvage rates the non-salvable loss is only 16 000 m^3. The western balsam bark beetle and Douglas-fir beetle are a concern, but as yet, accurate survey information does not exist. Also known to occur and cause periodic concern in this T.S.A. are the following pests; lodgepole terminal weevil, white pine weevil, Douglas-fir tussock moth and Western spruce budworm.

PEST MANAGEMENT OPPORTUNITIES

The western spruce budworm is being monitored until long term strategies are developed.

NECESSARY ACTIVITIES

Accurate surveys are needed to identify the area and volume affected by the western balsam bark and Douglas-fir beetles.

Table K. - M. 1 Estimated mortality losses on volume caused by current pest activity[a]

T.S.A.: Merritt
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	120 776	12 450	91 296			
spruce beetle	30 698	3 521	25 824			
Total	151 474	15 971	117 120			

a Mortality losses represent a loss for 1984 only.

Table K. - M. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Merritt
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
mountain pine beetle (regeneration delay)	424	179		
spruce beetle (regeneration delay)	14	10		
Douglas-fir tussock moth	14[b]	6		
laminated root rot			14 557	13 055
armillaria root disease			14 557	13 055
lodgepole pine dwarf mistletoe			79 320	69 800
Douglas-fir dwarf mistletoe			1 408	1 270
Total	14[b] 438	6 189	109 842	97 180

a Losses to the L.R.S.Y. will occur yearly over an extended time frame
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table K. - M. 3 Summary of information used to determine pest losses

T.S.A.: Merritt

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1	3.5	0.06	0.06
	"	2-4	3.25	0.06	0.06
	"	5,6	3.3	0.06	0.06
	Medium	1,5,6,8	1.8	0.06	0.06
	"	2-4	2.6	0.06	0.06
	Low	1	0.6	0.06	0.06
	"	4	1.05	0.06	0.06
	"	5,6	0.75	0.06	0.06
	Poor	1	0.8	0.06	0.06
	"	2-4	1.4	0.06	0.06
	"	5,6	1.0	0.06	0.06
	"	8	0.75	0.06	0.06
Douglas-fir dwarf mistletoe	Good	1	3.5	0.03	0.25
	"	5,6	3.3	0.03	0.15
	Medium	1	1.8	0.03	0.25
	"	5	2.6	0.03	0.15
	"	6	1.8	0.03	0.15
	"	8	1.0	0.03	0.15
	Poor	1	0.8	0.03	0.25
	"	5	1.4	0.03	0.15
	"	6,8	1.0	0.03	0.15
	Low	1	0.6	0.03	0.25
	"	5	1.05	0.03	0.15
	"	6	0.75	0.03	0.15
lodgepole pine dwarf mistletoe	Good	28	4.4	0.35	0.25
	"	29,30	3.9	0.35	0.15
	"	31	2.5	0.35	0.15
	Medium	28	3.1	0.35	0.25
	"	29,30	2.8	0.35	0.15
	"	31	2.5	0.35	0.15
	Poor	28	1.7	0.35	0.25
	"	29,30	1.7	0.35	0.15
	"	31	1.5	0.35	0.15
	Low	28	1.27	0.35	0.25
	"	29,30	1.27	0.35	0.15
	"	31	1.12	0.35	0.15
Douglas-fir tussock moth	Good Medium Poor Low	1,5,6	0.75[d]	-	0.6 + 0.3

a Refer to Table K. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.2. through 7.1.5. for the derivation of these numbers. Note: For armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

d Ross and Taylor 1983.

Table K. - M. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Merritt

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	85.9	88	pure pine medium site	212	3.1	74	227
spruce beetle	95.6	88	pure spruce medium site	418	2.9	120	353

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged based on past experience and existing logging plans.

4.2.4. OKANAGAN T.S.A. - SUMMARY STATEMENT

CONCERNS

Forest pests are having a severe impact on most stands throughout this T.S.A. Of primary concern are losses due to the dwarf mistletoes (lodgepole pine, larch, and Douglas-fir) which caused a combined net loss of 89 900 m^3/year (3.3% of A.A.C.). The mountain pine beetle causes large gross losses (360 800 m^3 for 1984) in this T.S.A. but because of the high salvage rates the non-salvable loss is only 34 200 m^3. Its counterpart, the spruce beetle, causes gross losses of 10 900 but again for the same reason the non-salvable loss is only 900 m^3. Root rots, armillaria root disease and laminated root rot cause significant growth losses (net combined loss of 73 900 m^3 or 2.7% of A.A.C.) and the black stain root disease is a concern, but has not been accurately surveyed. Defoliators, such as Douglas-fir tussock moth, larch carebearer, and larch bud moth may cause significant growth reductions in this T.S.A. but at present their losses are considered minimal.

PEST MANAGEMENT OPPORTUNITIES

Larch carebearer and larch bud moth are being monitored until cost effective strategies are developed.

Table K. - O. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Okanagan
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage) (Loss, m^3)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage) (Gain, m^3)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	360 828	34 192	307 729			
spruce beetle	10 889	931	8 382			
Total	371 717	35 123	316 111			

a Mortality losses represent a loss for 1984 only.

Table K. - O. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] on volume caused by current pest activity

T.S.A.: Okanagan
DATE: June 28, 1985
RATED BY: R. Edwards
S. Taylor

Not Accounted For In Pest	Losses in m^3 per year			
	Accounted For In Current Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			42 126	36 963
armillaria root disease			42 126	36 963
lodgepole pine dwarf mistletoe			85 860	81 533
larch dwarf mistletoe			6 098	5 649
Douglas-fir dwarf mistletoe			2 921	2 733
mountain pine beetle (regeneration delay)	623	401		
spruce beetle (regeneration delay)	7	3		
Douglas-fir tussock moth	775[b]	355		
Total	775[b] 630	355 404	179 131	163 841

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table K. - O. 3 Summary of information used to determine pest losses

T.S.A.: Okanagan

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
Douglas-fir dwarf mistletoe	Good	1	3.5	0.03	0.25
	"	5,6,8	3.3	0.03	0.15
	"	7	3.8	0.03	0.15
	Medium	1	1.8	0.03	0.25
	"	5,6,8	1.8	0.03	0.15
	"	7	2.85	0.03	0.15
	Poor	1	0.8	0.03	0.25
	"	5,6,8	1.0	0.03	0.15
	"	7	2.1	0.03	0.15
	Low	5,6,8	0.75	0.03	0.15
	"	1	0.6	0.03	0.25
lodgepole pine dwarf mistletoe	Good	28	4.4	0.35	0.25
	"	29,30	3.9	0.35	0.15
	"	31	2.5	0.35	0.15
	Medium	28	3.1	0.35	0.25
	"	29,30	2.8	0.35	0.15
	"	31	2.0	0.35	0.15
	Poor	28	1.7	0.35	0.25
	"	29,30	1.7	0.35	0.15
	"	31	1.5	0.35	0.15
	Low	28	1.27	0.35	0.25
	"	29,30	1.27	0.35	0.15
	"	31	1.12	0.35	0.15
larch dwarf mistletoe	Good	33	4.6	0.2	0.15
	"	34	4.6	0.2	0.25
	Medium	33	3.45	0.2	0.15
	"	34	3.45	0.2	0.25
	Poor	33	2.59	0.2	0.15
	"	34	2.59	0.2	0.25
	Low	34	1.94	0.2	0.25
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1	3.5	0.06	0.06
	"	2-4	3.25	0.06	0.06
	"	5,6,8	3.3	0.06	0.06
	"	7	3.8	0.06	0.06
	Medium	1,5,6,8	1.8	0.06	0.06
	"	2-4	2.6	0.06	0.06
	"	7	2.85	0.06	0.06
	Poor	1	0.8	0.06	0.06
	"	2-4	1.4	0.06	0.06
	"	5,6,8	1.0	0.06	0.06
	"	7	2.14	0.06	0.06
	Low	1	0.6	0.06	0.06
	"	4	1.05	0.06	0.06
	"	5,6,8	0.75	0.06	0.06
Douglas-fir tussock moth	Good Medium Poor Low	1,5,6	0.75[d]	-	0.6 + 0.3

a Refer to Table K. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.2. through 7.1.5. for the derivation of these numbers.
Note: For armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

d Ross and Taylor 1983.

Table K. - O. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Okanagan

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	94.8	90	pure pine medium site	260	3.1	74	227
spruce beetle	85.5	90	pure spruce medium site	327	2.9	120	353

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3. NELSON FOREST REGION - AN OVERVIEW

CONCERNS

Timber losses caused by bark beetles, root diseases and dwarf mistletoes are the major concerns in the Nelson Forest Region. Surveys in 1984 showed spruce and mountain pine beetle infestations currently active in 24 000 ha with an estimated nonsalvable loss of 365 000 m^3. Although not as obvious or well documented as bark beetle losses, root diseases and dwarf mistletoes are also causing losses, particularly in young stands and plantations. The annual net loss attributed to these diseases is estimated at 156 000 m^3. Stem and foliage pests are causing damage and will be of more concern in the future, particularly in plantations. No estimate of their impact has been made at this time.

PEST MANAGEMENT CONCERNS

There are a number of opportunities to reduce pest losses through the integration of pest management practices into the development and management of forest stands. Bark beetle populations can be kept at acceptable levels through timely salvage and control harvesting of infested stands, clean harvesting practices, detection and evaluation surveys, the use of trap trees, pheromones and single tree disposal. Root disease and dwarf mistletoe losses can be reduced on future stands through appropriate harvesting and silviculture prescriptions. Impact by blister rust on white pine can be lessened through branch pruning and planting less-susceptible stock. Larch casebearer populations can be kept at acceptable levels through biological control.

NECESSARY ACTIVITIES

There are a number of pest management activities that will be necessary to reduce pest losses. Bark beetle management will require ongoing surveys for the early detection and assessment of infested areas. Scheduling harvesting of infested stands to remove the maximum volume of currently infested wood prior to beetle flight periods is required. It is important use of trap trees, pheromones and single tree disposal to contain and slow down the spread of small infestations. Mistletoe control involves removing residuals over three meters during harvesting, removal of infected trees during spacing of young stands, and removal of infected seed trees within five years after seedlings are established.

Root disease management will require no partial cuts in infected stands, selection of less susceptible seed trees and seedlings and, where appropriate and cost effective, removal of infected stumps to reduce inoculum.

Develop and implement surveys to determine distribution and impact of dwarf mistletoe and root disease in the Nelson Forest Region.

Larch casebearer management will require the continuation and monitoring of the biological control program using parasites to reduce casebearer populations.

Table N. 1 Summary of Pest Losses for the Nelson Forest Region (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short-term losses to the bark beetles)

Pests (and loss duration)[a]	Type of loss[b]	Timber Supply Areas m^3/yr. or m^3/1984							
		Arrow	Boundary	Cranbrook	Golden	Invermere	Kootenay Lake	Revelstoke	Totals
mountain pine beetle	short-term								
	gross	38 544	72 939	105 772	8 989	874 224	19 971	--[c]	1 120 439
	non-salvable loss	14 490	20 255	25 100	2 395	281 419	3 811	--	347 470
	salvage	14 490	47 262	58 566	5 589	281 419	8 893	--	416 219
	long-term								
	regen delay gross	172	199	494	118	5 448	193	--	6 624
	regen delay net	111	157	262	83	2 586	66	--	3 265
spruce beetle	short-term								
	gross	10 836	--	12 364	--	1 367	59 233	19 902	103 692
	non-salvable loss	2 711	--	2 542	--	184	10 508	2 412	18 357
	salvage	5 665	--	5 931	--	430	24 518	5 628	42 172
	long-term								
	regen delay gross	52	--	160	--	6	303	146	667
	regen delay net	24	--	63	--	2	92	25	206
lodgepole pine dwarf mistletoe	long-term								
	gross	6 612	16 036	32 754	4 874	19 567	10 396	56	90 295
	net	4 794	10 678	22 564	4 109	12 245	7 417	28	61 835
armillaria root disease	long-term								
	gross	15 932	9 115	8 682	6 888	10 234	14 662	2 403	67 916
	net	10 686	8 543	6 683	5 801	8 082	11 724	1 685	53 204
larch dwarf mistletoe	long-term								
	gross	12 072	12 782	7 640	--	2 568	8 208	--	43 270
	net	9 389	11 998	6 096	--	1 900	6 875	--	36 258
laminated root rot	long-term								
	gross	3 186	--	--	--	--	2 932	480	6 598
	net	2 137	--	--	--	--	2 344	337	4 818

	Bark Beetles					Root Diseases		Dwarf Mistletoes	
	Gross	Non Salvable Loss	Salvage	Regen Delay		Gross	Net	Gross	Net
				Gross	Net				
Total Losses	1 224 131	365 827	458 391	7 291	3 471	74 514	58 022	133 565	98 093

a Loss duration can be described as either short or long-term in nature (i.e. short-term indicates a loss for 1984 only).

b Gross estimates are based on the gross land area prior to deductions for non-merchantable areas, environmentaly sensitive areas and operability. Net estimates are based on the net operable land base.

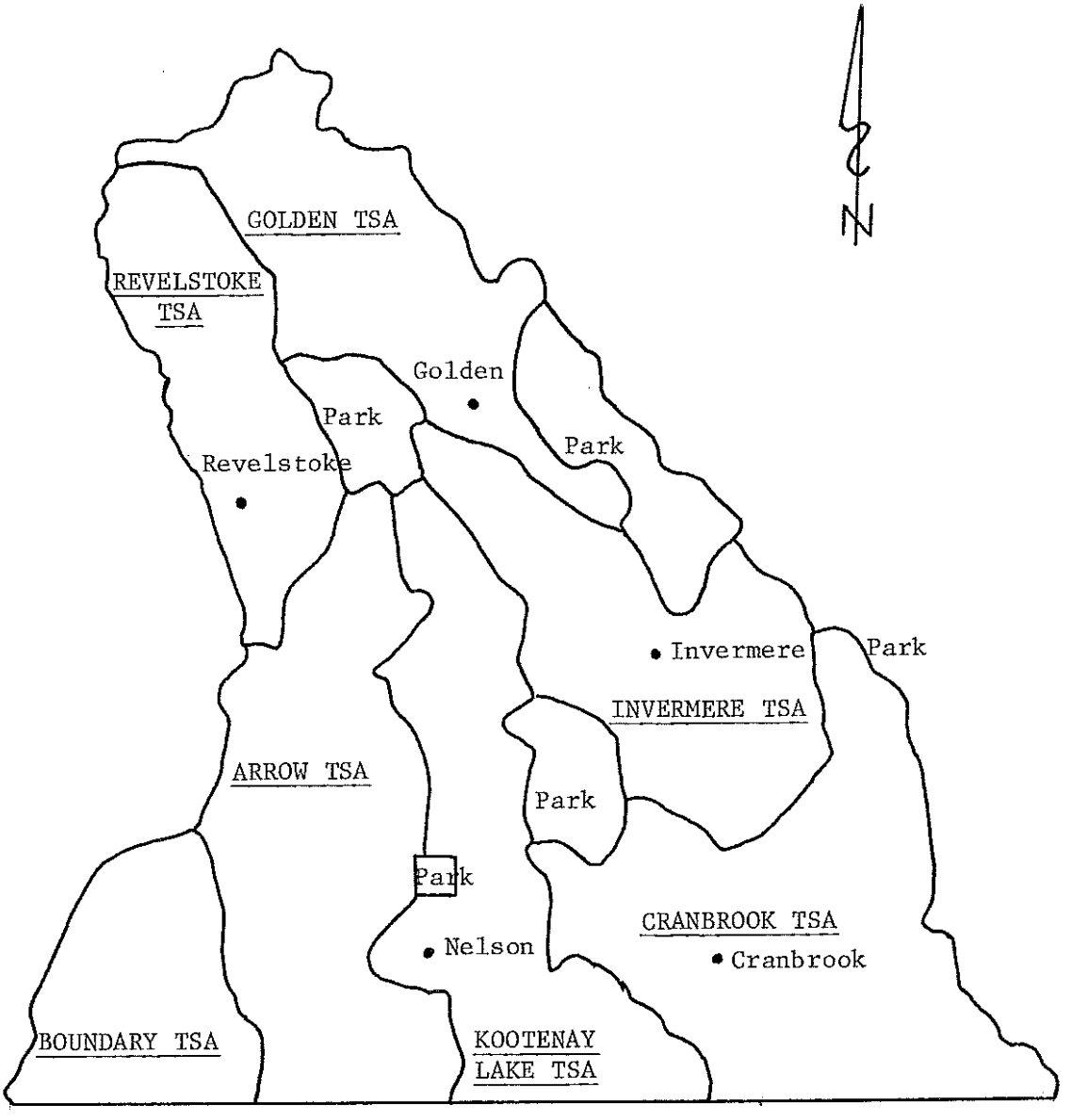
c Pest activity has not been identified as a major concern in these areas.

Table N. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Nelson Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (years)	Sites	Timber Supply Areas Affected:
laminated root rot	1-8(F,FC,FH,FS, FPL,FPy,FL, F Decid)	All	All	Arrow, Kootenay, Lake, Revelstoke
armillaria root disease	1-8(F,FC,FH,FS, FPL,FPy,FL,F Decid)	All	All	All
larch dwarf mistletoe	7(FL),33(LF), 34(L)	All	All	Arrow,Boundary, Cranbrook, Invermere, Kootenay Lake
spruce beetle	21-26(S, SF,SH + SC, SB,SPL,S Decid)	121+	All	Cranbrook, Invermere, Revelstoke, Arrow, Kootenay Lake
mountain pine beetle	28-31(PL, PLF, PLS, Pl Decid)	81+	All	All
lodgepole pine dwarf mistletoe	28-31(PL,PLF, PLS,PL Decid)	All	All	All

a Inventory Area Reports and Statistical Analysis Systems Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.

NELSON FOREST REGION



4.3.1. ARROW T.S.A. - SUMMARY STATEMENT

CONCERNS

Bark beetle infestations are the main concern in the Arrow T.S.A. at the present time. Infestations in 1984 were active on 640 ha with an estimated gross volume of 49,000 m^3 killed and a nonsalvable loss of 17,000 m^3. Armillaria and laminated root diseases in Douglas-fir stands and dwarf mistletoe in pine and larch stands show an estimated annual net loss of 27,000 m^3/year. Blister rust damage to white pine is widespread and is causing significant tree mortality to all age classes. Larch casebearer and bud moth have defoliated larch for the past several years, the impact by these defoliators is not considered significant at this time.

PEST MANAGEMENT OPPORTUNITIES

With spruce beetle populations at reduced levels, there is an opportuniry to pursue a preventative program, through prompt salvage of windthrown timber and appropriate logging practices. Dwarf mistletoe sanitation during harvesting and juvenile spacing will reduce mistletoe losses in future stands. Continuation of the biological control program against the larch casebearer should further reduce losses to larch stands.

NECESSARY ACTIVITIES

There are a number of pest management activities necessary to reduce pest losses in the Arrow T.S.A. Management of bark beetles will require ongoing aerial and ground surveys for the early detection and assessment of infestations and windthrown timber.

Dwarf mistletoe management in infected pine and larch stands will require a three meter knockdown clause in all cutting permits and removal of infected trees during spacing of young stands. Infected seed trees should be removed within five years after seedlings are established.

Develop and implement surveys to determine distribution and impact of root disease and dwarf mistletoe in the Arrow T.S.A.

Table N. - A. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Arrow
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	38 544	14 490	14 490			
spruce beetle	10 836	2 711	5 665			
Total	49 380	17 201	20 155			

a Mortality losses represent a loss for 1984 only.

Table N. - A. 2 Estimated growth and regeneration delay losses. (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Arrow
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			3 186	2 137
armillaria root disease			15 932	10 686
lodgepole pine dwarf mistletoe			6 612	4 794
larch dwarf mistletoe			12 072	9 389
mountain pine beetle (regeneration delay)	172	111		
spruce beetle (regeneration delay)	52	24		
Total	224	135	37 802	27 006

[a] Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - A. 3 Summary of information used to determine pest losses

T.S.A.: Arrow

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	5.2	0.20	0.25
	"	29-30	4.2	0.10	0.15
	"	31	3.125	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	29-30	3.1	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	2.1	0.20	0.25
	"	29-30	1.8	0.10	0.15
	"	31	1.875	0.10	0.15
	Low	28	1.575	0.20	0.25
	"	29-30	1.35	0.10	0.15
	"	31	1.41	0.10	0.15
larch dwarf mistletoe	Good	7,33	4.4	0.2	0.15
	"	34	4.4	0.2	0.25
	Medium	7,33	3.6	0.2	0.15
	"	34	3.6	0.2	0.25
	Poor	7,33	2.7	0.2	0.15
	"	34	2.7	0.2	0.25
	Low	7,33	2.0	0.2	0.15
	"	34	2.0	0.2	0.25
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1,8	4.6	0.05	0.01
	"	2,3	5.1	0.05	0.01
	"	4,5,7	4.0	0.05	0.01
	"	6	4.4	0.05	0.01
	Medium	1	2.9	0.05	0.01
	"	2-4	3.3	0.05	0.01
	"	5,6,8	2.7	0.05	0.01
	"	7	3.6	0.05	0.01
	Poor	1	1.6	0.05	0.01
	"	2-4	2.2	0.05	0.01
	"	5,6,8	1.7	0.05	0.01
	Low	1,5	1.2	0.05	0.01
	"	3	1.6	0.05	0.01
	"	7	2.0	0.05	0.01

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.13 and 7.14 for the derivation of these numbers.
Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table N. - A. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Arrow

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	75.2	50	PL 631-M	321.6	3.0	66	198.3
spruce beetle	74.8	70	SB 841-M	361.2	2.7	94	252

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.2. BOUNDARY T.S.A. - SUMMARY STATEMENT

CONCERNS

Mountain pine beetle losses are the main concern at the present time in the Boundary T.S.A. Surveys in 1984 showed infestations currently active in over 1 000 ha with an estimated gross volume of 73,000 m^3 killed and nonsalvable loss of 20,000 m^3. Spruce beetle populations are at low levels with no infestations being recorded in 1984. Armillaria root disease in Douglas-fir stands and dwarf mistletoe in pine and larch stands show an estimated net loss of 31,000 m^3/year. Blister rust on white pine is causing tree mortality in all age classes. Defoliation to larch stands by larch budmoth and casebearer has occurred for the past several years, the impact is not considered significant at this time.

PEST MANAGEMENT OPPORTUNITIES

There are a number of opportunities to further reduce bark beetle losses in the Boundary T.S.A. through the continuation and strengthening of the program in place. Dwarf mistletoe sanitation during harvesting and spacing will reduce mistletoe losses in new stands. Continuation of the biological control program against larch casebearer should further reduce losses to larch stands.

NECESSARY ACTIVITIES

There are a number of activities that will strengthen the present pest management program in the Boundary T.S.A. Bark beetle management will require ongoing aerial and ground detection surveys for the early detection and assessment of infested stands and windthrown timber. Armillaria root disease in Douglas-fir stands will require surveys to determine distribution and impact. Harvesting infected stands will require no partial cuts, selection of less susceptible seed trees and seedlings and, where appropriate, stump removal in restricted areas to reduce inoculum. Dwarf mistletoe management will require distribution and impact surveys and the enforcement of the three meter knockdown clause in infected cutblocks and the removal of infected trees during juvenile spacing.

Table N. - B. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Boundary
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	72 939	20 255	47 262			
Total	72 939	20 255	47 262			

a Mortality losses represent a loss for 1984 only.

Table N. - B. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Boundary
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			9 115	8 543
lodgepole pine dwarf mistletoe			16 036	10 678
larch dwarf mistletoe			12 782	11 998
mountain pine beetle (regeneration delay)	199	157		
Total	199	157	37 933	31 219

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - B. 3 Summary of information used to determine pest losses

T.S.A.: Boundary

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.7	0.20	0.25
	"	29-30	4.3	0.10	0.15
	"	31	3.125	0.10	0.15
	Medium	28	3.0	0.20	0.25
	"	29-30	2.7	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	1.8	0.20	0.25
	"	29-30	2.2	0.10	0.15
	"	31	1.875	0.10	0.15
	Low	28	1.35	0.20	0.25
	"	29-30	1.65	0.10	0.15
larch dwarf mistletoe	Good	7,33	3.7	0.2	0.15
	"	34	3.7	0.2	0.25
	Medium	7,33	2.8	0.2	0.15
	"	34	2.8	0.2	0.25
	Poor	7,33	2.2	0.2	0.15
	"	34	2.2	0.2	0.25
	Low	34	1.65	0.2	0.25
armillaria root disease	Good	1	4.1	--	0.05
	"	2,4	4.6	--	0.05
	"	5,6,8	3.3	--	0.05
	"	7	3.7	--	0.05
	Medium	1	2.2	--	0.05
	"	2-4	3.0	--	0.05
	"	5,6,8	2.4	--	0.05
	"	7	2.8	--	0.05
	Poor	1	0.7	--	0.05
	"	3,4	2.25	--	0.05
	"	5,6,8	1.0	--	0.05
	"	7	2.2	--	0.05

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4, for the derivation of these numbers.
Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table N. - B. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Boundary

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	92.5	70	PL 631-M	321.6	3.0	66	198.3

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.3. CRANBROOK T.S.A. - SUMMARY STATEMENT

CONCERNS

Forest pests causing appreciable losses at the present time in the Cranbrook T.S.A. are bark beetles, dwarf mistletoes and armillaria root disease. At the present time (1984) spruce and mountain pine beetle infestations are active in 4 100 ha with an estimated gross volume of 118,000 m^3 killed and a nonsalvable loss of 28,000 m^3. The large scale salvage programs that were initiated to deal with the infestations have disrupted long-term harvesting plans in the affected supply blocks. The distribution and impact of dwarf mistletoe in pine and larch stands and armillaria root disease in Douglas-fir stands is not well documented at the present time, however, preliminary estimates show the annual net loss at 35,000 m^3/year. Larch casebearer and sawfly have defoliated western larch stands for the past several years, the long-term effects of this defoliation are not known at the present time.

PEST MANAGEMENT OPPORTUNITIES

There is a good opportunity to further reduce bark beetle losses in the Cranbrook T.S.A. with the ongoing beetle management program that is now in place. Population levels can be reduced through an aggressive harvesting program of infested and susceptible stands, prompt salvage of windthrown timber and appropriate havesting practices. The reduction of dwarf mistletoe losses on future stands can be achieved through mistletoe sanitation clauses in cutting permits and juvenile spacing contracts. Armillaria root disease losses on new stands can be reduced through harvesting and silviculture treatments.

NECESSARY ACTIVITIES

There are a number of pest management activities that should be continued and strengthened to effectively deal with the current pest problems in the Cranbrook T.S.A. Bark beetle management will require aerial and ground surveys for the early detection and assessment of infestations.

Dwarf mistletoe management in infected pine and larch stands will require a three meter knockdown clause in all cutting permits and removal of infected trees during spacing of young stands. Infected seed trees left in cutblocks should be removed within five years after seedlings are established. Armillaria root disease management in infected Douglas-fir stands will require no partial cuts, selection of less susceptible seed trees and seedlings and, where appropriate and cost effective, stump removal to reduce inoculum.

Develop and implement surveys to determine distribution and impact of dwarf mistletoe and armillaria root disease in the Cranbrook T.S.A.

Table N. - C. 1 Estimated mortality losss caused by current pest activity[a]

T.S.A.: Cranbrook
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	105 772	25 100	58 566			
spruce beetle	12 364	2 542	5 931			
Total	118 136	27 642	64 497			

a Mortality losses represent a loss for 1984 only.

Table N. - C. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: Cranbrook
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			8 682	6 683
lodgepole pine dwarf mistletoe			32 754	22 564
larch dwarf mistletoe			7 640	6 096
mountain pine beetle (regeneration delay)	494	262		
spruce beetle (regeneration delay)	160	63		
Total	654	325	49 075	35 343

[a] Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - C. 3 Summary of information used to determine pest losses

T.S.A.: Cranbrook

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.6	0.20	0.25
	"	29-31	4.7	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	29-31	3.0	0.10	0.15
	Poor	28	1.8	0.20	0.25
	"	29-31	1.8	0.10	0.15
	Low	28	1.35	0.20	0.25
	"	29-31	1.35	0.10	0.15
larch dwarf mistletoe	Good	7,33	3.4	0.20	0.15
	"	34	3.4	0.20	0.25
	Medium	7,33	2.0	0.20	0.15
	"	34	2.0	0.20	0.25
	Poor	7,33	1.4	0.20	0.15
	"	34	1.4	0.20	0.25
	Low	7,33	0.6	0.20	0.15
	"	34	0.6	0.20	0.25
armillaria root disease	Good	1-6	4.7	--	0.05
	"	7	3.2	--	0.05
	Medium	1-4	2.8	--	0.05
	"	5,6,8	2.3	--	0.05
	"	7	1.7	--	0.05
	Poor	1-6,8	1.2	--	0.05
	"	7	1.3	--	0.05
	Low	1-8	0.5	--	0.05

Only gross inventory reports were available for this T.S.A., therefore N/G ratios were used to net down gross reports and they were:
lodgepole pine dwarf mistletoe: G (79%),M(79%),P(52.5%) and L(0%)
larch dwarf mistletoe: G (84%), M(83.3%),P(72.3%) and L(0%)
armillaria root disease: G (84%),M(83.3%),P(72.3%) and L(0%)

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.
Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table N. - C. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Cranbrook

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	79	70	PL 631-M	382.4	2.3	88	205.3
spruce beetle	68.5	70	SB 841-M	396.3	2.7	103	277.3

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.4. GOLDEN T.S.A. - SUMMARY STATEMENT

CONCERNS

For the past several years bark beetle tree mortality has been the major concern in the Golden T.S.A. Harvesting of infested stands has reduced bark beetle populations to manageable levels. Surveys in 1984 showed mountain pine beetle infestations currently active in 500 ha with an estimated gross volume of 9,000 m^3 killed and a nonsalvable loss of 2,400 m^3. Spruce beetle populations are at low levels with no infestations recorded in 1984. Armillaria root disease is a serious problem in Douglas-fir stands with the net annual loss estimated at 5,800 m^3/year. Dwarf mistletoe net impact, on lodgepole pine is estimated at 4,100 m^3/year. Blister rust impact on white pine was not estimated, however, this disease is widespread throughout the host range. Hemlock looper and blackheaded budworm have defoliated old growth hemlock-cedar stands for the past several years causing some top killing and tree mortality.

PEST MANAGEMENT OPPORTUNITIES

There is an opportunity to further reduce losses to mountain pine beetle in the Golden T.S.A. through prompt harvesting of currently infested stands and treatment of small infestations using pheromones and single tree disposal. The timely salvage of spruce blowdown, clean logging practices and trap trees should keep spruce beetle populations at low levels. Armillaria root disease impacts on new stands can be reduced through appropriate harvesting and silviculture prescriptions. The reduction of dwarf mistletoe impacts on future stands can be achieved through mistletoe sanitation of infected stands during harvesting and juvenile spacing.

NECESSARY ACTIVITIES

There are a number of pest management activities that will reduce pest losses in the Golden T.S.A. Management of bark beetles will require annual aerial and ground surveys for the early detection and assessment of infestations.

Armillaria root disease management in infested Douglas-fir stands will require no partial cuts, selection of less susceptible seed trees and seedlings and, where appropriate and cost effective, removal of infected stumps to reduce inoculum. Dwarf mistletoe management in infected pine stands will require a three meter knockdown clause in all cutting permits and removal of infected trees during spacing of young stands. Surveys should be developed and implemented to determine distribution and impact of dwarf mistletoe and Armillaria root disease in the Golden T.S.A.

Table N. - G. 1 Estimated mortality on volume losses caused by current pest activity[a]

T.S.A.: Golden
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	8 989	2 395	5 589			
Total	8 989	2 395	5 589			

a Mortality losses represent a loss for 1984 only.

Table N. - G. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: Golden
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			6 888	5 801
lodgepole pine dwarf mistletoe			4 874	4 109
mountain pine beetle (regeneration delay)	118	83		
Total	18	83	11 762	9 910

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - G. 3 Summary of information used to determine pest losses

T.S.A.: Golden

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	5.2	0.20	0.25
	"	29-30	4.2	0.10	0.15
	"	31	3.1	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	29-30	3.1	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	2.1	0.20	0.25
	"	29-31	1.8	0.10	0.15
	Low	28	1.5	0.20	0.25
	"	30	1.3	0.10	0.15
armillaria root disease	Good	1	4.3	--	0.05
	"	2-4	4.6	--	0.05
	"	5,8	3.6	--	0.05
	Medium	1	2.5	--	0.05
	"	2-4	2.9	--	0.05
	"	5,8	2.3	--	0.05
	Poor	1	1.4	--	0.05
	"	2-4	1.8	--	0.05
	"	5,8	1.3	--	0.05

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.
Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table N. - G. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Golden

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	88.8	70	PL 631-M	304.2	3.2	66	210.2

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.5. INVERMERE T.S.A. - SUMMARY STATEMENT

CONCERNS

Mountain pine beetle is the major concern in the Invermere T.S.A. Surveys in 1984 showed infestations currently active in 14 000 ha with an estimated gross volume of 874 000 m^3 killed and a net nonsalvable loss at 281 000 m^3. The current infesation accounts for over 50 percent of the total area infested by bark beetles in the Nelson Region. The large scale salvage programs that have been underway for the past several years have disrutped long-term harvesting plans in this T.S.A. Spruce beetle populations have remained at low levels during the past five years. Preliminary estimates of losses caused by Armillaria root disease in Douglas-fir stands and dwarf mistletoe in pine and larch stands show an annual net loss of 22 000 m^3/year. False hemlock looper has caused sporadic defoliation of Douglas-fir, however, the impact is not significant.

PEST MANAGEMENT OPPORTUNITIES

The major opportunity to reduce pest losses in the Invermere T.S.A. at the present time is to concentrate as much of the A.A.C. in mountain pine beetle infested stands, scheduling the harvesting to remove a maximum volume of currently infested wood prior to beetle flight periods. Spruce beetle populations can be kept at low levels through a continuing program of prompt salvage of windthrown timber and appropriate logging practices. Dwarf mistletoe sanitation clauses in cutting permits and juvenile spacing projects will reduce mistletoe impacts in future stands. Armillaria root disease impacts in future Douglas-fir stands can be reduced through appropriate harvesting and silviculture prescriptions.

NECESSARY ACTIVITIES

There are a number of activities that should be continued and strengthened to deal with the current pest problems in the Invermere T.S.A. Management of bark beetles will require annual aerial and ground surveys for the early detection and assessment of infestations.

Dwarf mistletoe management in infested pine and larch stands will require a three meter knockdown clause in all cutting permits and removal of infected trees during spacing of young stands. Infected seed trees should be removed within five years after seedlings are established.

Armillaria root disease management in infected Douglas-fir stands will require no partial cuts, selection of less susceptible seed trees and seedlings and, where appropriate and cost effective, removal of stumps to reduce inoculum.

Surveys need to be developed and implemented to determine distribution and impact of dwarf mistletoe and Armillaria root disease in the Invermere T.S.A.

Table N. - I. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Invermere
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	874 224	281 419	281 419			
spruce beetle	1 367	184	430			
Total	875 591	281 603	281 849			

a Mortality losses represent a loss for 1984 only.

Table N. - I. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: Invermere
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			10 234	8 082
larch dwarf mistletoe			2 568	1 900
lodgepole pine dwarf mistletoe			19 567	12 245
mountain pine beetle (regeneration delay)	5 448	2 586		
spruce beetle (regeneration delay)	6	2		
Total	5 454	2 588	32 369	22 227

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - I. 3 Summary of information used to determine pest losses

T.S.A.: Invermere

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.6	0.20	0.25
	"	29-30	4.7	0.10	0.15
	"	31	3.125	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	29-30	3.0	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	1.8	0.20	0.25
	"	29-30	1.8	0.10	0.15
	"	31	1.8	0.10	0.15
	Low	28	1.35	0.20	0.25
	"	29-30	1.35	0.10	0.15
	"	31	1.41	0.10	0.15
larch dwarf mistletoe	Good	7,33	3.4	0.20	0.15
	"	34	3.4	0.20	0.25
	Medium	7,33	2.0	0.20	0.15
	"	34	2.0	0.20	0.25
	Poor	7,33	1.4	0.20	0.15
	"	34	1.4	0.20	0.25
	Low	7	1.05	0.20	0.15
	"	34	1.05	0.20	0.25
armillaria root disease	Good	1-5,8	4.7	--	0.05
	"	7	3.2	--	0.05
	Medium	1-4,8	2.8	--	0.05
	"	5,6	2.3	--	0.05
	"	7	1.7	--	0.05
	Poor	1-6,8	1.2	--	0.05
	"	7	1.3	--	0.05
	Low	1,4,5,7,8	0.5	--	0.05

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table N. - I. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Invermere

Pest[a]	Net/Gross Ratio (%)	Salvage Factor (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	64.4	50	PL 631-M	382.4	3.2	69	221.9
spruce beetle	45.7	70	SB 841-M	396.4	2.9	94	273.0

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.6. KOOTENAY LAKE T.S.A. - SUMMARY STATEMENT

CONCERNS

Bark beetle infestations are the main concern in the Kootenay Lake T.S.A. at the present time. Infestations of spruce and mountain pine beetles in 1984 were active on 1 460 ha with an estimated gross volume of 79 000 m^3 killed and nonsalvable loss of 14 000 m^3. Armillaria and laminated root diseases in Douglas-fir stands and dwarf mistletoe in pine and larch stands show an estimated loss of 28 000 m^3/year. Blister rust damage to white pine is widespread and is causing significant tree mortality in all age classes. Larch casebearer and budmoth have defoliated larch for the past several years, the impact is not considered significant at this time.

PEST MANAGEMENT OPPORTUNITIES

There is an opportunity to further reduce losses to bark beetles in the Kootenay Lake T.S.A. through the continuation and strengthening of the present beetle management program. Dwarf mistletoe sanitation during harvesting and spacing will reduce impacts on future stands. Continuation of the biological control program against the larch casebearer will assist in reducing population levels.

NECESSARY ACTIVITIES

There are a number of pest management activities that should be continued in the Kootenay Lake T.S.A. Management of bark beetles will require ongoing aerial and ground surveys for the early detection and assessment of infested stands and windthrown timber.

Dwarf mistletoe management in infected pine and larch stands will require a three meter knockdown clause in all cutting permits and removal of infected trees during spacing of young stands. Infected seed trees should be removed within five years after seedlings are established.

Develop and implement surveys to determine distribution and impact of root disease and dwarf mistletoe in the Kootenay Lake T.S.A.

Table N. - K. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Kootenay Lake
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	19 971	3 811	8 893			
spruce beetle	59 223	10 508	24 518			
Total	79 194	14 319	33 411			

a Mortality losses represent a loss for 1984 only.

Table N. - K. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Kootenay Lake
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			2 932	2 344
armillaria root disease			14 662	11 724
lodgepole pine dwarf mistletoe			10 396	7 417
larch dwarf mistletoe			8 208	6 875
mountain pine beetle (regeneration delay)	193	66		
spruce beetle (regeneration delay)	303	92		
Total	496	158	36 198	28 360

[a] Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - K. 3 Summary of information used to determine pest losses

T.S.A.: Kootenay Lake

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	5.2	0.20	0.25
	"	29-30	4.2	0.10	0.15
	"	31	3.125	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	29-30	3.1	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	2.1	0.20	0.25
	"	29-30	1.8	0.10	0.15
	"	31	1.875	0.10	0.15
	Low	28	1.575	0.20	0.25
	"	29-30	1.35	0.10	0.15
	"	31	1.41	0.10	0.15
larch dwarf mistletoe	Good	7,33	2.3	0.20	0.15
	"	34	2.3	0.20	0.25
	Medium	7,33	2.1	0.20	0.15
	"	34	2.1	0.20	0.25
	Poor	7,33	1.4	0.20	0.15
	"	34	1.4	0.20	0.25
	Low	7	1.05	0.20	0.15
	"	34	1.05	0.20	0.25
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1	4.3	0.05	0.01
	"	2-4	4.6	0.05	0.01
	"	5,6,8	3.6	0.05	0.01
	"	7	4.0	0.05	0.01
	Medium	1	2.5	0.05	0.01
	"	2-4	2.9	0.05	0.01
	"	5,6,8	2.3	0.05	0.01
	"	7	3.2	0.05	0.01
	Poor	1	1.4	0.05	0.01
	"	2-4	1.8	0.05	0.01
	"	5,6,8	1.3	0.05	0.01
	"	7	2.2	0.05	0.01

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table N. - K. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Kootenay Lake

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	63.6	70	PL 631-M	321.6	3.2	66	210.2
spruce beetle	59.1	70	SB 841-M	358.6	2.7	94	252

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.3.7. REVELSTOKE T.S.A. - SUMMARY STATEMENT

CONCERNS

Spruce beetle infestations have been the major concern in the Revelstoke T.S.A. At the present, infestations are at a low level. Surveys in 1984 showed spruce beetle infestations currently active on 300 ha, with an estimated gross volume of 20 000 m^3 killed and a net nonsalvable loss of 2 400 m^3. Mountain pine beetle has caused scattered white pine mortality in mixed stands. Armillaria and laminated root disease in Douglas-fir stands show an estimated annual net loss of 2 000 m^3/year. Hemlock looper and blackheaded budworm have defoliated old growth hemlock-cedar stands for the past several years, causing some top killing and tree mortality. Blister rust damage to white pine is widespread and is causing significant tree mortality in all age classes.

PEST MANAGEMENT OPPORTUNITIES

With spruce beetle populations at low levels there is a good opportunity to pursue a preventative program through the prompt salvage of windthrown timber and appropriate logging practices.

NECESSARY ACTIVITIES

A number of pest management activities necessary to reduce losses in the Revelstoke T.S.A. can be integrated into the present harvesting and silviculture program. Spruce beetle management will require ongoing aerial and ground surveys for the early detection and assessment of infested stands and windthrown timber. Clean harvesting practices, prompt salvage of windthrown spruce, the use of trap trees and windfirm leave block boundaries. Hazard rate mature spruce stands, develop access and priorize harvesting of high hazard stands.

Develop and implement surveys to determine distribution and impact of root disease in the Revelstoke T.S.A.

Table K. - R. 1 Estimated mortality losses on volume caused by current pest activity[a]

T.S.A.: Revelstoke
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
spruce beetle	19 902	2 412	5 628			
Total	19 902	2 412	5 628			

a Mortality losses represent a loss for 1984 only.

Table N. - R. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: Revelstoke
DATE: June 18, 1985
RATED BY: E. Morris
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			480	337
armillaria root disease			2 403	1 685
lodgepole pine dwarf mistletoe			56	28
spruce beetle (regeneration delay)	146	25		
Total	146	25	2 939	2 050

[a] Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table N. - R. 3 Summary of information used to determine pest losses

T.S.A.: Revelstoke

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	5.2	0.20	0.25
	"	29	4.2	0.10	0.15
	Medium	28	3.2	0.20	0.25
	"	30	3.1	0.10	0.15
	"	31	2.5	0.10	0.15
	Poor	28	2.1	0.20	0.25
	"	29-31	1.8	0.10	0.15
	Low	28	1.5	0.20	0.25
	"	29	1.3	0.10	0.15
				armillaria root disease	laminated root rot
armillaria root disease and laminated root rot	Good	1	4.3	0.05	0.01
	"	2-4	4.6	0.05	0.01
	"	5,8	3.6	0.05	0.01
	"	7	4.0	0.05	0.01
	Medium	1	2.5	0.05	0.01
	"	2-4	2.9	0.05	0.01
	"	5,8	2.3	0.05	0.01
	Poor	1	1.4	0.05	0.01
	"	2-4	1.8	0.05	0.01
	"	5,8	1.3	0.05	0.01
	Low	1	1.05	0.05	0.01
	"	8	0.975	0.05	0.01

a Refer to Table N. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table N. - R. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Revelstoke

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
spruce beetle	40.4	70	SB 841-M	358.6	2.7	94	252

a Refer to section 7.1.1. for the derivation of these numbers.
b This salvage factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.4. PRINCE GEORGE FOREST REGION - AN OVERVIEW

CONCERNS

The timber losses for which pests are responsible traditionally have been associated with bark beetles in the Prince George Forest Region. While many factors have contributed to this situation, these losses should continue to decrease as gains in critical access development, realization of the potential for problems, management methods and new technology contribute to bark beetle control. However, a new group of pests have the potential to cause even greater losses: as the regenerated stands increase in numbers and age, pests of immature stands become significant. These pests can cause large economic losses at rotation age through their actions some 50 years earlier. While stocking may not be significantly lower than ideal, the remaining trees may be severely deformed or stunted, rendering them non-merchantable. Losses to mistletoe in lodgepole pine stands should decrease annually as mature, infested stands are replaced by disease-free regenerated stands. More recently the losses to root rots have been recognized to be significant. This group of pests is responsible for 54% of all net losses in the Prince George Forest Region.

PEST MANAGEMENT OPPORTUNITIES

Active management of pests will increase the timber volumes available for harvest. The integration of bark beetle management techniques into forest management activities will decrease the populations of these destructive insects. Losses to mistletoes in managed lodgepole pine can be controlled in the next rotation through integrated approaches using harvesting and sanitation procedures to result in stand yields greater than those expected from natural stands. The incorporation of root disease management strategies into forest management procedures will influence the volume yields of managed forests in a similar manner. The most profitable pest management opportunities are those directed towards the pests active in immature stands. Their worth will continue to increase as the mature forests are harvested and replaced with valuable regenerated forests. The management of these pests, however, presents many complex situations and unanswered questions.

NECESSARY ACTIVITIES

The key to successful management of forest pests is thorough and effective detection and assessment of pest activity. Once the presence and significance of a pest is determined, only then can effective, efficient control procedures be put in place. Bark beetle control plans require the harvesting of infested stands, post-harvesting sanitation and strategic placement of trap trees in conjunction with co-ordinated access development. Mistletoe management will include harvesting, post-logging treatment and ongoing sanitation procedures to establish and grow a vigorous, healthy lodgepole pine crop. Surveys of all free growing plantations greater than 10 years of age to determine the presence and significance of pests must be an integral part of management activities. If necessary, subsequent control action must be initiated to protect and enhance our investment in the future harvest. Surveys are especially required to determine the distribution and intensity of root diseases in the Prince George Forest Region.

Table P.G. 1 Summary of pest losses for the Prince George Forest Region (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short-term losses to the bark beetles)

Pests (and loss duration)[a]	Type of Loss[b]	Timber Supply Areas (m^3/yr. or m^3/1984)					
		Fort Nelson	Mackenzie	McBride	Peace	Prince George	Totals
spruce beetle	short-term						
	gross	--[c]	1 725	1 035	47 093	684 515	734 368
	non-salvable loss	--	760	647	11 074	85 837	98 318
	salvage	--	380	110	27 112	174 277	201 879
	long-term						
	regen delay gross	--	46	46	889	18 909	19 890
	regen delay net	--	26	32	492	3 187	3 737
tomentosus root rot	long-term						
	gross	142 061	63 760	18 167	90 421	167 104	481 513
	net	46 234	44 736	12 968	56 415	157 571	317 924
lodgepole pine dwarf mistletoe	long-term						
	gross	--	72 929	4 887	--	231 307	309 123
	net	--	57 598	2 068	--	202 818	262 484
armillaria root disease	long-term						
	gross	--	--	23 930	--	207 610	231 540
	net	--	--	15 450	--	195 874	211 324
mountain pine beetle	short-term						
	gross	--	--	108 901	--	13 613	122 514
	non-salvable loss	--	--	54 669	--	3 593	58 262
	salvage	--	--	9 648	--	7 296	16 944
	long-term						
	regen delay gross	--	--	541	--	55	596
	regen delay net	--	--	298	--	31	329
western balsam bark beetle	short-term						
	gross	--	28 050	--	--	1 650	29 700
	non-salvable loss	--	5 924	--	--	322	6 246
	salvage	--	2 962	--	--	654	3 616
	long-term						
	regen delay gross	--	121	--	--	25	146
	regen delay net	--	29	--	--	8	37
Douglas-fir beetle	short-term						
	gross	--	--	--	--	3 119	3 119
	non-salvageable loss	--	--	--	--	947	947
	salvage	--	--	--	--	1 922	1 922
	long-term						
	regen delay gross	--	--	--	--	9	9
	regen delay net	--	--	--	--	7	7

Table P.G. 1 continued

	Bark Beetles					Root diseases		Lodgepole pine dwarf mistletoe	
	Gross	Non-salvable Loss	Salvage	Regen Delay Gross	Regen Delay Net	Gross	Net	Gross	Net
Total Losses	889 701	163 773	224 361	20 641	4 110	713 053	529 248	309 123	262 484

a Loss duration can be described as either short or long-term in nature (i.e. short-term indicates a loss for 1984 only).

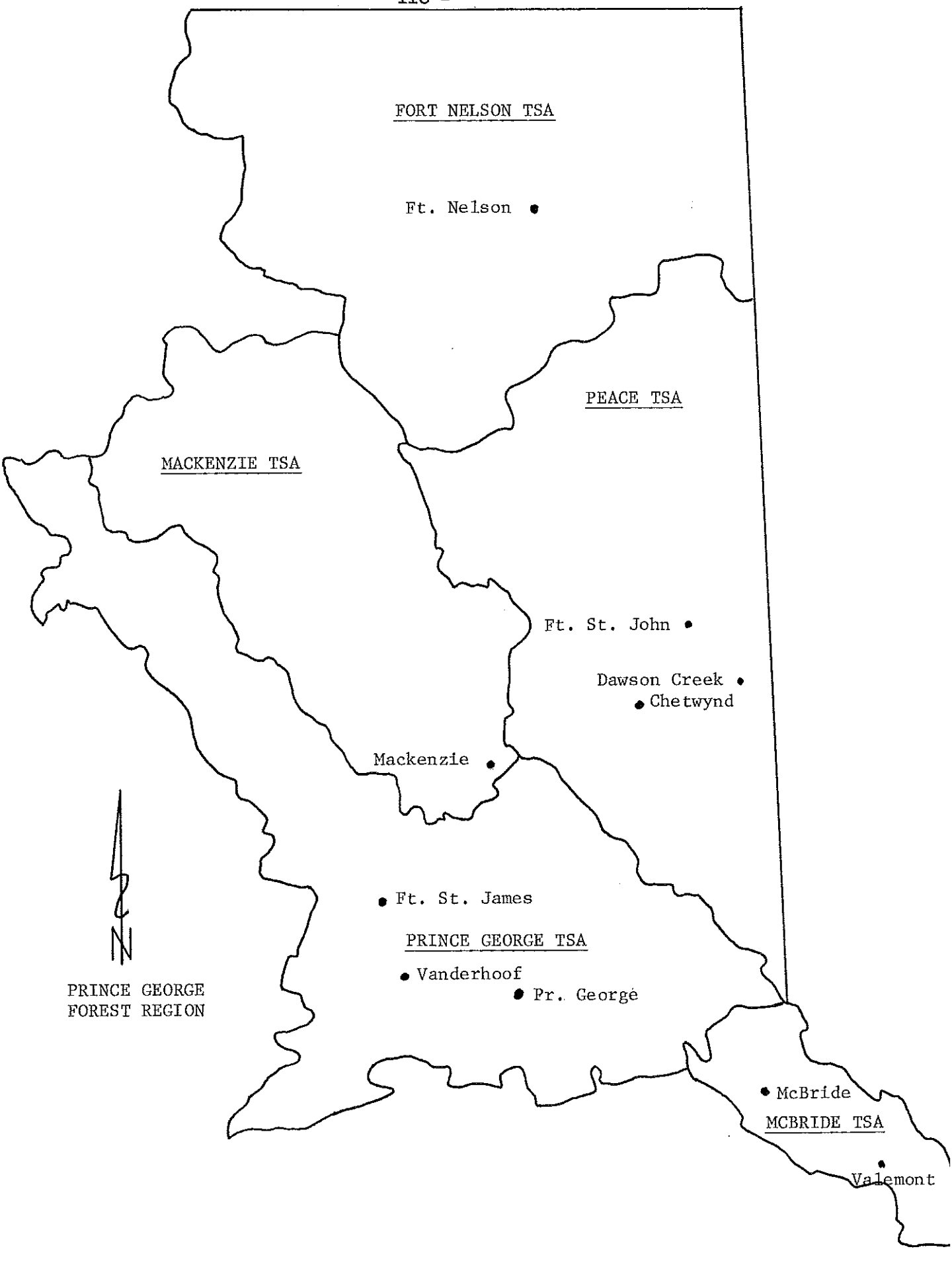
b Gross estimates are based on the gross land area prior to deductions for non-merchantable areas, environmentally sensitive areas and operability. Net estimates are based on the net operable land base.

c Pest activity has not been identified as a major concern in these areas.

Table P.G. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Prince George Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (Years)	Sites	Timber Supply Areas Affected:
tomentosus root rot	21-26(S, SF,SH and SC, SB, SPL, S Decid)	All	All	Prince George, McBride, Mackenzie, Fort Nelson, Peace
armillaria root disease	1(F), 4(FS), 5(FPL), 21-25(S, SF, SH and SC, SB, SPL)	All	All	Prince George, McBride
spruce beetle	21(S), 22(SF), 24(SB), 25(SPL)	121+	All	McBride, Prince George, Mackenzie, Peace
mountain pine beetle	27-31 (PW, PLB, PLF, PLS and PLB, PL Decid)	81+	All	McBride, Prince George
western balsam bark beetle	18(B), 20(BS)	81+	All	Mackenzie, Prince George
Douglas-fir beetle	1(F), 4(FS), 5(FPL),	101+	All	Prince George
lodgepole pine dwarf mistletoe	28(PL)	All	All	McBride, Prince George, Mackenzie

a Inventory Area Reports and Statistical Analysis Systems Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.


FORT NELSON TSA
Ft. Nelson
PEACE TSA
MACKENZIE TSA
Ft. St. John
Dawson Creek
Chetwynd
Mackenzie
Ft. St. James
PRINCE GEORGE TSA
Vanderhoof
Pr. George
McBride
MCBRIDE TSA
Valemont
PRINCE GEORGE
FOREST REGION

4.4.1. FORT NELSON TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Forest pests have not been major factors in the development of the forests of this T.S.A. Isolated and scattered mortality in mature spruce stands due to spruce beetle and Ips spp. is of little consequence. Light defoliation on spruce and balsam over an area of 7 500 ha was caused by eastern spruce budworm in 1984. While the infestation is expected to continue in 1985, growth losses attributable to this pest are insignificant. Various wood borers are present and active in large numbers in decked logs in the bush and, primarily, in logs stored in the millyards. These insects are responsible for significant impacts in the value of the manufactured product. A projected annual loss due to the tomentosus root rot of 46 200 m^3 (5.4% of the A.A.C.) occurs within the net operable land base of the T.S.A. (142 100 m^3/year on the gross land base).

PEST MANAGEMENT OPPORTUNITIES

Losses to bark beetles can be confined to current levels through conventional forest management techniques. Careful scheduling of harvesting and milling operations and complete clean-up of landings should significantly reduce the problems associated with wood boring insects. The incorporation of root disease management strategies, once developed, into forest management procedures will reduce the future losses to root diseases in regenerated forests. Since root disease impacts are incorporated in the growth curves (volume-age curves), any treatment to reduce their impact will presumably result in volume yields greater than those expected from natural stands.

NECESSARY ACTIVITIES

While insect pests are not currently causing significant timber losses, monitoring must be ongoing to ensure early detection and subsequent control

action. Early recognition of bark beetle activity, placement of trap trees as necessary and treatment of infested stands will maintain their current low levels. The processing of all borer-infested material prior to adult dispersal and post-logging treatment to minimize host material will, in time, reduce the borer populations to economically acceptable levels. Surveys are required to determine the distribution and intensity of tomentosus root rot and possibly other root diseases, in the Fort Nelson T.S.A.

Table P.G. - F. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Fort Nelson
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available.						
Total						

a Mortality losses represent a loss for 1984 only.

Table P.G. - F. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] on volume caused by current pest activity

T.S.A.: Fort Nelson
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
tomentosus root rot			142 061	46 234
Total			142 061	46 234

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.G. - F. 3 Summary of information used to determine pest losses

T.S.A.: Fort Nelson

Pest	Site Class	Inventory[a] Type Group	MAX M.A.I.[b] (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21,25,26	3.8	0.16	0.25
		24	3.4	0.16	0.25
	Medium	21,22,24-26	2.7	0.16	0.25
	Poor	21	1.2	0.16	0.25
		22,24	1.3	0.16	0.25
		25	1.4	0.16	0.25

a Refer to Table P.G. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to section 7.1.3. for the derivation of these numbers.

4.4.2. MACKENZIE TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Mistletoe, bark beetles and the threat of plantation pests are of current concern in the Mackenzie T.S.A. Western balsam bark beetle and spruce beetle are currently responsible for non-salvable losses of 5 900 m^3 and 800 m^3 respectively (gross losses: 28 000 and 1 700 m^3), while the lodgepole pine dwarf mistletoe causes a projected annual net loss of 57 600 m^3/yr (1.9% of A.A.C.) (gross loss 72 900 m^3/yr). As the plantations excede ages of 10 years, a new group of pests may become significant factors in forest development: white pine weevil, lodgepole terminal weevil and Warren's root collar weevil may become pests of these stands. Stem and gall rusts are evident in many naturally-occurring immature lodgepole pine stands and may also infest plantations. Plantation establishment may be hampered by black army cutworm which has been reported to the south of this T.S.A. A projection of the net annual loss to tomentosus root rot has been made at 44 700 m^3 (1.5% of the A.A.C.) (gross loss: 63 800 m^3/yr).

PEST MANAGEMENT OPPORTUNITIES

The non-salvage losses to spruce beetle will be maintained or reduced by salvage and sanitation harvesting of infested spruce stands. Similar strategies should favourably influence the impact of western balsam bark beetles. Net losses to lodgepole pine dwarf mistletoe can virtually be eliminated in the next rotation through integrated approaches using harvesting and sanitation procedures. Since losses due to lodgepole pine dwarf mistletoe are incorporated in the growth curves (volume over age curves), any treatments to reduce their impact will presumably result in volume yields greater than those expected from natural stands. Similarly, the incorporation of root disease management strategies, once developed, into forest management procedures will influence volume yields of managed forests. Significant pest management opportunities exist in the detection and subsequent control of pests in plantations and young stands.

NECESSARY ACTIVITIES

Bark beetle control plans require, subsequent to thorough detection and assessment, harvesting of infested stands and strategic placement of trap trees to maintain or reduce current non-salvage losses. Mistletoe management will include harvesting, post-logging treatment and ongoing sanitation procedures to establish and grow a vigorous, disease-free, lodgepole pine crop. Surveys of all plantations greater than 10 years of age to determine the presence and significance of plantation pests must be an integral part of management activities. If necessary, subsequent control action must be initiated to protect and enhance our investment in the future harvest. Surveys are required to determine the distribution and intensity of tomentosus root rot and possibly other root diseases in the Mackenzie T.S.A.

Table P.G. - Mc. 1 Estimated mortality loss on volume caused by current pest activity[a]

T.S.A.: Mackenzie
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
western balsam bark beetle	28 050	5 924	2 962			
spruce beetle	1 725	760	380			
Total	29 775	6 684	3 432			

a Mortality losses represent a loss for 1984 only.

Table P.G. - Mc. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: Mackenzie
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
lodgepole pine dwarf mistletoe			72 929	57 598
western balsam bark beetle (regeneration delay)	121	29		
spruce beetle (regeneration delay)	46	26		
tomentosus root rot			63 760	44 736
Total	167	55	136 689	102 334

[a] Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.G. - Mc. 3 Summary of information used to determine pest losses

T.S.A.: Mackenzie

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21,22,24	4.1	0.16	0.25
		25,26	3.8	0.16	0.25
	Medium	21	2.9	0.16	0.25
		22,24	2.6	0.16	0.25
		25,26	2.5	0.16	0.25
	Poor	21	1.2	0.16	0.25
		24	1.4	0.16	0.25
		25,26	1.1	0.16	0.25
	Low	21	0.9	0.16	0.25
		22,24	1.05	0.16	0.25
		25,26	0.825	0.16	0.25
lodgepole pine dwarf mistletoe	Good	28	3.6	0.35	0.25
	Medium	28	2.2	0.35	0.25
	Poor	28	0.6	0.35	0.25
	Low	28	0.45	0.35	0.25

a Refer to Table P.G. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. through 7.1.5. for the derivation of these numbers.

Table P.G. - Mc. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Mackenzie

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
western balsam bark beetle	32	33	B(S) 831-P	220	1.3	116	148.2
spruce beetle	68	33	SB 831-M	230	2.6	87	225.8

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.4.3. MCBRIDE TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Bark beetles, lodgepole pine dwarf mistletoe and the threat of increasing numbers of plantation pests are important considerations in the McBride T.S.A. Mountain pine beetle is currently responsible for net non-salvaged losses of 54 700 m^3 (gross: 108 900 m^3), spruce beetle is responsible for non-salvaged losses of 600 m^3 (gross: 1 000 m^3). Losses attributed to western balsam bark beetle while present, have not been quantified. Lodgepole pine dwarf mistletoe losses are calculated to be 2 100 m^3/yr (net) (gross: 4 900 m^3/yr) in lodgepole pine. Stem and gall rusts are evident throughout most naturally-occurring lodgepole pine stands and their spread into and effect upon plantations is of some concern. As the plantations excede ages of 10 years, a new group of pests are likely to become significant factors in stand development; white pine weevil, lodgepole terminal weevil and Warren's root collar weevil may become pests of these stands. Plantation establishment has occasionally been hampered by black army cutworm activity. Root diseases, primarily tomentosus root rot and armillaria root disease have been projected to cause net annual losses of 28 400 m^3/yr (gross: 42 100 m^3/yr).

PEST MANAGEMENT OPPORTUNITIES

The non-salvage losses to bark beetles can be reduced by salvage and sanitation harvesting of infested stands. Infestations of mountain pine beetle and spruce beetle can be limited through the use of trap trees, semiochemicals and co-ordinated access development. Net losses to lodgepole pine dwarf mistletoe can virtually be eliminated in the next rotation through integrated approaches using harvesting and sanitation procedures. Since the losses attributed to lodgepole pine dwarf mistletoe are incorporated in the growth curves (volume over age curves), any treatments to reduce their loss will presumably result in volume yields greater than those expected from natural stands. Similarly, the incorporation of root disease management strategies,

once developed, into forest management procedures will influence volume yields of managed forests. The control of pests of plantations and immature stands provides a great opportunity for significant yield gains at rotation age.

NECESSARY ACTIVITIES

Thorough detection and assessment procedures are critical in the development and execution of pest control strategies. Harvesting or other treatment of infested stands, post-harvesting treatment and strategic use of trap tree options are requirements of bark beetle management. Transportation restrictions during the flight period of mountain pine beetle may limit its rate and distance of spread. Mistletoe management through harvesting, site treatment and young stand sanitation will result in vigorous, disease-free lodgepole pine crops. Aggressive survey and control activities (as necessary) in all plantations of ages of 10 years and greater will result in maximization of the available harvest at rotation age. Surveys are required to determine the distribution and intensity of tomentosus root rot, armillaria root disease and possibly other root diseases in the McBride T.S.A.

Table P.G. - Mb. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: McBride
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
spruce beetle	1 035	647	110			
mountain pine beetle	108 901	54 669	9 648			
Total	109 936	55 316	9 758			

a Mortality losses represent a loss for 1984 only.

Table P.G. - Mb. 2 Estimated growth and regeneration delay losses (Losses on the long run sustained yield)[a] caused by current pest activity

T.S.A.: McBride
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
tomentosus root rot			18 167	12 968
armillaria root disease			23 930	15 450
lodgepole pine dwarf mistletoe			4 887	2 068
mountain pine beetle (regeneration delay)	541	298		
spruce beetle (regeneration delay)	46	32		
Total	587	330	46 984	30 486

[a] Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.G. - M.B. 3 Summary of information used to determine pest losses

T.S.A.: McBride

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21-23	4.1	0.16	0.25
		24	4.1	0.16	0.25
		25,26	4.0	0.16	0.25
	Medium	21-24	2.5	0.16	0.25
		25,26	2.6	0.16	0.25
	Poor	21-24	1.9	0.16	0.25
		25,26	1.4	0.16	0.25
	Low	21-26	0.5	0.16	0.25
armillaria root disease	Good	1	4.3	-	0.05
		4	4.6	-	0.05
		5	3.6	-	0.05
		21-24	4.1	-	0.05
		25	4.0	-	0.05
	Medium	1,21-24	2.5	-	0.05
		4	2.9	-	0.05
		5	2.3	-	0.05
		25	2.6	-	0.05
	Poor	1	1.4	-	0.05
		4	1.8	-	0.05
		5	1.3	-	0.05
		21-24	1.9	-	0.05
	Low	21-26	0.5	-	0.05
lodgepole pine dwarf mistletoe	Good	28	3.7	0.35	0.25
	Medium	28	2.2	0.35	0.25
	Poor	28	1.0	0.35	0.25
	Low	28	0.75	0.35	0.25

a Refer to Table P.G. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. through 7.1.5. for the derivation of these numbers.
Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table P.G. - Mb. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: McBride

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	59	15	PL 631-M	275	2.2	81	181.2
spruce beetle	72	15	SB 831-M	230	2.5	104	256.1

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.4.4. PEACE TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Bark beetles and the threat of plantation pests are of current concern in the Peace T.S.A. Spruce beetle is responsible for a current net loss of 11 100 m^3 of mature spruce (gross volume loss: 47 100 m^3). Some mortality due to western balsam bark beetle has been responsible for scattered, unquantified losses to subalpine fir within the T.S.A. With plantations approaching the 10-year age, white pine weevil and Warren's root collar weevil are expected to become active in spruce plantations and Warren's root collar weevil may be a factor in the development of pine plantations. Net losses to the root disease tomentosus root rot are calculated to be 56 400 m^3/yr (2.8% of the AAC) (gross losses: 90 400 m^3/yr).

PEST MANAGEMENT OPPORTUNITIES

Salvage and sanitation harvesting of beetle-attacked spruce stands will reduce the non-salvage loss of spruce beetle. Ground probes, to confirm and refine aerial detection, will be necessary to priorize harvesting operations, determine the most effective deployment of trap trees or develop alternate management plans. Continued liaison with the petroleum industry will minimize the impact of spruce beetle attributable to seismic operations. Early awareness of pest activity in immature forests will provide adequate time to develop and execute effective, aggressive control plans to maximize managed forest yields. The incorporation of root disease management strategies, once developed, into forest management procedures will reduce the future impacts to root diseases in regenerated forests. Since root disease impacts are incorporated in the growth curves (volume over age curves), any treatments to reduce their impact will presumably result in volume yields greater than those expected from natural stands.

NECESSARY ACTIVITIES

Current detection, assessment and control activities will reduce both the gross losses and the non-salvage loss of spruce beetle and the potential losses of western balsam bark beetle. All plantations should be surveyed between the ages of 10 and 15 years to determine the presence of plantation pests and their dynamics within each stand. Controls must be applied to any populations that are discovered. Surveys are required to determine the distribution and intensity of tomentosus root rot and possibly other root diseases, in the Peace T.S.A.

Table P.G. - Pe. 1 Estimated mortality loss caused by current pest activity[a]

T.S.A.: Peace
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
spruce beetle	47 093	11 074	27 112			
Total	47 093	11 074	27 112			

a Mortality losses represent a loss for 1984 only.

Table P.G. - Pe. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Peace
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
spruce beetle (regeneration delay)	889	492		
tomentosus root rot			90 421	56 415
Total	889	492	90 421	56 415

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.G. - Pe. 3 Summary of information used to determine pest losses

T.S.A.: Peace

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21,22			
		24-26	3.8	0.16	0.25
	Medium	21,22			
		24-26	2.7	0.16	0.25
	Poor	21,22	1.2	0.16	0.25
		24	1.3	0.16	0.25
		25,25	1.4	0.16	0.25
	Low	21,22	0.9	0.16	0.25
		24-26	1.0	0.16	0.25

a Refer to Table P.G. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to section 7.1.3. for the derivation of these numbers.

Table Pe. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Peace

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
spruce beetle	81	71	SB 831-M	230	2.7	97	263.9

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.4.5. PRINCE GEORGE TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

The bark beetles - spruce beetle, mountain pine beetle, Douglas-fir beetle and western balsam bark beetle - are responsible for current non-salvaged timber losses in the Prince George T.S.A. of 90 700 m^3. (gross 702 900 m^3). Lodgepole pine dwarf mistletoe significantly reduces timber yields in the lodgepole pine stands in the southern and western portions of the T.S.A. Net losses attributed to mistletoe have been projected to be 202 800 m^3 annually (2.4% of the A.A.C). Stem and gall rusts are evident throughout most naturally-occurring lodgepole pine stands and their spread into and effect upon plantations is of some concern. Pests of juvenile stands - primarily white pine weevil , lodgepole terminal weevil and Warren's root collar weevil - are active in most plantations over 10 years of age and may become significant factors in stand development. Plantation establishment occasionally has been hampered by black army cutworm activity. Root diseases, primarily tomentosus root rot and armillaria root disease, have been projected to cause net losses of 157 600 m^3/yr. and 195 900 m^3/yr. respectively (combined net loss of 4.1% of AAC).

PEST MANAGEMENT OPPORTUNITIES

The non-salvage losses to bark beetles can be reduced by salvage and sanitation harvesting of infested stands. Infestations of spruce beetle, mountain pine beetle and Douglas-fir beetle can be limited through the use of trap trees, semiochemicals and co-ordinated access development. Net losses to lodgepole pine dwarf mistletoe virtually can be eliminated in the next rotation through integrated approaches using harvesting and sanitation procedures. Since the impacts attributed to lodgepole pine dwarf mistletoe are incorporated in the growth curves (volume over age curves), any treatments to reduce their impact will presumably result in volume yields greater than those

expected from natural stands. Similarly, the incorporation of root disease management strategies, once developed, into forest management procedures will influence the volume yields of managed forests. The control of pests of plantations and immature stands provides a great opportunity for significant yield gains at rotation age.

NECESSARY ACTIVITIES

Thorough detection and assessment procedures are critical in the development and execution of pest control strategies. Harvesting or other treatment of infested stands, post-harvesting treatment and strategic use of trap tree options are requirements of bark beetle management. Mistletoe management through harvesting, site treatment and young stand sanitation will result in a vigorous, disease-free lodgepole pine crop. Aggressive survey and control activities (as necessary) in all plantations of ages of 10 years and greater will result in maximization of the available harvest at rotation age. Surveys are required to determine the distribution and intensity of tomentosus root rot, armillaria root disease, and possibly other root diseases in the Prince George T.S.A.

Table P.G. - Pr. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Prince George
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	13 613	3 593	7 296			
Douglas-fir beetle	3 119	947	1 922			
western balsam bark beetle	1 650	322	654			
spruce beetle	684 515	85 837	174 277			
Total	702 897	90 699	184 149			

a Mortality losses represent a loss for 1984 only.

Table P.G. - Pr. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Prince George
DATE: May 15, 1985
RATED BY: R. Cozens
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
tomentosus root rot			167 104	157 571
armillaria root disease			207 610	195 874
lodgepole pine dwarf mistletoe			231 307	202 818
mountain pine beetle (regeneration delay)	55	31		
western balsam bark beetle (regeneration delay)	25	8		
Douglas-fir beetle (regeneration delay)	9	7		
spruce beetle (regeneration delay)	18 909	3 187		
Total	18 998	3 233	606 021	556 263

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.G. - Pr. 3 Summary of information used to determine pest Losses

T.S.A.: Prince George

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21-24	4.1	0.16	0.25
		25-26	3.8	0.16	0.25
	Medium	21	2.9	0.16	0.25
		22-24	2.6	0.16	0.25
		25-26	2.5	0.16	0.25
	Poor	21	1.2	0.16	0.25
		22-24	1.4	0.16	0.25
		25-26	1.1	0.16	0.25
	Low	21,22			
		24-26	0.5	0.16	0.25
armillaria root disease	Good	1,4,5	4.4	-	0.05
		21-24	4.1	-	0.05
		25	3.8	-	0.05
	Medium	1,4,5,21	2.9	-	0.05
		22-24	2.6	-	0.05
		25	2.5	-	0.05
	Poor	1,4,5	1.5	-	0.05
		21	1.2	-	0.05
		22-24	1.4	-	0.05
		25	1.1	-	0.05
	Low	4	1.1	-	0.05
		21,22			
		24,25	0.5	-	0.05
lodgepole pine dwarf mistletoe	Good	28	3.6	0.35	0.25
	Medium	28	2.2	0.35	0.25
	Poor	28	0.6	0.35	0.25
	Low	28	0.45	0.35	0.25

a Refer to Table P.G. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers came from the Chapman Richard's Equations.

c Refer to sections 7.1.3. through 7.1.5. for the derivation of these numbers. Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table P.G. - Pr. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Prince George

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
Douglas-fir beetle	92	67	F(S) 841-M	385	2.9	82	236.1
western balsam bark beetle	59	67	B(S) 831-P	220	1.3	116	148.2
spruce beetle	38	67	SB 831-M	230	2.6	87	225.8
mountain pine beetle	80	67	PL 631-M	275	2.2	88	194.2

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.5. PRINCE RUPERT FOREST REGION - AN OVERVIEW

Table P.R. 1 Summary of pest losses for the Prince Rupert Forest Region (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short term losses to the bark beetles)

Pest (and loss duration)[a]	Type of Loss[b]	Timber Supply Areas (m^3/yr. or m^3/1984)								
		Bulkley	Cassiar	Kalum	Kispiox	Lakes	Morice	North Coast	Queen Charlottes	Totals
spruce beetle	short-term									
	gross	73 359	—[c]	1 060 668	56 304	45 920	505 094	--	--	1 741 345
	non-salv. loss	12 912	—	248 196	8 874	12 190	186 077	--	--	468 249
	salvage	51 647	--	27 577	35 496	28 443	279 116	--	--	422 279
	long-term									
	regen delay gross	449	--	2 819	214	396	940	--	--	4 818
	regen delay net	267	--	677	91	277	774	--	--	2 086
mountain pine beetle	short-term									
	gross	276 957	--	718 320	203 602	13 852	40 523	--	--	1 253 254
	non-salv. loss	49 963	--	291 926	129 696	5 357	11 135	--	--	488 077
	salvage	199 851	--	72 982	55 584	8 643	25 982	--	--	363 042
	long-term									
	regen delay gross	306	--	2 269	596	167	413	--	--	3 751
	regen delay net	199	--	1 026	522	69	317	--	--	2 133
hemlock dwarf mistletoe	long-term									
	gross	--	--	90 160	107 317	--	--	211 493	47 593	456 563
	net	--	--	37 077	89 955	--	--	43 697	29 724	200 453
lodgepole pine dwarf mistletoe	long-term									
	gross	11 934	57 511	858	3 227	64 193	48 245	--	--	185 968
	net	10 946	1 561	734	3 074	54 051	44 934	--	--	115 300
tomentosus root rot	long-term									
	gross	10 354	79 980	1 290	6 000	12 868	23 423	--	--	133 915
	net	9 427	8 477	402	5 144	11 544	21 987	--	--	56 981
spruce budworm (Growth Losses)	short-term									
	gross	9 427	—	37 923	2 822	--	--	--	--[d]	40 745
	net	--	--	722	1 876	--	--	--	--	2 598
spruce aphid	short-term									
	gross	--	--	--	--	--	--	4 550	9 243	13 793
	net	--	--	--	--	--	--	1 670	6 389	8 059
armillaria root disease	long-term									
	gross	--	--	1 612	7 499	--	--	1 491	2 485	13 087
	net	--	--	503	6 430	--	--	540	1 785	9 258
laminated root rot	long-term									
	gross	--	--	--	7 499	--	--	--	--	7 499
	net	--	--	--	6 430	--	--	--	--	6 430
porcupine	long-term									
	gross	--	--	--	--	--	--	3 198	--	3 198
	net	--	--	--	--	--	--	3 198	--	3 198
white pine weevil	long-term									
	regen delay gross	--	--	868	--	--	--	--	--	868
	regen delay net	--	--	868	--	--	--	--	--	868

Table P.R. 1 continued

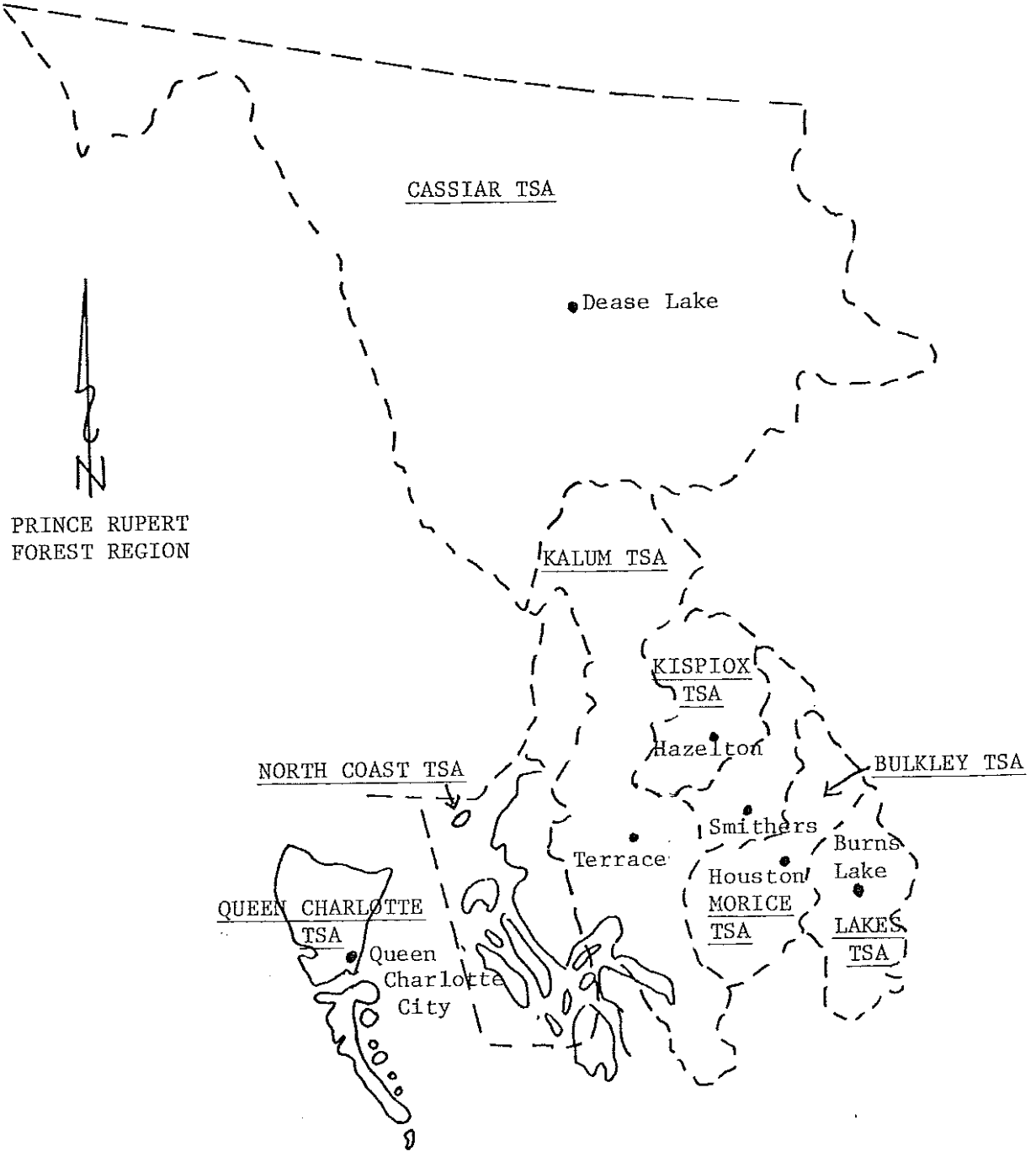
	Bark Beetles					Dwarf Mistletoes		White Pine Weevil		Root Diseases		Other	
	Gross	Non Salvable Loss	Salvage	Regen Delay Gross	Regen Delay Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net
Total	2 994 599	956 326	785 321	8 569	4 219	642 531	315 753	868	868	154 500	72 669	57 736	13 855

a Loss duration can be described as being either short or long-term in nature (i.e. short-term indicates a loss for 1984 only).
b Gross estimates are based on the gross land area prior to deductions for non-merchantable areas, environmentally sensitive areas and operability. Net estimates are based on the net operable land base.
c Pest activity has not been identified as a major concern in these areas.

Table P.R. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Prince Rupert Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (Years)	Sites	Timber Supply Areas Affected:
tomentosus root rot	21-26(S, SF,SH+ SC, SB, SPL, S Decid)	All	All	Bulkley, Cassiar, Kalum, Kispiox, Lakes, Morice
armillaria root disease	21-26 (S, SF, SH & SC, SB, SPL, S Decid)	All	All	Kalum, Kispiox, North Coast, Queen Charlottes
spruce beetle	21-25 (S, SH, SB, SPL, SF)	121+	All	Bulkley, Kalum, Kispiox, Lakes, Morice
mountain pine beetle	28-30 (PL, PLF, PLS and PLB)	81+	All	Bulkley, Kalum, Kispiox, Lakes, Morice
laminated root rot	21-26 (S, SF, SH & SC, SB, SPL, S Decid)	All	All	Kispiox
spruce budworm (2-Year-cycle budworm)	18(B), 20(BS), 21(S), 24(SB)	All	All	Kalum, Kispiox
white pine weevil	21(S)	0-40	All	Kalum
spruce aphid	21(S), 23(SH)	All	All	North Coast, Queen Charlottes
porcupine	16(HS), 23(SH)	40-60	All	North Coast
hemlock dwarf mistletoe	12-17 (H, HF, HC, HB, HS, H Decid)	All	All	Kalum, Kispiox, North Coast, Queen Charlottes
lodgepole pine dwarf mistletoe	28(PL)	All	All	Bulkley, Cassiar, Kalum, Kispiox, Lakes, Morice

a Inventory Area Reports and Statistical Analysis Systems Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.


CASSIAR TSA
Dease Lake
PRINCE RUPERT
FOREST REGION
KALUM TSA
KISPIOX
TSA
Hazelton
NORTH COAST TSA
BULKLEY TSA
Smithers
Terrace
Burns
Lake
Houston
MORICE
TSA
LAKES
TSA
QUEEN CHARLOTTE
TSA
Queen
Charlotte
City

4.5.1. BULKLEY T.S.A. - SUMMARY STATEMENT

Table P.R. - B. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Bulkley
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	276 957	49 963	199 851			
spruce beetle	73 359	12 912	51 647			
Total	350 316	62 875	251 498			

a Mortality losses represent a loss for 1984 only.

Table P.R. - B. 2 Estimated growth and regeneration delay losses (Losses on the long run sustaind yield)[a] caused by current pest activity

T.S.A.: Bulkley
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
tomentosus root rot			10 354	9 427
lodgepole pine dwarf mistletoe			11 934	10 946
mountain pine beetle (regeneration delay)	306	199		
spruce beetle (regeneration delay)	449	267		
Total	755	466	22 288	20 373

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.R. - B. 3 Summary of information used to determine pest losses

T.S.A.: Bulkley

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.2	0.35	0.25
	Medium	28	2.8	0.35	0.25
	Poor	28	1.5	0.35	0.25
	Low	28	1.1	0.35	0.25
tomentosus root rot	Good	21-26	4.1	0.16	0.25
	Medium	21-26	3.2	0.16	0.25
	Poor	21-26	1.4	0.16	0.25
	Low	21-26	.5	0.16	0.25

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

Table P.R. - B. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Bulkley

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	90.2	80	lodgepole pine medium site	349	2.2	88	194.2
spruce beetle	88	80	spruce medium site	285	2.6	87	225.8

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.5.2. CASSIAR T.S.A. - SUMMARY STATEMENT

Table P.R. - C. 1 Estimated mortality losses caused by current pest acitivity[a]

T.S.A.: Cassiar
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available						
Total						

a Mortality losses represent a loss for 1984 only.

Table P.R. - C. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Cassiar
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
tomentosus root rot			79 980	8 477
lodgepole pine dwarf mistletoe			57 511	1 561
Total			137 491	10 038

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.R. - C. 3 Summary of information used to determine pest losses

T.S.A.: Cassiar

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
tomentosus root rot	Good	21-26	4.1	0.16	0.25
	Medium	21-26	3.2	0.16	0.25
	Poor	21-26	1.4	0.16	0.25
	Low	21-26	0.5	0.16	0.25
lodgepole pine dwarf mistletoe	Good	28	2.375	0.35	0.25
	Medium	28	1.9	0.35	0.25
	Poor	28	0.8	0.35	0.25
	Low	28	0.6	0.35	0.25

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

4.5.3. KALUM T.S.A. - SUMMARY STATEMENT

Table P.R. - Ka. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Kalum
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	718 320	291 926	72 982			
spruce beetle	1 060 668	248 196	27 577			
Total	1 778 988	540 122	100 559			

a Mortality losses represent a loss for 1984 only.

Table P.R. - Ka. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Kalum
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			1 612	503
tomentosus root rot			1 290	402
hemlock dwarf mistletoe			90 160	37 077
lodgepole pine dwarf mistletoe			858	734
2-Year-cycle budworm			37 923[b]	722
white pine weevil (regeneration delay)	868	868		
mountain pine beetle (regeneration delay)	2 269	1 026		
spruce beetle (regeneration delay)	2 819	677		
Total	5 956	2 571	93 920 37 923[b]	38 716 722

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table P.R. - Ka. 3 Summary of information used to determine pest losses

T.S.A.: Kalum

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good Medium Poor Low	28 28 28 28	4.7 2.8 1.5 1.1	0.35 0.35 0.35 0.35	0.25 0.25 0.25 0.25
hemlock dwarf mistletoe	Good Medium Poor Low	12-17 12-17 12-17 12-17	4.4 4.2 2.6 2.0	0.5 0.5 0.5 0.5	0.32 or 0.19 0.32 or 0.19 0.32 or 0.19 0.32 or 0.19
armillaria root	Good Medium Poor Low	21-26 21-26 21-26 21-26	4.1 3.2 1.4 0.5	-- -- -- --	0.05 0.05 0.05 0.05
tomentosus root rot	Good Medium Poor Low	21-26 21-26 21-26 21-26	4.1 3.2 1.4 0.5	0.16 0.16 0.16 0.16	0.25 0.25 0.25 0.25
2-year-cycle budworm (the N/G ratio used was 0.01904)	Medium	18, 20, 21, 24	3.2	Refer to Section 7.1.6.	

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3., 7.1.4., and 7.1.6. for the derivation of these numbers. Note: For armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table P.R. - Ka. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Kalum

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	51	20	lodgepole pine medium site	353	2.8	87	240.4
spruce beetle	26	10	spruce medium site	610	3.2	105	334.2
white pine weevil	100	N/A	Spruce	--[c]	4.1	94	384.9

a Refer to sections 7.1.1. and 7.1.6. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Co-ordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.
c This estimate was not required as the effect of the weevil on regeneration delay was calculated.

4.5.4. KISPIOX T.S.A. - SUMMARY STATEMENT

Table P.R. - Ki. 1 Estimated mortality losses caused by current Pest activity[a]

T.S.A.: Kispiox
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	203 602	129 696	55 584			
spruce beetle	56 304	8 874	35 496			
Total	259 906	138 570	91 080			

a Mortality losses represent a loss for 1984 only.

Table P.R. - Ki. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Kispiox
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			7 499	6 430
armillaria root disease			7 499	6 430
tomentosus root rot			6 000	5 144
hemlock dwarf mistletoe			107 317	89 955
lodgepole pine dwarf mistletoe			3 227	3 074
2-year-cycle budworm			2 822[b]	1 876
mountain pine beetle (regeneration delay)	596	522		
spruce beetle (regeneration delay)	214	91		
Total	810	613	131 542 2 822[b]	111 033 1 876

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table P.R. - Ki. 3 Summary of information used to determine pest losses

T.S.A.: Kispiox

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good Medium Poor Low	28 28 28 28	4.7 2.8 1.5 1.1	0.35 0.35 0.35 0.35	0.25 0.25 0.25 0.25
hemlock dwarf mistletoe	Good Medium Poor Low	12-17 12-17 12-17 12-17	4.4 4.2 2.6 1.3	0.5 0.5 0.5 0.5	0.32 or 0.19 0.32 or 0.19 0.32 or 0.19 0.32 or 0.19
tomentosus root rot	Good Medium Poor Low	21, 23-26 21, 23-26 21, 23-26 21, 23-26	4.1 3.2 1.4 0.5	0.16 0.16 0.16 0.16	0.25 0.25 0.25 0.25
armillaria root disease and laminated root rot	Good Medium Poor Low	12-26 12-26 12-26 12-26	4.1 3.2 1.4 0.5	armillaria root disease 0.05 0.05 0.05 0.05	laminated root rot 0.05 0.05 0.05 0.05
2-year-cycle budworm	Medium	18, 20, 21, 24	3.2	Refer to Section 7.1.6.	

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3., 7.1.4.and 7.1.6. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table P.R. - Ki. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Kispiox

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	91	30	pine medium site	319	2.8	87	240.4
spruce beetle	79	80	spruce medium site	255	3.2	105	334.2

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.5.5. LAKES T.S.A. - SUMMARY STATEMENT

Table P.R. - L. 1 Estimated mortality losses on volume caused by current pest activity[a]

T.S.A.: Lakes
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	13 852	5 357	8 643			
spruce beetle	45 920	12 190	28 443			
Total	59 772	17 547	37 086			

a Mortality losses represent a loss for 1984 only.

Table P.R. - L. 2 Estimated growth amd regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Lakes
DATE: May 23, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
lodgepole pine dwarf mistletoe			64 193	54 051
tomentosus root rot			12 868	11 544
mountain pine beetle (regeneration delay)	167	69		
spruce beetle (regeneration delay)	396	277		
Total	563	346	77 061	65 595

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.R. - L. 3 Summary of information used to determine pest losses

T.S.A.: Lakes

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	3.4	0.35	0.25
	Medium	28	2.3	0.35	0.25
	Poor	28	1.0	0.35	0.25
	Low	28	0.75	0.35	0.25
tomentosus root rot	Good	21, 24	3.7	0.16	0.25
	Good	25, 26	3.5	0.16	0.25
	Medium	21, 22, 24	2.6	0.16	0.25
	Medium	25, 26	2.4	0.16	0.25
	Poor	21, 24-26	1.5	0.16	0.25
	Low	21, 24-26	0.5	0.16	0.25

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

Table P.R. - L. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Lakes

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	76	80	Pine medium site	251.5	2.6	75	198.7
spruce beetle	89	70	Spruce medium site	300.6	2.6	95	246.2

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.5.6. MORICE T.S.A. - SUMMARY STATEMENT

Table P.R. - M. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Morice
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	40 523	11 135	25 982			
spruce beetle	505 094	186 077	279 116			
Total	545 617	197 212	305 098			

a Mortality losses represent a loss for 1984 only.

Table P.R. - M. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yeild)[a] caused by current pest activity

T.S.A.: Morice
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
lodgepole pine dwarf mistletoe			48 245	44 934
tomentosus root rot			23 423	21 987
mountain pine beetle (regeneration delay)	413	317		
spruce beetle (regeneration delay)	940	774		
Total	1 353	1 091	71 668	66 921

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table P.R. - M. 3 Summary of information used to determine pest losses

T.S.A.: Morice

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
lodgepole pine dwarf mistletoe	Good	28	4.2	0.35	0.25
	Medium	28	2.8	0.35	0.25
	Poor	28	1.5	0.35	0.25
	Low	28	1.1	0.35	0.25
tomentosus root rot	Good	21, 24-26	4.1	0.16	0.25
	Medium	21, 24-26	3.2	0.16	0.25
	Poor	21, 24-26	1.4	0.16	0.25
	Low	21, 24-26	0.5	0.16	0.25

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers.

Table P.R. - M. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Morice

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	92	70	pine medium site	191	2.8	87	240.4
spruce beetle	92	60	spruce medium site	316	2.6	87	225.8

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

4.5.7. NORTH COAST T.S.A. - SUMMARY STATEMENT

Table P.R. - N. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: North Coast
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available						
Total						

a Mortality losses represent a loss for 1984 only.

Table P.R. - N. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: North Coast
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			1 491	540
hemlock dwarf mistletoe			211 493	43 697
spruce aphid			4 550[b]	1 670
porcupine	3 198	3 198		
Total	3 198	3 198	212 984 4 550[b]	44 237 1 670

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table P.R. - N. 3 Summary of information used to determine pest losses

T.S.A.: North Coast

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
hemlock dwarf mistletoe	Good	12-16	12.3	0.5	0.32 or 0.19
	Medium	12-17	6.4	0.5	0.32 or 0.19
	Medium	14-16	7.0	0.5	0.32 or 0.19
	Poor	12-17	3.2	0.5	0.32 or 0.19
	Poor	14-16	3.8	0.5	0.32 or 0.19
	Low	12	2.4	0.5	0.32 or 0.19
	Low	14-16	2.85	0.5	0.32 or 0.19
armillaria root disease	Good	21-26	11.3	--	0.01
	Medium	21-26	9.2	--	0.01
	Poor	21-26	4.3	--	0.01
	Low	21-26	3.2	--	0.01
spruce aphid (the N/G ratio used was 0.6912)	Medium	21, 23	9.1	Refer to Section 7.1.8.	

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3., 7.1.4. and 7.1.8. for the derivation of these numbers.
Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

Table P.R. - N. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: North Coast

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
Porcupine	100	N/A	hemlock medium site	--[c]	12.3	56	701.3

a Refer to section 7.1.7. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on existing logging plans.
c This estimate was not required as the effect of the porcupine on regeneration delay was calculated.

4.5.8. QUEEN CHARLOTTE T.S.A. - SUMMARY STATEMENT

Table P.R. - Q. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Queen Charlottes
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available						
Total						

a Mortality losses represent a loss for 1984 only.

Table P.R. - Q. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Queen Charlottes
DATE: May 24, 1985
RATED BY: V. Barge
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
armillaria root disease			2 484	1 785
hemlock dwarf mistletoe			47 593	29 724
spruce aphid			9 243[b]	6 389
Total			50 077 9 243[b]	31 509 6 389

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.
b This loss represents pest activity for 1984 only and cannot be added to the long-term losses in this column.

Table P.R. - Q. 3 Summary of information used to determine pest losses

T.S.A.: Queen Charlottes

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
hemlock dwarf mistletoe	Good	12,16	12.3	0.5	0.32 or 0.19
	Medium	12,17	6.4	0.5	0.32 or 0.19
	Medium	14,16	7.0	0.5	0.32 or 0.19
	Poor	12,17	3.2	0.5	0.32 or 0.19
	Poor	14,16	3.8	0.5	0.32 or 0.19
	Low	12,17	2.4	0.5	0.32 or 0.19
	Low	14,16	2.9	0.5	0.32 or 0.19
armillaria root disease	Good	21-26	11.3	--	0.01
	Medium	21-26	9.1	--	0.01
	Poor	21-26	4.3	--	0.01
	Low	21-26	3.2	--	0.01
spruce aphid (the N/G ratio used was 0.367)	Medium	21, 23	9.1	Refer to Section 7.1.8.	

a Refer to Table P.R. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to section 7.1.3., 7.1.4. and 7.1.8. for the derivation of these numbers. Note: for armillaria root disease a combined incidence and reduction to M.A.I. figure is used.

4.6. VANCOUVER FOREST REGION - AN OVERVIEW

CONCERNS

Pest concerns in the Vancouver Forest Region are primarily associated with root diseases, hemlock dwarf mistletoe and the white pine weevil. Losses from laminated root rot in second growth Douglas-fir are currently the most signficant. If left after harvest, infestation levels could more than double throughout the subsequent rotation.

The white pine weevil is a serious impediment to the establishment of sitka spruce plantations. The planting of sitka spruce has been restricted within areas found to contain medium or high risks of weevil attack. Numerous previously established plantations of sitka spruce are severely infested, and are being converted to alternative species.

Unlike the other Forest Regions in the Province, bark beetle infestations are not a major concern in the Vancouver Region. Infestations are limited to the eastern fringes of the Region and are generally scattered in small pockets within timber which is often inaccessible and uneconomical for harvesting.

Of additional concern is the western spruce budworm. Although currently not responsible for timber losses, this insect's population levels are cyclic causing widespread defoliation over a period of years every 10 to 15 years.

PEST MANAGEMENT OPPORTUNITIES AND NECESSARY ACTIVITIES

The primary gains from pest management in the Vancouver Region will be obtained through the treatment of root diseases. Treating Douglas-fir stands, by mechanically pulling infected stumps or by using laminated root rot resistant species in infection centers will improve upon the natural productivity of the site by putting these non productive holes back in production. The treatment of stumps for annosus root disease during juvenile

spacing will help reduce some of the anticipated impacts from this disease in second growth stands.

The felling of all residual hemlock above three meters in height at the time of harvest will effectively eliminate significant impacts from hemlock dwarf mistletoe. This can easily be accomplished via the three meter knockdown clause incorporated in timber cutting permits. The use of prescribed fire will also be effective in sanitizing clearcuts from mistletoe as will the removal of infected trees during juvenile spacing and thinning operations.

Strategies to deal with the white pine weevil include site rehabilitation, species conversion, planting restrictions (planting in low and medium hazard areas only), leader clipping and the continued support of research.

Sanitation harvesting and salvage of bark beetle infested timber where possible will reduce bark beetle impacts to acceptable levels. Other control techniques utilizing trap trees, semiochemicals and single tree disposal as appropriate will also help reduce losses. The prioritization of western spruce budworm damaged stands for harvesting will help prevent future losses as well as salvage damaged trees from previous outbreaks.

Table V. 1 Summary of pest losses for the Vancouver Forest Region (Volumes are presented in cubic meters/year for growth and regeneration delay losses, and in cubic meters for 1984 for short-term losses to the bark beetles)

Pests (and loss duration)[a]	Type of loss[b]	Timber Supply Areas m^3/yr or m^3/1984						
		Fraser	Mid Coast	Nootka	Kingcome	Quadra	Soo	Totals
hemlock dwarf mistletoe	long-term gross	46 895	165 553	69 196	119 271	90 842	21 847	513 604
	net	44 829	67 880	62 677	98 690	64 661	16 643	355 388
laminated root rot	long-term gross	64 634	16 500	16 481	12 176	126 261	30 568	266 620
	net	59 585	7 887	15 640	11 551	115 655	27 682	238 000
armillaria root disease	long-term gross	7 035	1 657	1 459	1 202	12 227	3 712	27 292
	net	5 978	792	1 382	1 116	10 958	3 309	23 535
mountain pine beetle	short-term gross	2 150	--[c]	--	--	--	17 159	19 303
	non-salvable loss	1 268	--	--	--	--	11 000	12 268
	salvage	131	--	--	--	--	1 354	1 485
	long-term regen delay gross	37	--	--	--	--	663	700
	regen delay net	19	--	--	--	--	474	493
Douglas-fir beetle	short-term gross	705	--	--	--	--	8 592	9 297
	non-salvable loss	705	--	--	--	--	6 655	7 360
	salvage	0	--	--	--	--	618	618
	long-term regen delay gross	26	--	--	--	--	126	152
	regen delay net	26	--	--	--	--	105	131
white pine weevil	long-term gross	--	958	1 072	545	148	--	2 723
	net	--	958	1 072	545	148	--	2 723

	Bark Beetles					White Pine Weevil		Root Diseases		Hemlock Dwarf Mistletoe	
	Gross	Non-salvable Loss	Salvage	Regen Delay Gross	Regen Delay Net	Gross	Net	Gross	Net	Gross	Net
Total Loss	28 606	19 628	2 103	852	624	2 723	2 723	293 912	261 535	513 604	355 388

a Loss duration can be described as either short or long-term in nature (i.e. short-term indicates a loss for 1984 only)

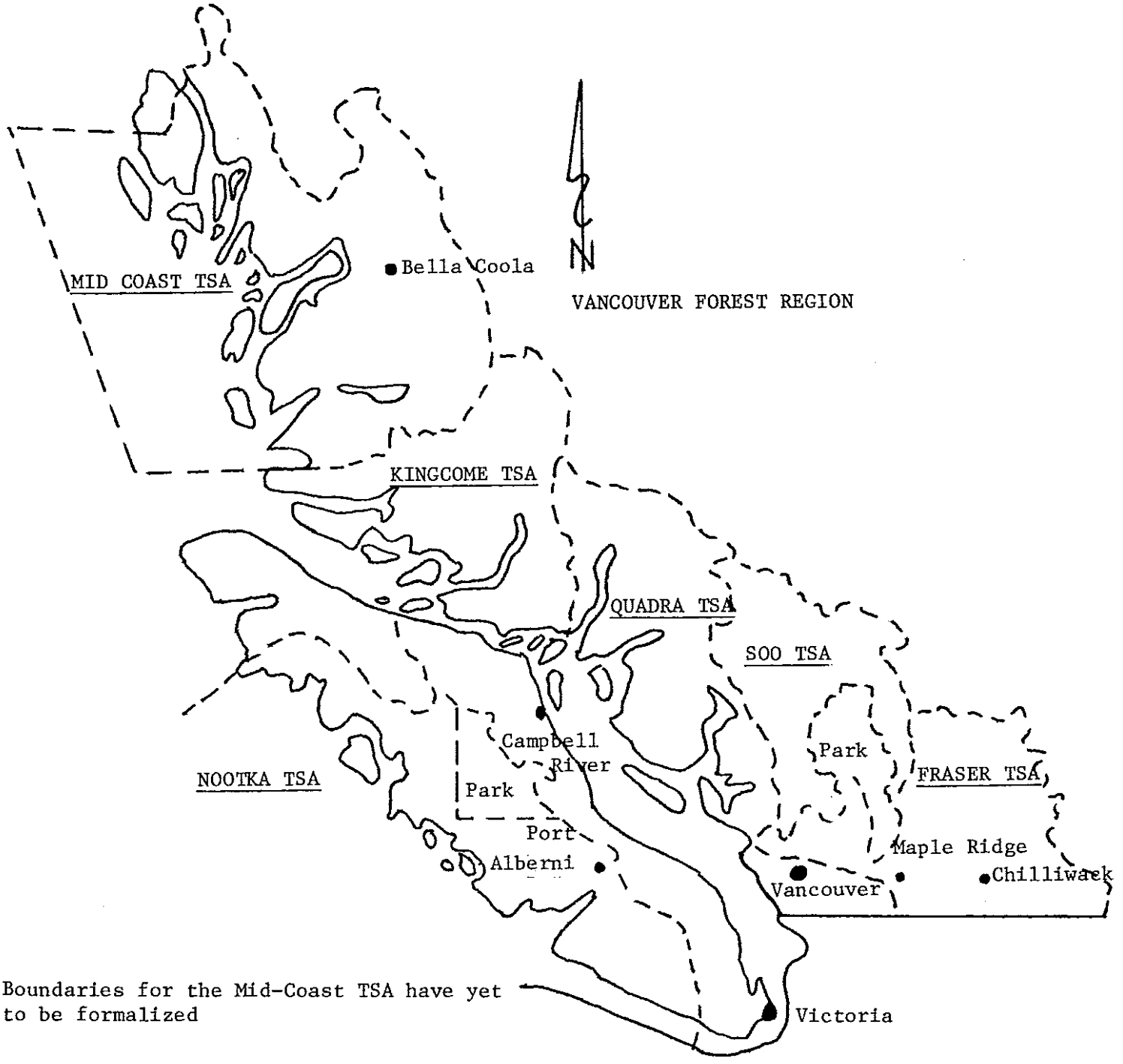
b Gross estimates are based on the gross land area prior to deductions for non-merchantable areas, environmentally sensitive areas and operability. Net estimates are based on the net operable land base.

c Pest activities have not been identified as a major concern in these areas.

Table V. 2 Characteristics of susceptible stands used to generate inventory area reports[a] - Vancouver Forest Region

Pest	Inventory Type Groups (and leading species)	Age Range (years)	Sites	Timber Supply Areas Affected:
laminated root rot	1(F), 3(FH), 5-6(FPL, FPy)	All	All	All
armillaria root disease	1(F), 3(FH), 5-6(FPL, FPy)	All	All	All
hemlock dwarf mistletoe	12-17(H, HF, HC, HB, HS, H Decid)	All	All	All
Douglas-fir beetle	1(F), 5(FPL), 6(FPy)	121+	All	Fraser, Soo
mountain pine beetle	28-30(PL, PLF, PLS)	81+	All	Fraser, Soo
white pine weevil	21-23(S, SF, SH and SC)	0-20 yr	G,M	Nootka, Kingcome, Quadra, Midcoast

a Inventory Area Reports and Statistical Analysis System Reports are synonymous and were generated on the advice of the Planning and Inventory Branch, British Columbia Forest Service.



Boundaries for the Mid-Coast TSA have yet to be formalized

4.6.1. FRASER TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Pest losses of primary concern in this T.S.A. are mostly associated with root diseases, hemlock dwarf mistletoe, and bark beetles. Losses from laminated root rot in Douglas-fir are currently the most significant. Bark beetle losses in the T.S.A. are generally non-recoverable. These infestations generally are scattered in small pockets of timber which is currently inaccessible and generally uneconomical for harvesting. In addition to losses reported here, numberous bark beetle infestations are located in timber currently outside the net operable land base, but adjacent to susceptible stands in the net operable land base. Of additional concern is the western spruce budworm. Although currently not responsible for timber losses, this insect's population levels are cyclic causing widespread defoliation over a period of years, every 10 to 15 years. 1981 was the last year of recorded defoliation.

Projected net volume growth losses are estimated at 110 400 m^3/year (6.5% of A.A.C.) while bark beetle non-salvable losses are 2 000 m^3.

PEST MANAGEMENT OPPORTUNITIES

The treatment of root diseases at harvest either by stump pulling or planting resistant species will largely reduce future losses in second growth Douglas-fir. Also the maintenance of the three meter knockdown clause at harvest will virtually eliminate future losses from hemlock dwarf mistletoe. Due to the fact that impact from these two pests are largely accounted for in growth curves (volume over age curves) treatments to reduce their losses will presumably provide gains over and above the expected natural productivity.

Salvage and sanitation harvesting of bark beetle infested timber will reduce bark beetle losses to acceptable levels. Other control techniques utilizing trap trees, semiochemicals and single tree disposal as appropriate will help reduce future losses. The prioritization of western spruce budworm damaged stands for harvesting will help prevent future losses, as well as salvage damaged trees from previous outbreaks.

NECESSARY ACTIVITIES

The threat of root disease centers expanding to two or more times the current levels in second growth Douglas-fir stands necessitates treatment for the disease just to maintain productivity. Priority for treatment will be placed on good and medium sites. All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate hemlock dwarf mistletoe losses. Further loss reductions will be achieved in previously established planatations in the course of stand tending treatments.

Even though current bark beetle losses in the Fraser T.S.A. are not large, the trend is for one of annual expansion. If efforts are not taken to reduce current infestations, losses can be expected to increase.

Surveys are required to determine the distribution and intensity of various root diseases in the T.S.A.

Table V. - F. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Fraser
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	2 150	1 268	131			
Douglas-fir beetle	705	705	0			
Total	2 855	1 973	131			

a Mortality losses represent a loss for 1984 only.

Table V. - F. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Fraser
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			64 634	59 585
armillaria root disease			7 035	5 978
hemlock dwarf mistletoe			46 895	44 829
mountain pine beetle (regeneration delay)	37	19		
Douglas-fir beetle (regeneration delay)	26	26		
Total	63	45	118 564	110 392

a Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table V. - F. 3 Summary of information used to determine pest losses

T.S.A.: Fraser

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				laminated root rot	armillaria root disease
laminated root rot and armillaria root disease	Good	1	10.7	0.14	0.01
		3	9.6	0.14	0.01
		5-6	10.9	0.14	0.01
	Medium	1	7.4	11.5	0.01
		3	6.9	11.5	0.01
		5-6	7.7	11.5	0.01
	Poor	1	2.9	4.5	0.01
		3	3.0	4.5	0.01
		5-6	3.5	4.5	0.01
	Low	1	?	3.4	0.01
		3	?	3.4	0.01
		5-6	?	3.4	0.01
hemlock dwarf mistletoe	Good	12,15,17	7.6	0.5	0.32
	Medium	12	4.5	0.5	0.32
		13-16	5.5	0.5	0.19
		17	4.5	0.5	0.32
	Poor	12	2.4	0.5	0.32
		13-16	2.7	0.5	0.19
		17	2.4	0.5	0.19
	Low	12	1.8	0.5	0.32
		13-16	2.0	0.5	0.19

a Refer to Table V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - The average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to section 7.1.3. and 7.1.4. for the derivation of these numbers. Note: For armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - F. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A.: Fraser

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	86	15	P1F 633-M	111.4	2.8	87	240.4
Douglas-fir beetle	100	0	F 841-M	433	7.7	64	494.5

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on past eperience and existing logging plans.

4.6.2. KINGCOME TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Pests of concern within the Kingcome T.S.A. are hemlock dwarf mistletoe, white pine weevil and the western blackheaded budworm. Hemlock dwarf mistletoe is the major pest widespread throughout the T.S.A.

The white pine weevil is a serious impediment to the management of sitka spruce. The planting of sitka spruce has been completely restricted within areas of high risk of weevil attack and numerous sitka spruce plantations have been severely infested.

The western blackheaded budworm has been responsible for widespread defoliation of hemlock in the past but is presently not a problem. Future outbreaks are expected.

The mountain pine beetle has killed most of the mature pine in the Klinaklini River valley in the northern portion of the Kingcome T.S.A. This area has been excluded from the net operable land base due to inaccessibility.

Total project volume net growth losses for this T.S.A. are estimated at 111 400 m^3/year (6.6% of A.A.C.)

PEST MANAGEMENT OPPORTUNITIES

The felling of all residual hemlock above three meters in height at the time of harvest will effectively reduce significant losses from hemlock dwarf mistletoe. The use of prescribed fire will also be effective in sanitizing clearcuts from mistletoe as will the removal of infected trees during juvenile spacing and thinning operations.

Restricting the planting of sitka spruce to areas of low risks of weevil attack will limit future losses from this pest. The rehabilitation and species conversion of severely infested sitka spruce plantations will prevent additional losses and maintain site productivity.

NECESSARY ACTIVITIES

All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate mistletoe losses. Further loss reductions will be achieved in previously established planatations in the course of stand tending treatments.

Sitka spruce should not be planted in areas found to contain high risk of weevil attack. Severely infested planatations should be rehabilitated or converted to alternative species.

Table V. - K. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Kingcome
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available						
Total						

a Mortality losses represent a loss for 1984 only.

Table V. - K. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Kingcome
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			12 176	11 551
armillaria root disease			1 202	1 116
hemlock dwarf mistletoe			119 271	98 690
white pine weevil (regeneration delay)	545	545		
Total	545	545	132 649	111 357

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table V. - K. 3 Summary of information used to determine pest losses

T.S.A.: Kingcome

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				laminated root rot	armillaria root disease
armillaria root disease and laminated root rot	Good	1,5	11.4	0.14	0.01
	Good	3	11.4	0.14	0.01
	Medium	1,5	7.3	0.115	0.01
	Medium	3	7.3	0.115	0.01
	Poor	1,5	3.2	0.045	0.01
	Poor	3	3.2	0.045	0.01
	Low	1	1.2	0.034	0.01
hemlock dwarf mistletoe	Good	12	12.3	0.50	0.32
	Good	13-17	12.3	0.50	0.19
	Medium	12	6.4	0.50	0.32
	Medium	13-16	7.0	0.50	0.19
	Medium	17	6.4	0.50	0.19
	Poor	12	3.2	0.50	0.32
	Poor	13-16	3.8	0.50	0.19
	Poor	17	3.2	0.50	0.19
	Low	12	2.4	0.50	0.32
	Low	13-16	2.9	0.50	0.19
	Low	17	2.4	0.50	0.19

a Refer to Table V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - K. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A: Kingcome

Pest[a]	Net/Gross Ratio (%)	Salvage Factor (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
white pine weevil	100	N/A	spruce	-[b]	9.1	68	617.9

a Refer to section 7.1.5. for the derivation of these numbers.
b This estimate was not required as the effect of the weevil on regeneration delay was calculated.

4.6.3. MID COAST TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Hemlock dwarf mistletoe, white pine weevil and bark beetles are the pests of concern in the Mid Coast T.S.A. Hemlock dwarf mistletoe provides the largest losses and is widespread throughout the T.S.A.

The white pine weevil is a serious impediment to the management of sitka spruce in this T.S.A. Two generalized areas of weevil risk have been identified, a high and a low. Planting has been restricted to the area of low risk of weevil attack. Many previously established sitka spruce plantations are severely infested.

Bark beetle infestations have spilled over into the T.S.A. from the Chilcotin Plateau. The status and locations of these infestations are, at present, not well known.

Total project volume net growth losses for this T.S.A. are estimated at 76 567 m^3/yr (5.5% of A.A.C.).

PEST MANAGEMENT OPPORTUNITIES

The felling of residual hemlock above three meters in height at the time of harvest will effectively reduce significant losses from hemlock dwarf mistletoe. The use of prescribed fire will also be effective in sanitizing clearcuts from mistletoe as will the removal of infected trees during juvenile spacing and thinning operations.

Restricting the planting of sitka spruce to areas of low risks of weevil attack will limit future losses from this pest. The rehabilitation and species conversion of severely infested sitka spruce plantations will prevent additional losses and maintain site productivity.

NECESSARY ACTIVITIES

All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate mistletoe losses. Further loss reductions will be achieved in previously established plantations in the course of stand tending treatments.

Sitka spruce should not be planted in areas found to contain high risks of weevil attack. Severely infested plantations should be rehabilitated or converted to alternative species.

The status of bark beetle infestations in the Mid Coast T.S.A. should be assesed.

Table V. - M. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Midcoast
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available.						
Total						

a Mortality losses represent a loss for 1984 only.

Table V. - M. 2 Estimated growth and regeneration delay losses, (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Midcoast
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			16 500	7 887
armillaria root disease			1 657	792
hemlock dwarf mistletoe			165 553	67 888
white pine weevil (regenmeration delay)	2 723	2 723		
Total	2 723	2 723	183 710	76 567

a Losses to L.R.S.Y. will occur yearly over an extended time frame.

Table V. - M. 3 Summary of information used to determine pest losses

T.S.A.: Midcoast

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
hemlock dwarf mistletoe	Good	12	12.3	0.5	0.32
	Good	13-17	12.3	0.5	0.19
	Medium	12	6.4	0.5	0.32
	Medium	17	6.4	0.5	0.19
	Medium	13-16	7.0	0.5	0.19
	Poor	12	3.2	0.5	0.32
	Poor	17	3.2	0.5	0.19
	Poor	13-16	3.8	0.5	0.19
				laminated root rot	armillaria root disease
laminated root root and armillaria root disease	Good	1,5	11.4	0.14	0.01
	Good	3	11.4	0.14	0.01
	Medium	1,5	7.3	0.115	0.01
	Medium	3	7.3	0.115	0.01
	Poor	1,5	3.2	0.045	0.01
	Poor	3	3.2	0.045	0.01
	Low	1,5	1.2	0.034	0.01
	Low	3	1.2	0.034	0.01

a Refer to V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - M. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Midcoast

Pest[a]	Net/Gross Ratio (%)	Salvage Factor (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
white pine weevil	100	N/A	spruce	--[b]	9.1	68	617.9

a Refer to Section 7.1.5. for the derivation of these numbers.
b This estimate was not required as the effect of the weevil on regeneration delay was calculated.

4.6.4. NOOTKA TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Pest losses of concern in the Nootka T.S.A. are mostly associated with root disease, hemlock dwarf misteltoe and white pine weevil. The largest losses are from hemlock dwarf mistletoe in western hemlock. Laminated root rot in second growth Douglas-fir and the chance of expansion in subsequent rotations is also of primary concern.

The Nootka T.S.A. contains medium and high risk white pine weevil areas. There are also numerous plantations of sitka spruce which are seriously infested by the weevil. The planting of sitka spruce has, therefore, been restricted throughout the T.S.A.

Total projected volume net growth losses for this T.S.A. are estimated at 79 700 m^3/year (5.7% of A.A.C.).

PEST MANAGEMENT OPPORTUNITIES

The treatment of root diseases at harvest either by stump pulling or planting resistant species will largely reduce future losses in second growth Douglas-fir. Also the maintenance of the three meter knockdown clause at harvest will virtually eliminate future losses from hemlock dwarf mistletoe. Due to the fact that losses from these two pests are largely accounted for in growth curves (volume over age curves) treatments to reduce their impacts will presumably provide gains over and above the expected natural productivity.

Restricting the planting of sitka spruce to areas of low and medium risks of white pine weevil attack will limit future losses from this pest. The rehabilitation and species conversion of severely infested sitka spruce plantations will prevent additional losses and maintain site productivity.

NECESSARY ACTIVITIES

The threat of root disease centers expanding to two or more times the current levels in second growth Douglas-fir stands necessitates treatment for the disease just to maintain productivity. Priority for treatment will be placed on good and medium sites. All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate hemlock dwarf mistletoe losses. Further loss reductions will be achieved in previously established plantations in the course of stand tending treatments.

Sitka spruce should not be planted within areas of high risk of weevil attack. Within areas that have a medium risk of weevil attack, sitka spruce should only be planted up to 20% of the stand composition, provided that minimum stocking levels of acceptable alternative species are maintained. Severely infested plantations should be rehabilitated or, converted to alternative species.

Table V. - N. 1 Estimated mortality losses on volume caused by current pest activity[a]

T.S.A.: Nootka
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available.						
Total						

a Mortality losses represent a loss for 1984 only.

Table V. - N. 2 Estimated growth and regeneration delay losses (Losses to the the long run sustained yield)[a] caused by current pest activity

T.S.A.: Nootka
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			16 481	15 640
armillaria root disease			1 459	1 382
hemlock dwarf mistletoe			69 196	62 677
white pine weevil (regeneration delay)	1 072	1 072		
Total	1 072	1 072	87 136	79 699

[a] Impacts to the L.R.S.Y. will occur yearly over an extended time frame.

Table V. - N. 3 Summary of information used to determine pest losses

T.S.A.: Nootka

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				laminated root rot	armillaria root disease
laminated root rot and armillaria root disease	Good	1,5	10.3	0.14	0.01
	Good	3	11.4	0.14	0.01
	Medium	1,5	7.2	0.115	0.01
	Medium	3	8.1	0.115	0.01
	Poor	1,3,5	3.2	0.045	0.01
	Low	1,3,5	1.2	0.034	0.01
hemlock dwarf mistletoe	Good	12	12.0	0.5	0.32
	Good	13-16	10.5	0.5	0.19
	Good	17	12.0	0.5	0.19
	Medium	12	6.0	0.5	0.32
	Medium	13-16	6.2	0.5	0.19
	Medium	17	6.0	0.5	0.19
	Poor	12	2.3	0.5	0.32
	Poor	13-16	4.4	0.5	0.19
	Poor	17	2.3	0.5	0.19
	Low	12	1.7	0.5	0.32
	Low	13-16	3.3	0.5	0.19
	Low	17	1.7	0.5	0.19

a Refer to Table V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: For armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - N. 4 Summary of information used to determine pest losses (mortality and regeneration delay losses)

T.S.A: Nootka

Pest[a]	Net/Gross Ratio (%)	Salvage Factor (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
white pine weevil	100	N/A	spruce	--[b]	9.1	68	617.9

a Refer to section 7.1.5. for the derivation of these numbers.
b This estimate was not required as the effect of the weevil on regeneration delay was calculated.

4.6.5. QUADRA TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Pest losses of concern in this T.S.A. are mostly associated with root disease,hemlock dwarf mistletoe and the white pine weevil. Losses from laminated root rot in second growth Douglas-fir are of primary concern. Nearly 100% of all Douglas-fir stands surveyed for laminated root rot in the Quadra T.S.A. were found to contain this disease. Average levels of infection by area were found as follows: good site 14%, medium site 11.5%, poor site 4.5%. If left untreated after harvest, these levels of infection could more than double throughout the next rotation.

The Quadra T.S.A. is within an area found to contain high risks of white pine weevil attack. Many sitka spruce plantations within the T.S.A. are seriously infested. As a result, sitka spruce has been restricted as a species for planting in this T.S.A.

Total projected volume net growth losses in this T.S.A. are estimated at 191 300 m^3/year (9.6% of A.A.C.).

PEST MANAGEMENT OPPORTUNITIES

The treatment of root diseases at harvest either by stump pulling or planting resistant species will largely reduce future losses in second growth Douglas-fir. Also the maintenance of the three meter knockdown clause at harvest will virtually eliminate future losses from hemlock dwarf mistletoe. Due to the fact that losses from these two pests are largely accounted for in growth curves (volume over age curves) treatments to reduce their losses will presumably provide gains over and above the expected natural productivity.

Planting alternative species to sitka spruce in areas with high risks of attack from white pine weevil will eliminate future losses from this pest. The rehabilitation or species conversion of severely infested plantations will prevent additional losses and maintain site productivity.

NECESSARY ACTIVITIES

The threat of root disease centres expanding to two or more times the current levels in second growth Douglas-fir stands necessitates treatment for the disease just to maintain productivity. Priority for treatment should be good sites. All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate hemlock dwarf mistletoe losses. Further loss reductions will be achieved in previously established plantations in the course of stand tending treatments.

Sitka spruce should generally not be planted within this T.S.A. Severely infested plantations of sitka spruce should be rehabilitated or converted to alternative species.

Table V. - Q. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Quadra
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
No reliable data currently available.						
Total						

a Mortality losses represent a loss for 1984 only.

Table V. - Q. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Quadra
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			126 261	115 655
armillaria root disease			12 227	10 958
hemlock dwarf mistletoe			90 842	64 661
white pine weevil (regeneration delay)	148	148		
Total	148	148	229 330	191 274

[a] Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table V. - Q. 3 Summary of information used to determine pest losses

T.S.A.: Quadra

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				laminated root rot	armillaria root disease
laminated root rot and armillaria root disease	Good	1,5	10.3	0.14	0.01
	Good	3	11.4	0.14	0.01
	Medium	1,5	7.2	0.115	0.01
	Medium	3	8.1	0.115	0.01
	Poor	1,5	3.2	0.045	0.01
	Poor	3	3.2	0.045	0.01
	Low	1,3,5	1.2	0.034	0.01
hemlock dwarf mistletoe	Good	12	12.0	0.5	0.32
	Good	13-16	10.5	0.5	0.19
	Good	17	12.0	0.5	0.19
	Medium	12	6.0	0.5	0.32
	Medium	13-16	6.2	0.5	0.19
	Medium	17	6.0	0.5	0.19
	Poor	12	2.3	0.5	0.32
	Poor	13-16	4.4	0.5	0.19
	Poor	17	2.3	0.5	0.19
	Low	12	1.7	0.5	0.32
	Low	13-16	3.3	0.5	0.19
	Low	17	1.7	0.5	0.19

a Refer to table V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - Q. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Quadra

Pest[a]	Net/Gross Ratio (%)	Salvage Factor (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
white pine weevil	100	N/A	spruce	--[b]	9.1	68	617.9

a Refer to section 7.1.5. for the derivation of these numbers.
b This estimate was not required as the effect of the weevil on regeneration delay was calculated.

4.6.6. SOO TIMBER SUPPLY AREA - SUMMARY STATEMENT

CONCERNS

Pest losses of primary concern in this T.S.A. are those associated with root diseases, hemlock dwarf mistletoe, and bark beetles. Losses from laminated root rot in second growth Douglas-fir are of significant concern, but in old growth timber they are variable and non-recoverable. At present, bark beetle losses in the T.S.A. are also generally non-recoverable. These infestations are largely scattered in small pockets of timber which are currently inaccessible and generally uneconomical for harvesting. Long hauling distances and poor markets significantly hinder the salvage and control of mountain pine beetle infestations. Of additional concern is the western spruce budworm. Although currently not responsible for losses, this insect's population levels are cyclic, causing widespread defoliation over a period of years, every 10 to 15 years. 1981 was the last year of recorded defoliation.

Total projected volume net growth losses for this T.S.A. are estimated at 47 600 m^3/year (6.8% of A.A.C.) while non-salvable losses are 17 700 m^3.

PEST MANAGEMENT OPPORTUNITIES

The treatment of root diseases at harvest either by stump pulling or planting resistant species will largely reduce future losses in second growth Douglas-fir. Also the maintenance of the three meter knockdown clause at harvest will virtually eliminate future losses from hemlock dwarf mistletoe. Due to the fact that losses from these two pests are largely accounted for in growth curves (volume over age curves), treatments to reduce their losses will presumably provide gains over and above the expected natural productivity.

Salvage and sanitation harvesting of bark beetle infested timber will reduce bark beetle losses to acceptable levels. Other control techniques

utilizing trap trees, semiochemicals, and single tree disposal as appropriate will help reduce future losses. The prioritization of western spruce budworm damaged stands for harvesting will help prevent future losses, as well as salvage damaged trees from previous outbreaks.

NECESSARY ACTIVITIES

The threat of root disease centres expanding to two or more times from the current levels in second growth Douglas-fir stands necessitates treatment for the disease just to maintain productivity. Priority for treatment will be placed on good and medium sites. All cutblocks in western hemlock must have the three meter knockdown clause maintained during harvesting operations or receive a prescribed burn during site preparation to eliminate hemlock dwarf mistletoe losses. Further loss reductions will be achieved in previously established plantations in the course of stand tending treatments.

If efforts are not taken to reduce current bark beetle infestations, losses can be expected to increase. These mortality losses must be assessed with respect to timber supplies within the T.S.A.

Surveys are required to determine the distribution and intensity of various root diseases in this T.S.A.

Table V. - S. 1 Estimated mortality losses caused by current pest activity[a]

T.S.A.: Soo
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3					
	Not Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)			Accounted For In Current Volume Estimations (Net Decay, Waste and Breakage)		
	Gross	Non Salvable Loss	Salvage	Gross	Non Salvable Loss	Salvage
mountain pine beetle	17 159	11 000	1 354			
Douglas-fir beetle	8 592	6 655	618			
Total	25 751	17 655	1 972			

a Mortality losses represent a loss for 1984 only.

Table V. - S. 2 Estimated growth and regeneration delay losses (Losses to the long run sustained yield)[a] caused by current pest activity

T.S.A.: Soo
DATE: May 13, 1985
RATED BY: D. Hepner
S. Taylor

Pest	Losses in m^3 per year			
	Not Accounted For In Current Volume Estimations (Net Decay)		Accounted For In Current Volume Estimations (Net Decay)	
	Gross	Net	Gross	Net
laminated root rot			30 568	27 682
armillaria root disease			3 712	3 309
hemlock dwarf mistletoe			21 847	16 643
mountain pine beetle (regeneration delay)	663	474		
Douglas-fir beetle (regeneration delay)	126	105		
Total	789	579	56 127	47 634

[a] Losses to the L.R.S.Y. will occur yearly over an extended time frame.

Table V. - S. 3 Summary of information used to determine pest losses

T.S.A.: Soo

Pest	Site Class	Inventory[a] Type Group	MAX[b] M.A.I. (m^3/yr/ha)	Incidence[c]	Reduction[c] to M.A.I.
				laminated root rot	armillaria root disease
laminated root rot and armillaria root disease	Good	1	10.3	0.14	0.01
	Good	3	11.4	0.14	0.01
	Medium	1,5,6	7.2	0.115	0.01
	Medium	3	8.1	0.115	0.01
	Poor	1,5,6	3.2	0.045	0.01
	Poor	3	3.2	0.045	0.01
	Low	1,3,5	1.2	0.034	0.01
hemlock dwarf mistletoe	Good	12	12.0	0.5	0.32
	Good	13-16	10.5	0.5	0.19
	Good	17	12.0	0.5	0.19
	Medium	12	6.0	0.5	0.32
	Medium	13-16	6.2	0.5	0.19
	Medium	17	6.0	0.5	0.19
	Poor	12	2.3	0.5	0.32
	Poor	13-16	4.4	0.5	0.19
	Poor	17	2.3	0.5	0.19
	Low	12	1.7	0.5	0.32
	Low	13-16	3.3	0.5	0.19
	Low	17	1.7	0.5	0.19

a Refer to Table V. 2 for the leading species associated with these inventory type group numbers.

b MAX M.A.I. - the average annual increment of the stand is greatest at this point, these numbers come from the Chapman Richard's Equations.

c Refer to sections 7.1.3. and 7.1.4. for the derivation of these numbers. Note: for armillaria root disease and laminated root rot a combined incidence and reduction to M.A.I. figure is used.

Table V. - S. 4 Summary of information used to determine pest losses
(mortality and regeneration delay losses)

T.S.A.: Soo

Pest[a]	Net/Gross Ratio (%)	Salvage Factor[b] (%)	Average Susceptible Type	Total Volume per Hectare (m^3/ha)	MAX M.A.I. (m^3/ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m^3/ha)
mountain pine beetle	72	2	P1F6-M	111.4	2.8	87	240.4
Douglas-fir beetle	85	12.3	F8-M	433	7.7	64	494.5

a Refer to section 7.1.1. for the derivation of these numbers.
b This factor is estimated by the Regional Pest Management Coordinator and it is his best estimate of what will be salvaged from current attack based on existing logging plans.

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7. APPENDICES

7.1. Detailed Methods for Calculating Pest Losses

7.1.1. Bark Beetles

7.1.1.1. Cariboo Approach

7.1.1.2. Non-Cariboo Approach

7.1.2. Douglas-fir Tussock Moth

7.1.2.1. Growth Losses

7.1.2.2. Mortality Losses

7.1.3. Root Diseases

7.1.3.1. Laminated Root Rot and Armillaria Root Disease

7.1.3.2. Tomentosus Root Rot

7.1.4. Dwarf Mistletoes

7.1.5. White Pine Weevil

7.1.6. Western Spruce and 2-Year-Cycle Budworms

7.1.6.1. Growth Losses

7.1.6.2. Mortality Losses

7.1.7. Porcupine

7.1.8. Spruce Aphid

7.1.9. Regeneration Delay Losses

7.2. Glossary

7.1. Detailed Methods for Calculating Pest Losses

This section describes in detail the methods for calculating all pest losses presented in this docuement.

7.1.1. Bark Beetles

The methods described herein were used to make estimates of losses for the mountain pine beetle, spruce beetle, Douglas-fir beetle and western balsam bark beetle. One of two types of approaches (Cariboo, Non-Cariboo) are used for calculating mortality losses, depending on the information available. Both approaches rely on the results of current survey information. To use the Cariboo Approach bark beetle infestations should be mapped onto forest cover type maps and the area of the individual attacked forest types should be calculated. Gross volumes should be calculated from these areas using prescribed methods (Taylor 1982) and these gross volumes may be used as inputs into this approach. To use the Non-Cariboo approach only areas of light, moderate and severe infestations have to be known. Therefore, the input into the Cariboo approach is volume and into the Non-Cariboo approach, area. Regardless of the approach which is used, the losses which will be calculated are: non-salvable losses (m^3), salvage losses (m^3)[a], gross losses (m^3, losses over the total crown land base) and regeneration delay estimates (m^3/year).

Common to both approaches are the regeneration delays to be used in calculating regeneration delay losses on non-salvaged attack areas. These delays only include additional delays directly attributable to the respective pest. These

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[a] Note: Salvage estimates (m^3) may be 25% less than reported due to some deterioration between the time of attack and harvest, which results in unavoidable waste. This waste would then make the non-salvaged loss greater by this difference.

delays (Hall[a], personal communication, Cozens[b], personal communication) are:

Mountain pine beetle	15 years
Spruce beetle	10 - 25 years
Douglas-fir beetle	15 years
Western balsam bark beetle	0 - 15 years

7.1.1.1. Cariboo Approach - This approach may be used to calculate losses where relatively detailed information on attacked stands is available. To use this approach follow the steps outlined below:

Step 1 Determine the gross infested volume based on surveys over current red attack areas. Volumes used in this approach must have been derived by dot counting individual attack polygons and then applying the appropriate loss factors[c] and volume over age curves to each distinct forest type.

Step II Determine the net operable land/gross land ratio by referring to S.A.S. reports[d]. The net operable infested area may also be generated by subtracting known volumes and areas not in the operable land base, as the case may be for large blocks of timber that are inoperable for obvious reasons (e.g. inaccessibility). However, if this second approach is used then precise T.S.A. definitions of merchantability, operability, and environmental sensitivity must be followed in making the deductions.

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a Protection Branch, British Columbia Forest Service, Victoria.

b Protection Section, British Columbia Forest Service, Prince George Forest Region.

c The appropriate loss factors can be found in Taylor, 1982. A more detailed explanation on obtaining gross volumes can also be found in this report.

d S.A.S. reports can be obtained from either the Regional Planning Officer or the Headquarter's Systems Development Forester.

Step III Estimate the non-salvage factor as follows:

- if 70% of the currently attacked stands will be salvaged, then the non-salvage factor is .3, as at this stage we are only concerned with non-salvable losses. Salvage is estimated by the Regional Pest Management Coordinator (P.M.C.) and it should be his best estimate of what will be salvaged from current attack based on past experience and existing logging plans.

Step IV Place the values obtained in steps I through III into the following formula:

$$\underset{(m^3)}{\text{Non-Salv. Loss}} = \underset{(m^3)}{\text{Gross Infested Volume}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Non-Salv. Factor}$$

Step V To determine the potential salvage losses, place the salvage factor (.7 for the example in Step III) into the formula in Step IV as follows:

$$\underset{(m^3)}{\text{Salvage Potential}} = \underset{(m^3)}{\text{Gross Infested Volume}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Salvage Factor } (.7)$$

Step VI To determine regeneration delay losses two areas must first be calculated, one area on which to base the net regeneration delay loss and one on which gross regeneration delay is based. To calculate these areas use the following formulas:

$$\text{(A) } \underset{\text{Area (Ha)}}{\text{Net Regen. Delay}} = \underset{\text{(Ha)}}{\text{Gross Area}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Non Salv. Factor}$$

$$\text{(B) } \underset{\text{Area (Ha)}}{\text{Gross Regen. Delay}} = \underset{\text{(Ha)}}{\text{Gross Area}} - (\underset{\text{(Ha)}}{\text{net area}} \times \text{salvage factor})$$

The net area in Step VI (B) is determined by multiplying the Gross Area (Ha) by the Net Op. Land Area/Gross Land Area ratio.

To claculate regeneration delay losses (m^3/year), place the areas determined in A and B above, into the formula in section 7.1.9. Place the appropriate regeneration delay estimates presented in section 7.1.1. into this formula (7.1.9.).

7.1.1.2 Non-Cariboo Approach - this approach may be used where detailed information on attacked stands does not exist. It is based on an estimate of total volume per hectare over large undifferentiated areas and as such, it introduces some subjectivity into the loss estimates. To use this approach follow the steps outlined below:

Step I Determine the net operable infested area[a] by using the following formula:

$$\text{Net Op. Infested Area (ha)} = \text{Gross Infested Area (ha)} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}}$$

The gross area is the number of hectares of current red attack broken down into light, moderate or high severity classes. The Net Op. Land Area/Gross Land Area ratio is determined from S.A.S. reports.

Step II Determine the total volume per hectare of attack by estimating the average attacked stands forest type label over this large undifferentiated area (i.e. species, composition, age, height, and site) for the individual severity levels and then refer to volume over age curves (using the appropriate utilization level) to obtain the m^3/ha of total volume of all species combined. This estimate will be the P.M.C.'s best estimate.

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a If the distribution of the gross infested area is disportionately large (i.e. disportionately different from the Net Op. Land Area / Gross Land Area ratio) into either the net or gross land area, then deviations from this approach may occur providing these areas can be accurately identified.

Step III Use the following midpoints (or other appropriate ones) for each severity class[a].

- 0.03 for Light Attacks
- 0.15 for Moderate Attacks
- 0.45 for High Attacks (Hall[b], personal communication)

Step IV Estimate the non-salvage factor using the same technique that was previously discussed.

Step V Determine the non-salvable loss by placing the values obtained in Steps I through IV into the following formula:

Non-Salv. Loss (m^3) = Net Op. Infested Area (ha of light attack) X Total Vol/ha (m^3/ha) X .03 X Non-Salv. Factor (intensity midpoint)

This example estimates the non-salvable loss for a light attack and this procedure must be repeated for moderate and high attacks.

Step VI To determine the potential salvage losses place the salvage factor (discussed in Step III and V of the Cariboo Approach) into the following formula:

Salvage Potential (m^3) = Net Op. Infested Area (ha of light attack) χ Total Vol/ha (m^3/ha) χ .03 χ Salvage Factor intensity midpoint

Step VII To determine the gross loss, place the gross infested area (from Step I) into the following formula:

Gross Loss (m^3) = Gross Infested Area (Ha of light attack) χ Total Vol/ha (m^3/ha) χ .03 intensity midpoint

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a The range in percent of trees infested for each severity class is light attacks 1 - 5%, moderate attacks 6 - 25% and high attacks 25+%. This rating system may vary slightly from region to region, for example, the Kamloops region uses: light attacks 1 - 5%, moderate attacks 6 - 30% and high attacks 30+%. Use the appropriate midpoints for the rating system in existence.

b Protection Branch, British Columbia Forest Service, Victoria.

Step VIII To determine the regeneration delay losses, follow the procedure outlined in Step VI of the Cariboo Approach.

7.1.2 Douglas-fir tussock moth - the timber losses resulting from this insect consist of two components, growth and mortality, which are calculated separately. These losses will be expressed for the current year only (m^3/1984) and do not represent a loss to L.R.S.Y. (i.e. they may be considered as short-term losses only). Growth and mortality are a function of the number of times an area has been defoliated and are calculated as follows:

7.1.2.1. Growth Losses

Step I Determine the infestation area from surveys based on areas of current attack. This area must be broken down into areas of repeat defoliation. For example, for a 200 hectare defoliation in the current year, one must determine how much of this area is repeat defoliation. If 100 hectares is repeat defoliation then the infestation area used in later steps is 100 hectares (defoliated once) and 100 hectares (defoliated twice). Even if no defoliation occurred in the current year an area may be suffering from growth loss and in this case, the year of recovery must be known.

Step II Determine the net operable area/gross land area ratio as previously discussed.

Step III Determine the growth loss reduction from Table A-I.

Step IV Determine the MAX M.A.I. using the Chapman Richard's Equation.

Step V Substitute the values determined in Steps I through IV into the following formula:

$$\underset{(m^3/yr)}{\text{Growth Loss}} = \underset{(ha)}{\text{Infestation Area}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \underset{\text{M.A.I.}}{\text{Reduct. in}} \times \underset{(m^3/yr/ha)}{\text{MAX M.A.I.}}$$

Table A-I Factors used to determine Douglas-fir tussock moth growth and mortality losses[a]

Infestation Duration (Number of Times an Area is Defoliated)	Growth Loss (Proportional reduction of M.A.I.)	Mortality Loss (Proportional reduction of Susceptible Volume)
1	0.3	0.05
2	0.6	0.15
3	1.0	0.30
Recovery Period (year of recovery)		
1st	0.6	0.0
2nd	0.3	0.0

a (Ross and Taylor 1983)

7.1.2.2. Mortality Losses

Step I Determine the infestation area as discussed in part i above.

Step II Determine the net operable land area/gross land area ratio as previously discussed.

Step III Determine the mortality loss by referring to Table A-I.

Step IV Determine the susceptible volume per hectare by first estimating the average stands forest type label (i.e. species, composition, age, height, and site). Next use inventory data to obtain the volume per hectare for only the susceptible species.

Step V Place the values determined in Steps I through IV into the following formula:

$$\underset{(m^3)}{\text{Mortality Loss}} = \underset{(ha)}{\text{Infest. Area}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \underset{}{\text{Mortality Loss}} \times \underset{(m^3/ha)}{\text{Suscept. Vol}}$$

Note: the year of recovery is not required for the mortality loss estimates.

7.1.3. Root Diseases

7.1.3.1. Laminated root rot and Armillaria root disease

Effects of these diseases are expressed as a loss to the L.R.S.Y. Data used in calculating these losses are based on the Vancouver Forest Region laminated root rot surveys in coastal second growth stands from which various assumptions as to the scale of loss and the susceptible area have been made for other regions. This approach was necessitated by the lack of root rot survey information in other regions. Follow the steps described below to calculate these losses.

Step I Determine the susceptible area from S.A.S. reports based on the input provided in the Regional Susceptible Characteristics Tables (Tables C. 2, K. 2, N. 2, P.G. 2, P.R. 2 and V. 2). There should be one table for each region. For coastal laminated root rot this area must be broken down into good, medium, and poor sites; this is not necessary for the interior.

Step II Determine the reduction to MAX M.A.I. for coastal laminated root rot by using the reduction figures 0.14, 0.115, 0.045 and 0.034 respectively for good, medium, poor and low sites. For coastal armillaria root disease the reduction figure is 0.01 for all sites (Beale[a], personal communication). These reduction figures are based on the Vancouver Forest Regions root disease surveys[b].
For interior forest regions use 0.05 (Muir[c], personal communication) as a guideline for both laminated root rot and armillaria root disease, unless additional work in the region can substantiate another figure. However, keep the figures within a range of 0.01 and 0.14.

Step III Determine the MAX M.A.I. using the Chapman Richard's Equation.

Step IV Place the values obtained in Steps I through III into the following formula:

$$\underset{(m^3/yr)}{\text{Loss}} = \underset{(ha)}{\text{Susceptible Area (Net)}} \times \text{Reduction in M.A.I.} \times \underset{(m^3/yr/ha)}{\text{MAX M.A.I.}}$$

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a Protection Section, British Columbia Forest Service, Vancouver Forest Region.
b Except the low site figure of .034, which was estimated to be 75% of the poor figure.
c Protection Branch, British Columbia Forest Service, Victoria.

Repeat this formula using the gross susceptible area to arrive at gross losses.

7.1.3.2. Tomentosus root rot

These losses are expressed as a loss to L.R.S.Y. The impact and incidence information are based on local studies in the Prince George Forest Region and are assumed to apply to other regions.

Step I Determine the susceptible area from S.A.S. reports, based on the input provided in the Region Susceptible Characteristics Tables (Tables C. 2, K. 2, N. 2, P.G. 2, P.R. 2, and V. 2).

Step II Determine the incidence of infected susceptible stands by using 0.16[a].

Step III Determine the reduction to MAX M.A.I. by using 0.25[b].

Step IV Determine the MAX M.A.I. using the Chapman Richard's Equation.

Step V Place the values specified in Steps I through IV into the following formula:

Loss (m^3/yr) = Susceptible Area (Net) (ha) x Incidence x Reduct. to M.A.I. x MAX M.A.I. (m^3/yr/ha)

Repeat this formula using the gross susceptible area to arrive at gross losses.

7.1.4. Dwarf mistletoes - the effects of these pests are expressed as a loss to L.R.S.Y. Follow the steps outlined below to calculate hemlock, lodgepole pine, Douglas-fir, and larch dwarf mistletoe timber losses.

Step I Determine the susceptible area from S.A.S. reports based on the input provided in the Regional Susceptible Characteristics Tables (Tables C. 2, K. 2, N. 2, P.G. 2, P.R. 2, and V. 2).

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a (van der Kamp and Merler 1984). The figure used in this exercise (0.16) has been adjusted downward from the figure (0.284) quoted in this study, as this figure only applied to the 40 - 60 age group, and incidence is assumed to decrease with the age of the stand.

b This reduction figure comes from the above mentioned study and applies to the 40 - 60 year age group, it is assumed to apply to other age groups. This study quotes a figure of 0.20 which reflects the reduction of basal increment which applies to healthy stands, since unmanaged stand data will be used to calculate M.A.I.'s this figure has been adjusted to 0.25 and is assumed to say something about growth loss.

Step II Determine the incidence of infected susceptible stands by referring to Table A-II. Local figures may be used in place of these figures provided they can be substantiated, however, try to stay within the range provided in brackets.

Step III Determine the reduction to M.A.I. by referring to Table A-II. Use these figures as a guide only, localized estimates are likely to provide better results.

Step IV Determine the MAX M.A.I. using the Chapman Richard's Equation.

Step V Calculate the loss by substituting the values obtained in Steps I through IV into the following formula.

$$\underset{(m^3/yr)}{\text{Loss}} = \underset{(ha)}{\text{Susceptible Area (Net)}} \times \text{Incidence} \times \text{Reduct. to M.A.I.} \times \underset{(m^3/yr/ha)}{\text{MAX M.A.I.}}$$

Repeat this formula using the gross susceptible area to arrive at gross impacts.

7.1.5 White Pine Weevil - losses to this pest will only be calculated for severe infestations[a] as determined from surveys. This loss will be treated as a 20 year regeneration delay loss (Wood[b], personal communication). This approach assumes that after a severe infestation the stands current growth is reduced to zero and that a satisfactory growth rate can ony be obtained by rehabilitating the area.

Gross and net losses will be the same for this pest, as only areas in the net land base are usually surveyed. Take the surveyed area and use it in the formula in section 7.1.9.

Light to moderate weevil infestations are considered to have an insignificant impact on timber losses and will not be calculated until better assessment techniques are available.

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a Severe infestations are defined as those with greater than 5 % of the stems infected with current atack (Carlson et al 1984)

b Protection Section, British Columbia Forest Service, Vancouver Forest Region.

Table A- II Data used to derive dwarf mistletoe losses

Species (dwarf mistletoe)	Incidence (allowable range) (Portion of Susceptible Area Infested)	Loss (Proportional reduction to M.A.I.)
hemlock	0.5[a] (0.15 - 0.6)	0.32[b] pure stands 0.19[b] mixed stands
lodgepole pine	0.35[c] (0.20 - 0.45)	0.25[d] pure stands 0.15[d] mixed stands
Douglas-fir	0.03[c] (0.02 - 0.43)	0.25[d] pure stands 0.15[d] mixed stands
larch	0.2[c] (0.01 - 0.5)	0.25[d] pure stands 0.15[d] mixed stands

a Beale, Personal Communication. Protection Section, British Columbia Forest Service, Vancouver Forest Region.

b (Thomson et al. 1985) This studies' loss was adjusted to estimate the increase over the existing increment.

c Van Sickle, Personal Communication. Environment Canada, Canadian Forestry Service, Pacific Forestry Centre. (Based on a 1 100 km roadside survey).

d Muir, Personal Communication. Protection Branch, British Columbia Forest Service, Victoria.

7.1.6 Western spruce and 2-year-cycle budworms - the loss due to the western spruce budworm consists of a growth and mortality component, while the loss due to the 2-year-cycle budworm consists of a growth component only and mortality[a] is considered negligible. The losses due to these insects are determined as follows:

7.1.6.1. Growth Losses

Step I Determine the infestation area based on areas of current attack. This area must be broken down into areas of repeat defoliation. For example, for a 200 hectare defoliation in the current year, one must determine how much of this area is repeat defoliation. If 100 hectares is defoliated twice, then the infestation area used in later steps is 100 hectares (defoliated once) and 100 hectares (defoliated twice). Even if no defoliation occurred in the current year, an area may still be suffering from growth loss and the recovery year must be known.

Step II Determine the net operable land area/gross land area ratio, as previously discussed.

Step III Determine the reduction in M.A.I. from Table A-III. There are two sets of figures, one each for the western spruce budworm and 2-year-cycle budworm, use the correct ones. For example, if the western spruce budworm is currently in its third year of a cycle, then a reduction figure of .40 could be applied to those areas which have been attacked for 3 consecutive years. Note, it is also possible to have areas which have only been attacked twice and hence the reduction figure .2 would be applied. To determine the reduction to M.A.I. during the recovery period[b] use the lower half of table A-III.

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a Alfaro, Personal Communication. Environment Canada, Canadian Forestry Service, Pacific Forestry Centre.

b Usually during the recovery period there will be no defoliation.

Table A - III Western spruce and 2-year-cycle budworm growth loss data

Infestation Duration (Number of Times an Area is Defoliated)	western spruce budworm[a] (Proportional reduction of M.A.I.)	2-year-cycle budworm [a] (Proportional reduction of M.A.I.)
1	0	0
2	0.20	0.10
3	0.40	0
4	0.60	0.30
5	0.80	0.20
6	1.00	0.50
7	1.00	0.40
8		0.70
9		0.60
10		0.90

Recovery Period (Year of Recovery)	Length of Outbreak (Yrs.) 6	5	4	3	2	1	Length of Outbreak (Yrs.) 10	9	8	7	6	5	4	3
1st	.80	.60	.40	.20	0	0	.70	.40	.60	.20	.40	0	.20	0
2nd	.60	.40	.20	0			.50	.20	.40	0	.20		0	
3rd	.40	.20	0				.30	0	.20		0			
4th	.20	0					.20		0					
5th	0						0							

a Alfaro, Personal Communication. Environment Canada, Canadian Forestry Service, Pacifi Forestry Centre.

Step IV Determine the MAX M.A.I. using the Chapman Richard's Equation.

Step V Place the values determined in steps I through IV into the following formula:

$$\underset{(m^3/yr)}{\text{Loss}} = \underset{(ha)}{\text{Infestation Area}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Reduct. in M.A.I.} \times \underset{(m^3/yr/ha)}{\text{MAX M.A.I.}}$$

7.1.6.2. Mortality Losses (western spruce budworm)

Step I Determine the infestation area as discussed in Section 7.1.6.1. above.

Step II Determine the net operable land area/gross land area ratio as previously discussed.

Step III Determine the reduction in mortality by referring to Table A-IV. This table gives mortality figures for the Kamloops and Vancouver Forest Regions.

Step IV Determine the susceptible volume per hectare by first estimating the average stands forest type label (i.e. species, composition, age, height, and site). Next use inventory data to obtain the volume per hectare for only the susceptible species.

Step V Place the values obtained in Steps I through IV into the following formula:

$$\underset{(m^3)}{\text{Net Mortality Loss}} = \underset{(ha)}{\text{Infest. Area}} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \underset{\text{Loss}}{\text{Mortality in}} \times \underset{(m^3/yr)}{\text{Suscep. Vol.}}$$

Note: The year of recovery is not required for mortality loss estimates. To obtain the gross mortality loss, repeat the above calculation without the Net Operable/Gross Land Area Ratio.

Table A-IV Western spruce budworm mortality loss data

Infestation Duration (Number of Times an Area is Defoliated)	Mortality Loss[a] (Proportional Reduction of Susceptible Volume)	
	Kamloops[b]	Vancouver
1-3	0	0
4	0.01	0.01
5	0.02	0.03
6	0.03	0.05
7	0.04	0.07

a Alfaro, Personal Communication. Environment Canada, Canadian Forestry Service, Pacific Forestry Centre. (Based on 64 Forest Insect and Disease Survey Plots).

b These figures are to be used to estimate mortality losses in the Cariboo Forest Region.

7.1.7. Porcupine - this loss will be calculated as a regeneration delay (m^3/year), as in severe attacks this pest reduces a stand's value to zero until a complete rehabilitation project is undertaken (Barge[a], personal communication). Calculate this loss as follows:

Step I Determine the net susceptible area from surveys. Because this pest usually attacks young logged over stands (40-60 years) the assumption has been made that net and gross losses are the same.

Step II Use a regeneration delay of 15 years and follow the instructions in Section 7.1.9.(regeneration delay).

7.1.8. Spruce aphid -This pest's loss will be calculated as a loss based on survey data from the current year only. Historic information on this pest is not sufficiently accurate to make long-term estimates at this time.

Calculate this loss as follows:

Step I Determine the gross susceptible area from surveys.

Step II Determine the net operable land area/gross land area ratio as previously discussed.

Step III Use a reduction to MAX M.A.I. of 0.1[b]. An estimate of incidence is not required for this pest as the susceptible area is derived from surveys.

Step IV Determine the MAX M.A.I. using the Chapman Richard's Equation. To obtain this figure an estimate of the average susceptible forest type must be made.

Step V Calculate the loss by substituting the values obtained in Steps I through IV into the following formula:

$$\text{Net Loss } (m^3/yr) = \text{Susceptible Area (ha)} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \frac{\text{Reduct. to MAX M.A.I.}}{\text{MAX M.A.I.}} \times \text{MAX M.A.I. } (m^3/yr)$$

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a Protection Section, British Columbia Forest Service, Prince Rupert Forest Region.

b Alfaro, Personal Communication. Environment Canada, Canadian Forestry Service, Pacific Forestry Centre.

7.1.9. Regeneration Delay Losses[a] - these losses will be calculated for bark beetles, porcupine, and severe white pine weevil infestations and will be expressed as a reduction to L.R.S.Y. (m^3/year). To calculate these losses follow the steps outlined below:

Step I Determine the MAX M.A.I. for the average susceptible forest type. To calculate this figure the species composition, age, site, and height of the average type will have to be known.

Step II For the forest type described in Step I, determine the volume at culmination age and the culmination age.

Step III Use the appropriate regeneration delay number.

Step IV Determine the susceptible area. Consult the bark beetle (section 7.1.1.[b]), weevil (section 7.1.5.) or porcupine (section 7.1.7.) when making this determination.

Step V Take the numbers determined in steps I through IV and place them into the following formula:

$$\underset{(m^3/\text{year})}{\text{Regen Delay Loss}} = \left[\underset{(m^3/yr/ha)}{\text{MAX M.A.I.}} - \frac{\text{Volume at Culmin. Age } (m^3/ha)}{\underset{\text{(years)}}{\text{Culmin. Age}} + \underset{\text{(years)}}{\text{Regen. Delay}}}\right] \times \underset{\text{(ha)}}{\text{Susceptible Area}}$$

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a Regeneration delay losses for root diseases will not be calculated as assessment techniques are not well-developed.

b For bark beetles this area is either the non-salvaged area for net regeneration delays or net salvaged area subtracted from the gross land area for the gross regeneration delay, while for weevils and porcupine it is the surveyed area.

7.2. GLOSSARY

Accounted For Pests - These pests are often hard to identify in forest stands. Therefore volume over age curves and average volume lines are lower than they otherwise would be had these pests not occurred. A loss resulting from an accounted for pest is presumed to result in a gain over and above existing growth curves.

Annual Allowable Cut (A.A.C.) - an annual rate of timber harvesting specified by the Chief Forester, Ministry of Forests for an area of land for a period of time, usually five years.

Average Volume Lines (A.V.L.) - aggregations of individual growth curves to ease data manipulation.

Chapman Richard's Equation -an inventory yeild curve used to predict yields of imature stands.

Crown Land - has the same meaning as in the Land Act, but does not include land owned by an agent of the crown.

Culmination Age - (Doliner and Borden 1984).

Forest Type - refers to a specific timber type designated by a label such as F 831-M (Species, Age, Height, Stocking and Site).

Gross Losses - losses occurring on the total crown forest land base.

Growth Loss -(Doliner and Borden 1984).

Impact - (Doliner and Borden 1984).

Incidence - (Doliner and Borden 1984).

Inventory Type Group - refers to an aggregation of primary and secondary species into one of 42 groups. e.g. F, FPL, B (Inventory Branch 1980).

Long Run Sustained Yield (L.R.S.Y.) - a measure of land productivity derived from the M.A.I. with areas reduced to reflect proposed management options.

Maximum Mean Annual Increment (MAX M.A.I.) - for M.A.I. see (Doliner and Borden 1984). MAX M.A.I. is the point where the annual increment of a stand is the greatest i.e. M.A.I. culminates.

Mortality Loss - (Doliner and Borden 1984).

Net Operable/Gross land Area Ratio - a ratio arrived at from Planning -Inventory Branch tables used to net down gross land areas or volumes.

Net Operable Land base - crown forest land minus non-merchantable areas, environmentally sensitive areas and non-operable areas.

Non-salvaged Losses - the loss to the net land base assuming that any anticipated salvage takes place.

Recovery Period - refers to increment recovery after a defoliator attack. The recovery period can last a number of years until growth rates recover to pre-outbreak levels.

Regeneration (Regen) Delay Losses - losses to the L.R.S.Y. which are calculated for bark beetle infestations, porcupine and severe weevil infestations. Regeneration delays represented in this document only include addition delays directly attributable to the respective pest. To arrive at the total regeneration delay, an additional time span is needed to allow for normal crop establishment.

Salvage - an estimate by the Regional Pest Management Coordinator of what will be salvaged from current attack based on past experience and existing logging plans.

Site - the capacity of an area to support tree growth. Sites used in this report (Good, Medium, Poor and Low) are derived from the leading tree species height at a given stage of development.

Statistical Analysis System Reports (S.A.S. Reports) - A report generating system which stores forest area and volume information from which raw data was generated to feed pest loss calculations. Areas and volumes generated were based on actual stand ages at the time of the original inventory survey rather than projected ones. Also, S.A.S. report results differ from inventory estimates in some T.S.A.'s due to unexplained data gaps. (Pelchat, personnel communication)

Timber Supply Area (T.S.A.) - means land designated as a T.S.A. under Section 6 of the Forest Act.

Tree Farm Licence (T.F.L.) - means a T.F.L. entered into under Part 3,Division (5) (Forest Act) or under the former Act, and includes a forest management licence entered into before January 1, 1958.

Unaccounted For Pests - pests which cause sudden noticeable mortality and growth impacts in infested areas. Their impacts on future harvests are harder to determine than the accounted for category. These pests have not been accounted for in current growth estimations (A.V.L.'s or V.A.C.'s).

Volume at Culmination Age - volume of a stand at MAX M.A.I.

Volume Over Age Curves - growth curves which predict volume over a specific age range for each Ministry of Forests inventory growth type, site class and forest inventory zone for forest stands.

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a Inventory and Planning Branch, British Columbia Forest Service, Victoria.