



Ministry of
Forests

FOREST INSECT & DISEASE IMPACTS IN TREE FARM LICENCES

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TABLE OF CONTENTS

	<u>Page</u>
LETTER OF TRANSMITTAL.....	v
FOREWORD.....	vi
1. INTRODUCTION.....	1
2. METHODS.....	3
3. PROVINCIAL SUMMARY.....	12
4. TREE FARM LICENSE SUMMARIES.....	
4.1 TFL #1 SKEENA CELLULOSE INCORPORATED.....	18
4.2 TFL #3 SLOCAN FOREST PRODUCTS LIMITED.....	24
4.3 TFL #5 WELDWOOD OF CANADA LIMITED.....	27
4.4 TFL #6 WESTERN FOREST PRODUCTS LIMITED.....	30
4.5 TFL #8 POPE AND TALBOT LIMITED.....	35
4.6 TFL #10 WELDWOOD OF CANADA LIMITED.....	39
4.7 TFL #13 GALLOWAY LUMBER COMPANY.....	43
4.8 TFL #14 CRESTBROOK FOREST INDUSTRIES LIMITED.....	46
4.9 TFL #15 WEYERHAEUSER CANADA LIMITED.....	50
4.10 TFL #18 CLEARWATER TIMBER PRODUCTS LIMITED.....	55
4.11 TFL #19 CANADIAN PACIFIC FOREST PRODUCTS LIMITED.....	56
4.12 MANAGED FARM UNIT #19 MACMILLAN BLOEDEL LIMITED.....	60
4.13 TFL #23 WESTAR TIMBER LIMITED.....	64
4.14 TFL #24 WESTERN FOREST PRODUCTS LIMITED.....	69

TABLE OF CONTENTS (Continued)

	<u>Page</u>
4.15 TFL #25 WESTERN FOREST PRODUCTS LIMITED.....	74
4.16 TFL #26 DISTRICT OF MISSION.....	78
4.17 TFL #30 NORTHWOOD PULP AND TIMBER LIMITED.....	81
4.18 TFL #33 FEDERATED COOPERATIVES LIMITED.....	84
4.19 TFL #35 WEYERHAEUSER CANADA LIMITED.....	87
4.20 TFL #37 CANADIAN FOREST PRODUCTS LIMITED.....	90
4.21 TFL #38 WELDWOOD OF CANADA LIMITED.....	96
4.22 TFL #39 MACMILLAN BLOEDEL LIMITED.....	100
4.23 TFL #41 EUROCAN PULP AND PAPER COMPANY.....	107
4.24 TFL #42 TANIZUL TIMBER LIMITED.....	110
4.25 TFL #43 SCOTT PAPER LIMITED.....	115
4.26 TFL #44 MACMILLAN BLOEDEL LIMITED.....	117
4.27 TFL #45 FLETCHER CHALLENGE CANADA LIMITED.....	122
4.28 TFL #46 FLETCHER CHALLENGE CANADA LIMITED.....	126
4.29 TFL #47 FLETCHER CHALLENGE CANADA LIMITED.....	130
4.30 TFL #49 FLETCHER CHALLENGE CANADA LIMITED.....	135
4.31 TFL #51 WESTAR TIMBER LIMITED.....	139
5. ACKNOWLEDGEMENTS.....	140
6. REFERENCES.....	141

TABLE OF CONTENTS (continued)

	<u>Page</u>
7. APPENDICES.....	144
7.1 DETAILED METHODS FOR CALCULATING PEST IMPACTS.....	145
7.1.1 BARK BEETLES (MOUNTAIN PINE, SPRUCE AND DOUGLAS-FIR)..	145
7.1.1.1 CARIBOO APPROACH.....	146
7.1.1.2 NON-CARIBOO APPROACH.....	147
7.1.2 WESTERN BALSAM BARK BEETLE.....	148
7.1.3 DOUGLAS-FIR TUSSOCK MOTH.....	148
7.1.3.1 GROWTH IMPACTS.....	148
7.1.3.2 MORTALITY IMPACTS.....	149
7.1.4 ROOT DISEASES.....	149
7.1.4.1 LAMINATED ROOT ROT AND ARMILLARIA ROOT DISEASE....	149
7.1.4.2 LAMINATED ROOT ROT (VANCOUVER FOREST REGION).....	151
7.1.4.3 TOMENTOSUS ROOT ROT.....	152
7.1.5 DWARF MISTLETOES.....	153
7.1.6 WHITE PINE WEEVIL.....	155
7.1.7 WESTERN SPRUCE BUDWORM (WSEW).....	157
7.1.8 REGENERATION DELAY IMPACTS.....	159
7.1.9 PORCUPINES.....	160
7.2 GLOSSARY.....	161
7.3 COMMON AND SCIENTIFIC NAMES FOR MAJOR PESTS FOUND IN B.C.	164
7.4 PROVINCIAL TSA/TFL INDEX MAPS.....	165

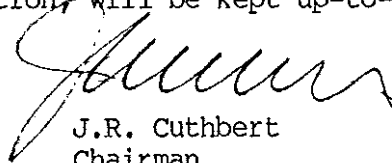
FOREST PEST REVIEW COMMITTEE of BRITISH COLUMBIA

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 both Timber Supply Areas (TSAs) and Tree Farm Licences (TFLs) in the Province. The TSA tabulations were completed in 1986, and these tabulations for pests on TFLs fulfill the Chief Forester's request.

In 1983 the Committee believed that forest pests in several planning units had greatly influenced timber harvesting and other forest management activities. However, pest effects, i.e., tree mortality, and reduced growth and yield, were not addressed in management plans. In particular, pest data were needed to assess effects on short-term supplies of mature timber and on long-term forest productivity of immature stands, and to determine where pest effects could be either avoided or managed.

The data for this report were provided by, or derived from results of research studies and surveys by the Canadian Forestry Service, industry, and B.C. Forest Service. Where data were lacking, results were extrapolated from other regions or determined by local specialists. Methods were selected, and data for the project were tabulated and analyzed in consultation with the Council of Forest Industries (COFI) of B.C., Northern Interior Lumber Sector of COFI, Cariboo Lumber Manufacturers Association, and Interior Lumber Manufacturer's Association.

This compilation represents our current, best estimates of pest-caused forest impacts in TFLs in B.C. Although some data are tentative, this tabulation is expected to be useful for current planning needs. Readers of this report are encouraged to comment and provide suggestions. The Forest Pest Review Committee will ensure that the report, along with expected future amendments and revisions based on new information, will be kept up-to-date and relevant.



J.R. Cuthbert
Chairman
January 10, 1989

FOREWORD

In order to assist pest management personnel in improving future issues of this report, the Protection Branch requests users to offer comments and suggestions.

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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 pest caused impacts. The provincial government, for example, has allocated several million dollars annually since 1984 to reduce the impacts 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 designed to be a supporting document for Tree Farm License (TFL) and pest management planning. It provides estimates of pest impacts on timber volume for each TFL in British Columbia based on available survey data, extrapolation of research results, and professional opinion.

The report has two main objectives:

- to estimate the respective impacts of forest pests for each TFL (these estimates include mortality and growth impacts, salvage potential, and regeneration delays); and,
- to review current damage appraisal and survey information and 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 dwarf mistletoe studies carried out in the Province and root disease studies in coastal second growth 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 Soo and Sunshine Timber Supply Areas (TSA) have used managed stand yield tables developed with information from a root disease survey in the Vancouver Region to identify treatment opportunities.

Associated with the task of collecting and recording pest management data are current attempts to improve incorporation of pest impact data into procedures used to assess pest affects on future timber supplies and other elements of the forest resource base. At present, to account for mortality losses from fires, insects and disease, a deduction is made from the estimated long-run sustained yield (LRSY) capacity of the TSA. Also, equally as important is mitigating pest effects on growth as this could and should improve allocation of scarce protection, silviculture and harvesting funds.

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

2. METHODS

The methods used deal with three major types of impacts (mortality, growth reduction, and regeneration delay) for each pest group and are uniformly applied to all TFLs. The 1987 survey information that was used to develop these impacts was obtained from TFL holders, British Columbia Forest Service (BCFS), or Canadian Forestry Service (CFS) surveys.

All impacts were calculated for the private and Crown components of the net operable and gross land bases. These land bases were obtained from either management and working plans or the respective TFL holder. Frequently, gross areas were unavailable since they were not kept in collatable form after net-downs were made for environmentally sensitive, operable, and non-merchantable areas. Occasionally, only gross areas were available; this was usually due to an inventory update where net-downs had not occurred.

Mortality impacts are based on current survey data and produce short-term (1 year) salvage estimates and impact figures. The bulk of these impacts occur on mature timber types. Included in this impact category is mortality from bark beetles for example, mountain pine beetle,^a spruce, Douglas-fir beetle and western balsam bark beetle and some defoliators for example, Douglas-fir tussock moth.^b

a. Common pest names are used throughout the text and scientific names can be found in appendix 7.3.

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

While methods are available to calculate impacts for the above pests, only impacts due to the mountain pine beetle are estimated in this report. Impacts of other bark beetles and defoliators were not calculated because insufficient survey information was available within TFLs. Blister rusts, diseases, and the western blackheaded budworm may also cause mortality in stands but this loss was not measured; assessment techniques are not well developed for these pests.

Current survey data are used to estimate salvage opportunities, nonsalvable and gross impacts. An alternative approach is to average mortality due to pest actions over the previous infestation period(s) to produce an average estimate of annual mortality. However, this method was deemed unsuitable because existing modelling efforts for catastrophic pests are still developmental and have yet to be applied operationally (Reed and Errico, 1985). Furthermore, pest survey and impact records are not sufficiently accurate to make reliable long-term averages for many pests. However, current, ongoing studies in some areas of the Province may overcome some of these developmental problems.

Growth impacts are generally treated as long-term impacts on the LRSY and are used to calculate pest impacts resulting from root diseases and dwarf mistletoes. These impacts are based on areas of susceptible timber types that have been determined in consultation with Branch and Regional Forest Pathologists (Table 2.1). It is assumed in this approach that growth responses due to these pests will remain constant over future rotations.

Table 2.1 Inventory type groups and leading species used to generate susceptible stand areas

Pest	Tree Farm Licenses Affected	Inventory Type Group (and leading species)
armillaria root disease	3,5,6,8,13,14,23,33,35,49	1-8 (F,FC+FCy,FH,FS, FPl,FPy,Fl,F Decid)
Douglas-fir dwarf mistletoe	15,49	1(F),5-8(FPl,FPy,Fl, F Decid)
hemlock dwarf mistletoe	1,6,10,19,MFU 19,24-26, 37-39,41,44-47	12-17 (H,HF,HC,HB,HS, H Decid)
laminated root rot	3,8,15,23,30,33,35,49	1-8 (F,FC+FCy,FH,FS, FPl,Fl,FDecid)-Interior
	6,10,MFU 19,25,37-39,44, 46,47	1-3 (F,FC+FCy,FH) -Coastal
larch dwarf mistletoe	3,8,13,15,23	33,34 (LF,L) ^a
lodgepole pine dwarf mistletoe	3,8,13,14,15,23,42,49	28-31 (Pl,PlF,PlS+PlB, Pl Decid), 5 FPl ^b
	42	28 (Pl) for Northern TFLs only
tomentosus root rot	5,30,42	21-26 (S,SF,SH+SC,SB, SPL,S Decid)
	33,35,49	5% of 1-8 ^c (F,FC+FCy, FH,FS,FPl,FPy,Fl,FS)

a. Totals for these type groups often included 7(FL) and 27(Pw), therefore deductions were made to delete these unnecessary areas.

b. FPL was only included when its area could be separated from other growth types.

c. Merler, pers. comm., Protection Section, BCFS, Kamloops Forest Region. This trend was only noticed in the Kamloops Region.

This approach involves estimating the total susceptible area for pests which cause growth impacts and applying an impact figure based on the Maximum Mean Annual Increment (MAX MAI). The total susceptible area is generally used for calculating impacts, regardless of the stand's current age, as LRSY is affected by impacts which occur over several rotations of a stand, i.e., the current age mosaic holds less importance on a 200 year planning horizon, as presumably all overmature timber will be amortized in a much shorter time-frame and a managed forest obtained. This older component of the stand will not accumulate to the same extent as it has in the past. Usually, growth impact increases or reductions in subsequent rotations as a result of current management practices were ignored. However, as more information on pest effects becomes available, these impacts will be included in future revisions of this document.

Exceptions to this long-term approach are growth impacts resulting from the Douglas-fir tussock moth, which will be calculated as an impact based on survey data for the current year; and the white pine and western spruce budworm, which will be calculated as an impact occurring at the end of the rotation. Methods for these pests are based on CFS modelling initiatives and were not employed in this report due to insufficient historic information on survey areas.

Regeneration delay impacts are treated as long-term impacts to LRSY and will be calculated for bark beetle infestations. These impacts are usually 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.

Once pest impacts on trees have been classified according to the three major categories (mortality, growth reduction, and regeneration delay) each category must be further subdivided into "Accounted-for" versus "Not-accounted-for" in regards to the existing growth curves. The justification behind this breakdown is that data is treated differently in each category in the yield estimation process. Table 2.2 sorts 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).

Table 2.2 Summary of major pests accounted or not accounted for in stand volume estimates based on category of impact

	Not Accounted For in Current Volume Estimations	Accounted For in ^a Current Volume Estimations
Mortality Impacts	mountain pine beetle spruce beetle Douglas-fir beetle Douglas-fir tussock moth	
Growth Impacts	porcupine	laminated root rot armillaria root disease tomentosus root rot dwarf mistletoes (lodgepole pine, Douglas-fir, hemlock and larch) Douglas-fir tussock moth western blackhead budworm western spruce budworm 2-year-cycle budworm western balsam bark beetle
Regeneration Delay Impacts	mountain pine beetle spruce beetle Douglas-fir beetle western balsam bark beetle white pine weevil	

-
- a. Even though with these pests tree mortality might be involved, the ultimate effect on a total stand is to reduce the stand growth.

Accounted-for pests usually cause insidious impacts as a result of growth reductions and can be referred to as OPPORTUNITIES to increase yields pending some management action. These pests are accounted for in two ways depending on the type of survey (inventory or research/experimental) that was used to derive the yield curves:

- In inventory surveys (used to produce unmanaged stand yield tables), insidious areas of accounted-for pests were inadvertently included in the sampling design when plots were established and, hence, were incorporated into the total survey area resulting in decreased yields. If inventory plots were not established in a random fashion, then, depending on the nature of the plot bias, the accounted-for assumptions may only be partially true.
- Managed stand yield tables were often derived from research/experimental plots that excluded areas under the influence of pests. The resulting yields, therefore, represent those that can be obtained only from full management. Factors are then used to reduce yields due to pests and other influences. These factors are very general and the accurate identification of pest opportunities will help to further refine their values.

Impacts from pests that are found in the "Not-accounted-for" category have not been factored into yield estimates. These pests usually cause sudden mortality that is noticeable in infested stands. The impact of pests in this category on future harvests depends upon the stand's current age class distribution and future harvesting regimes.

Decay is found in the "Accounted-for versus Mortality" category in table 2.2. Decay has not been calculated for two reasons: MAIs used in yield analysis are net decay meaning that decay has already been deducted; and, 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 impacts are found in Appendix 7.1. Also included are methods for the western balsam bark beetle, Douglas-fir beetle, spruce beetle, Douglas-fir tussock moth, western spruce budworm and the white pine weevil, which were not used in impact calculations but will be useful in the future as survey information improves or these pests become a serious concern.

Provincial and TFL impact statements (found in sections 4.1 to 4.31) usually consist of five and four tables respectively and include statements on pest concerns and activities.

Provincial Tables

Table 3.1 Estimated mortality impacts and salvage potential caused by current pest activity.

Table 3.2 Estimated growth impacts/opportunities caused by forest pests.

Table 3.3 Regeneration delay impacts/opportunities caused by forest pests and areas upon which they are based.

Table 3.4 Forested areas which are susceptible to pests.

Table 3.5 Surveyed areas (1987) of pest infestation.

Tree Farm License Tables

Table 4.1.1. Estimated mortality impacts, salvage potential and infested areas caused by current pest activity.

Table 4.1.2. Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield) and areas occupied by susceptible species.

Table 4.1.3. Summary of information used to determine growth impacts.

Table 4.1.4. Summary of information used to determine mortality impacts.

Tables 4.1.1. and 4.1.4. are not always found in each TFL package due to the absence of mortality type pests in those TFLs.

3. PROVINCIAL SUMMARY

CONCERNS

Pest concerns are quantified, where possible, in Tables 3.1. to 3.5. Table 3.4 and 3.5 also describe present and past occurrence of the respective pest within that TFL to provide a starting point for TFL holders working towards the joint solution of pest problems.

Pests of major significance on the coast^a include hemlock dwarf mistletoe (238 900 m³/yr), laminated root rot (261 700 m³/yr), western blackheaded budworm (12 600 ha of defoliation in 1987) and the white pine weevil. Annosus root rot, greenstriped forest looper, and seedling weevils are of minor concern but occur frequently in coastal TFLs.

Interior pest concerns include Armillaria species (23 800 m³/yr), lodgepole pine dwarf mistletoe (52 300 m³/yr), mountain pine beetle (5 500 ha surveyed for damage in 1987), tomentosus root rot (17 300 m³/yr), and western spruce budworm (22 100 ha of defoliation in 1987). Four other pests - black stain root disease, larch dwarf mistletoe (34 400 m³/yr), spruce beetle, and white pine blister rust - are currently of minor significance but occur frequently in the interior TFLs.

a. Coastal TFLs include the following: 1, 6, 10, 19, MFU 19, 24-26, 37-39, 41, 43-47, while interior areas comprise the rest.

Table 3.4. Forested areas which are susceptible to pests

PEST	TFL #1's and Areas (ha)																				Total
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	
Douglas-fir dwarf mistletoe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
hemlock dwarf mistletoe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
larch dwarf mistletoe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
lodgepole pine dwarf mistletoe	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
armillaria root disease	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
laminated root rot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tsunami root rot	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Gross:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
- Net:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a Past or present occurrences within TFL. Impact levels are unknown. (P)
b Unadvised root rot and hemlock root disease susceptible areas are identical.
c Excludes net impacts from TFL #2.

Table 3.5. Surveyed areas (1987) of pest infestation

PEST	TFL #1's and Areas (ha)																				Total
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	
black stain root disease	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Douglas-fir beetle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fennel annulus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
giant spruce looper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
mountain pine beetle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
seedling weevils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
spruce beetle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
western balsam bark beetle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
western blackheaded budworm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
western spruce budworm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
white pine blister rust	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
white pine sawfly	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
porcupine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a These areas are based on a combination of Industry, Canadian Forestry Service and BGS aerial surveys

ACTIVITIES

General comments on future activities or projects are proposed to achieve one of three data needs:

- determine the pest's effect on yield (stand or forest level);
- identify increased yields that may result from pest treatments; and
- develop improved pest treatment strategies and therefore decision making.

Most of the following project proposals can best be addressed through the coordinated action of industry, BCFS and CFS at the regional level. The appropriate pest specialist should be consulted for further elaboration and discussion on project details prior to initiation.

- (1) Provincial Armillaria species and laminated root rot estimates are based on the Vancouver Forest Region surveys. Additional surveys are required in the Interior Regions with work on Armillaria being considered the priority. On the coast, laminated root rot is the primary concern and current modelling efforts should be continued.
- (2) Budworms. The current permanent sample plot (PSP) initiatives for the western spruce budworm in the Kamloops Forest Region should be continued as should modelling efforts. Expansion to Vancouver Island of the PSP program for the western blackheaded budworm is also desirable.

(3) Dwarf mistletoe projects are required for some species:

- Hemlock dwarf mistletoe. Measure incidence in immature stands to increase accuracy both of professional estimates and one prime assumption, i.e. incidence in these stands is reduced from mature ones because of harvesting and silvicultural practices. Also, the area of the Woss Lake study should be expanded to widen the area of applicability of results and check another assumption, i.e. effect on MAI and incidence in immature stands decreases as site quality increases.
- Larch and lodgepole dwarf mistletoe incidence and impact information is largely based on professional estimates and needs improvement. Due to the minor nature of impacts from Larch dwarf mistletoe in comparison to other pests, this survey work is not considered a priority, but localized studies in specific TSAs/TFLs in the Nelson and Kamloops Forest Regions should be considered.

(4) Annosus root rot. Measure the effect on yield in spaced or commercially thinned stands.

(5) Tomentosus root rot incidence and impact estimates are based on small-scale studies conducted by Van Der Kamp^a and Merler^b, 1984 and professional estimates by C. Lewis^c. This work, together with recent FRDA projects, should be examined with the aim of expanding the base of damage appraisal information.

a. University of British Columbia, Vancouver

b. Protection Section, BCFS, Kamloops Forest Region

c. Student, Oregon State University

- (6) White pine weevil. Collect data on weevil incidence and effects on yield in high hazard zones to increase the area of applicability of existing impact models.
- (7) Many other pests require additional survey and damage appraisal work (blackstain root disease, greenstriped forest looper, seedling weevils, and white pine blister rust).

4.1 TFL #1 SKEENA CELLULOSE INCORPORATED

CONCERNS

The mountain pine beetle attacked 2 028 hectares of timber throughout the TFL but is not considered a serious problem as:

- most of the attack is on the operable land base and 90% of it will be salvaged;
- lodgepole pine represents a minor species within the TFL;
- there is a relative absence of mature pine stands; and
- beetle populations are static or have exhibited only minor growth in the last three years.

Current populations of spruce beetle have been at endemic levels since an outbreak in 1982/83. As with pine, spruce represents a minor species and is usually found in mixed stands. To date, the white pine weevil has caused severe^a infestations on 3,000 hectares of spruce plantations of which 500 hectares will require rehabilitation.

The hemlock dwarf mistletoe is present in mature and overmature stands, but decreased incidence levels are expected after harvest in second growth stands due to improved harvesting practices.

a. Greater than 5% of the stems infected.

Porcupines are a problem on spaced sites, attacking the hemlock component of either pure hemlock or hemlock/balsam stands. A survey within the Erlandson Drainage indicated that mortality for 1987 was 1.4%. However, additional data from TSA lands indicates that mortality has doubled from 1986 to 1987, and that cumulative mortality is in the 5-10% range. Lodgepole pine dwarf mistletoe has not been noticed, perhaps due to the relative absence of mature pine stands.

ACTIVITIES

Aerial surveys for pest damage are usually conducted in conjunction with other flights. Salvage will occur on 90% of the infested mountain pine beetle areas. Past control measures for this pest and the spruce beetle have included the selection of trap trees, pheromone baiting, lethal trap trees, and fall and burn programs. Efforts to manage the white pine weevil consist of the continued practice of planting spruce to good sites and otherwise planting alternative species.

Table 4.1.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #1
 DATE: June 22, 1988
 RATED BY: D. Tuomi and
 S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Nonsalvageable		
mountain pine beetle	159 100	15 900	142 800	2 028 ^a
Total	159 100	15 900	142 800	2 028

- a. From 1987 CFS Forest Insect and Disease Survey. Consists of the following areas (ha) of red attack; 156 light; 1560 moderate and 312 severe intensity of attack.

Table 4.1.2 Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #1
DATE: June 22, 1988
RATED BY: D. Tuomi and
S. Taylor

Pest	Impacts Opportunities (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
mountain pine beetle (regen. delay)	108	101	203	203
hemlock dwarf mistletoe ^b	-	14 600	-	107 900
porcupine	-	7 100	-	2 500
Total	108	21 801	203	110 603

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. This pest is considered accounted for in current yield estimations and therefore its impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.1.3 Summary of information used to determine growth impacts

TFL: #1

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)
				Immature	Mature	
hemlock	hemlock	G	6.8	10	50	3 ^c
dwarf	pure and	M	4.7	20	50	6
mistletoe	mixed stands	P	2.7	30	50	15
porcupine	hemlock mixed and spaced stands	M	4.7	-	-	100

a. MAIs were provided by Skeena Cellulose Inc.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

Table 4.1.4 Summary of information used to determine mortality and regeneration delay impacts

TFL: #1

Pest	Net/Gross Ratio (%)	Salvage Factor (%)	Total Volume per hectare (m ³ /ha)	MAX MAI (m ³ /ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m ³ /ha)
mountain pine beetle	100	90	325	3.6	85	307

4.2 TFL #3 SLOCAN FOREST PRODUCTS LIMITED

CONCERNS

Major pest outbreaks were not located in the TFL by CFS-BCFS (1987) aerial mapping flights. However, these flights did locate one patch of two-year-cycle budworm, of approximately 90 ha, near frog mountain and two areas, 7 to 10 trees, of mountain pine beetle infestation on white pine along the Slocan River. This beetle poses no immediate threat, but the spruce beetle does and two areas are currently under salvage.

Calculated net impacts from armillaria root disease, laminated root rot, larch and lodgepole pine dwarf mistletoes amount to 2,850 m³ per year. Other pathogens occurring in this TFL include black stain root disease, white pine blister rust, indian paint fungus, and Fomes pini.

ACTIVITIES

Table 4.2.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #3
DATE: Sept. 21, 1987
RATED BY: T. Dods and
S. Taylor

Pest	Impacts Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
larch dwarf mistletoe	1 500	1 200	3 900	3 100
lodgepole pine dwarf mistletoe	900	700	3 100	2 200
armillaria root disease(ARD) and laminated root(LRR)	1 100 (ARD-900) (LRR-200)	950 (ARD-800) (LRR-150)	6 100	5 200
Total	3 500	2 850	13 100	10 500

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.2.2 Summary of information used to determine growth impacts

TFL: #3

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)		
larch dwarf mistletoe	Fl, Pw ^b	G	4.0	90 ^c	15 ^d	-		
	L, FL	M	3.2	90	15	-		
		P	2.2	90	15	-		
		L	1.65	90	15	-		
lodgepole pine dwarf mistletoe	Pl	G	3.7	90 ^c	25 ^d	-		
		M	2.2	90	25	-		
		P	1.0	90	25	-		
		L	0.75	90	15	-		
	PlF, PlS	G	3.7	90	15	-		
	PlB	M	2.6	90	15	-		
		P	1.3	90	15	-		
		L	0.975	90	15	-		
armillaria root disease and laminated root rot	F	M	2.5	-	-		ARD ^e	LRR ^e
		P	1.4	-	-		5	1
	FC, FCy, FH, FS	G	4.6	-	-		5	1
		M	2.9	-	-		5	1
		P	1.8	-	-		5	1
		L	1.35	-	-		5	1
	FPl, FPY, FDecid, Py	G	3.6	-	-		5	1
		M	2.3	-	-		5	1
		P	1.3	-	-		5	1

a. This number is an estimate of the percentage of the susceptible area that is infected.

b. No deductions were made for the area of Pw or Py types.

c. Norris, pers. comm., Protection Section, BCFS, Nelson Forest Region.

d. Refer to Section 7.1.5 for the derivation of these numbers.

e. Consists of a combined estimate of incidence and effect on MAI, see Section 7.1.4.

4.3 TFL #5 - WELDWOOD OF CANADA LIMITED

CONCERNS

Canadian Forestry Service aerial surveys (1987) did not locate any large pest infestations in the license area. However, the mountain pine and Douglas-fir beetles are minor problems. Single tree attacks due to the mountain pine beetle are coming into the TFL from the Quesnel TSA and have been present for several years without expanding. The white pine weevil has been found on white spruce plantations 10 to 20 feet in height in the northern parts of the TFL. Pathogens are not a concern in this TFL, although the presence of lodgepole pine dwarf mistletoe has yet to be confirmed.

ACTIVITIES

Aerial surveys are conducted annually to detect pest presence and one small patch of Douglas-fir beetle attack is scheduled for salvage in 1987. Planting non-susceptible species in place of white spruce is being considered to reduce the impact of white pine weevil.

Table 4.3.1 Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield)^a and area occupied by susceptible species

TFL: #5
DATE: Dec. 15, 1987
RATED BY: J. Breadon and
S. Taylor

Pest	Impacts Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
armillaria root disease	1 900	-	11 900	-
tomentosus root rot	1 100	-	8 400	-
Total	3 000	-	20 300	-

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.3.2 Summary of information used to determine growth impacts

TFL: #5

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)	Effect on MAI (%)	Effect on Yield (%)
armillaria	F	G	3.43	-	-	5 ^c
root disease	FS, FB	G	3.54	-	-	5
	FPl, FDec	G	3.08	-	-	5
	F, FS, FPl					
	FDec	M	2.37	-	-	5
	F, FS, FPl					
	FDec	P	1.00	-	-	5
tomentosus	S, SF, SB	G	4.11	30 ^d	12 ^d	-
root rot	SPl, SDec	G	2.92	30	12	-
	S, SF, SB,					
	SPl, SDec	M	2.10	30	12	-

a. MAI in these types is based upon the culmination volume, but uses the selected management age rather than the culmination age.

b. This number is an estimate of the percentage of susceptible area that is infected

c. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.1

d. Refer to Section 7.1.4.3 for the derivation of these numbers.

4.4 TFL #6 WESTERN FOREST PRODUCTS LIMITED

CONCERNS

Pests found in this TFL include the following:

- western blackheaded budworm (WBHB). The last two outbreaks of this insect occurred in 1955-57 and 1970-72, and currently (1988) another outbreak appears to be starting. During these outbreaks there was some concern that severe defoliation would lead to immediate growth losses, top-kill, and mortality. Presently, long-term damage to the TFL is unknown.
- greenstriped forest looper. In 1968-69 the last outbreak occurred and caused serious mortality at Atkins Cover and east of Port Alice. The population's collapse was attributed to rodents feeding on the pupae, which over-winter in the duff, and to fungal activity.
- hemlock needle miner last occurred in 1965 and caused negligible damage.
- seedling weevils are present in endemic populations which increase after harvest and can cause significant mortality pockets on plantations.
- white pine weevil. Currently 100 hectares is lightly (< 5%) infested and therefore not at serious risk. This TFL is located in a low hazard weevil zone.

- hemlock dwarf mistletoe is present in significant amounts on most mature and overmature stands, but decreased incidence levels are expected after harvest in second growth stands due to improved harvesting practices.
- laminated root rot and Annosus root rot. Root rot surveys (1977) found infection centers in recent cut-overs on the TFL. Annosus root rot was found at low to moderate levels in space stands and extremely high Armillaria root disease levels were found.

ACTIVITIES

The licensee maintains general surveillance of the TFL for evidence of pest attacks. Cooperation with the CFS and the staff conducting the annual Forest Insect and Disease Survey is maintained.

Other activities conducted in TFL include:

- operational aerial treatments in 1957 and 1972, using DDT and fenitrothion, respectively, against the WBHB. Another aerial treatment tested phosphamidon and dimethoate in 1965 on the hemlock needle miner.
- salvage of affected timber in areas of mortality caused by greenstriped forest looper.

- planting in pockets of mortality, which have been attacked by seedling weevils. More specific control actions can be found in Hepner, undated.

- reducing the occurrence of hemlock dwarf mistletoe in second-growth stands through prescribed burns and the removal of infected residuals following harvest. Sanitation cuttings of 213 hectares occurred at Jenne Landing (1972) and Holberg (1979).

Table 4.4.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #6
DATE: April 11, 1988
RATED BY: J. Leasing and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	16 900	-	86 900
armillaria root disease (ARD) and laminated root rot (LRR)	-	1 300 (ARD-200) (LRR-1 100)	-	2 100
Total	-	18 200	-	89 000

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore their impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.4.2 Summary of information used to determine growth impacts

TFL: #6

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)	Effect on Yield (%)
				Immature ^c	Mature ^c		
hemlock	hemlock,	G	13.6 (12.0) ^d	10	50	Pure Mixed	-
dwarf	pure and	M	9.7 (8.9)	20	50	5 3	-
mistletoe	mixed	P	4.3	30	50	10 6	-
	stands					25 15	-
armillaria	pure & mixed	G	12.7	-	-	-	ARDE LRRE
root	D.fir (natural	M	8.2	-	-	-	1 7
disease &	& unspaced)	P	3.0	-	-	-	1 4
laminated	pure D.fir	G	14.3	-	-	-	1 1
root rot	(planted &	M	9.2	-	-	-	1 7
	spaced)	P	3.3	-	-	-	1 4
	pure D.fir	G	11.8	-	-	-	1 1
	(planted &					-	1 6
	spaced)					-	

- 34 -

- MAIs were provided by Western Forest Products Limited.
- This number is an estimate of the percentage of susceptible area that is infected.
- Refer to Section 7.1.5 for the derivation of these numbers.
- These MAIs apply to pure and mixed hemlock stands which have been spaced and naturally regenerated.
- Consists of a combined estimate of incidence and effect on MAI, see Section 7.1.4.

4.5 TFL #8 - POPE AND TALBOT LTD.

CONCERNS

Aerial mapping flights in 1987 indicated that the infested area of mountain pine beetle attack has doubled over 1986. This infestation of 2,000 hectares represents the major pest concern of the licensee. In addition, the Regional Pathologist has indicated that armillaria root disease, tomentosus root rot, laminated root rot, black stain root disease, lodgepole pine and larch dwarf mistletoe occur in the TFL.

ACTIVITIES

There was an active salvage program from 1973 to 1986 for mountain pine beetle and most of the mortality has been removed. Harvest plans have recently been adjusted to allow for expanded salvage of new attack.

Table 4.5.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #8
DATE: Jan. 5, 1988
RATED BY: G. Eichel and S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested area (ha)
	Gross	Nonsavable		
mountain ^a pine beetle	87 200	_b	_b	2 000
Total	87 200	-	-	2 000

a. This information was compiled by the Nelson Forest Region from 1987 aerial survey flights and includes the area of red attack.

b. These estimates were not available, but salvage should be considerable as harvest rates were recently increased.

Table 4.5.2 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #8
 DATE: Jan. 8, 1988
 RATED BY: G. Eichel and
 S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
armillaria root disease (ARD) and laminated root rot (LRR)	-	4 200 (ARD-3 500) (LRR- 700)	-	34 000
larch dwarf mistletoe	-	8 600	-	30 400
lodgepole pine dwarf mistletoe	-	14 300	-	28 700
Total	-	27 100	-	93 100

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.5.3 Summary of information used to determine growth impacts

TFL: #8

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/hr)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)		
larch dwarf mistletoe	FL,PW,LF L	G	2.7	90 ^b	15 ^c	-		
		M	1.7	90	15	-		
		P	0.5	90	15	-		
lodgepole pine dwarf mistletoe	Pl	G	4.7	90 ^b	25 ^c	-		
		M	3.0	90	25	-		
		P	1.8	90	25	-		
	PlF, PlS	G	4.3	90	15	-		
		M	2.7	90	15	-		
		P	2.2	90	15	-		
	Pl Decid	G	4.3	90	15	-		
		M	2.7	90	15	-		
armillaria root disease and laminated root rot	F	G	3.4	-	-		ARD ^d	LRR ^d
		M	1.5	-	-		5	1
		P	0.5	-	-		5	1
	FC,FCy,FH,FS	G	3.6	-	-		5	1
		M	1.4	-	-		5	1
		P	0.5	-	-		5	1
	FPl,FPy,FDecid,Py	G	2.5	-	-		5	1
		M	1.2	-	-		5	1
		P	0.6	-	-		5	1
	FL,PW,LF L	G	2.7	-	-		5	1
		M	1.7	-	-		5	1
		P	0.5	-	-		5	1

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Norris, pers. comm., Protection Section, BCFS, Nelson Forest Region.

c. Refer to Section 7.1.5 for the derivation of these numbers.

d. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

4.6 TFL #10 WELDWOOD OF CANADA LIMITED

CONCERNS

Pests found in the TFL include the following:

- white pine weevil. There are 300 hectares of Sitka spruce plantations that have experienced severe attack but have not been rehabilitated. The weevil is not a major problem because Sitka spruce comprises a minor component of the TFL's cut.
- hemlock dwarf mistletoe is present in significant amounts on most mature and overmature stands, but decreased incidence levels are expected after harvest in second growth stands due to normal harvesting and silvicultural practices.
- estimates of impacts due to laminated root rot are provided because it has been identified in nearby TSA lands.
- white pine blister rust occurs on western white pine within the TFL, but this tree constitutes a minor portion of the licensee's cut.

ACTIVITIES

TFL staff regularly monitors the incidence and levels of pest damage during the course of their normal duties. In addition, communication is maintained with BCFS staff on aerial and ground surveys.

Corrective action for the white pine weevil involves planting non susceptible species, and no Sitka spruce has been planted since 1982. Western white pine stems infected with blister rust are removed during normal brush and stocking control operations.

Normal harvesting and silvicultural practices used to reduce the impact of hemlock dwarf mistletoe include felling infected residuals (three meter knock down clause) and prescribed burns.

Table 4.6.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #10
DATE: April 12, 1988
RATED BY: R. Beaumont
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	5 200	1 800	18 400	8 000
laminated root rot	4 200	3 200	10 400	6 500
Total	9 400	5 000	28 800	14 500

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.6.2 Summary of information used to determine growth impacts

TFL: #10

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on ^c MAI (%)	Effect on Yield (%)

				Immature	Mature		
hemlock	H	G	12.8	10	50	5	-
dwarf		M	6.6	20	50	10	-
mistletoe		P	2.8	30	50	25	-
		L	2.1	40	50	30	-
	HF,HC,HB	G	11.4	10	50	3	-
	HS,HDecid	M	6.4	20	50	6	-
		P	4.8	30	50	15	-
		L	3.6	40	50	20	-
laminated	F	G	10.8	-	-	-	11 ^d
root rot		M	7.9	-	-	-	5
		P	4.1	-	-	-	1.9
		L	1.5	-	-	-	-
	FH & FC	G	12.3	-	-	-	14
		M	8.8	-	-	-	6
		P	3.6	-	-	-	3
		L	1.5	-	-	-	-

a. MAIs were provided by Weldwood of Canada Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

d. This number is an estimate of the percentage of susceptible area that is infected.

4.7 TFL #13 GALLOWAY LUMBER COMPANY

CONCERNS

Pest outbreaks were not found in this TFL by CFS-BCFS (1987) aerial mapping flights. However, these flights did locate six to seven areas of mountain pine beetle attack on lodgepole pine in the Bull River drainage.

Calculated net impacts from armillaria root disease, larch and lodgepole pine dwarf mistletoes amounted to 2,700 m³ per year. Other pathogens occurring in this TFL include black stain root disease, white pine blister rust, indian paint fungus, and Fomes pini.

ACTIVITIES

Table 4.7.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #13
DATE: Sept. 22, 1987
RATED BY: W. Damstrong
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
larch dwarf mistletoe	450	400	1 300	1 100
lodgepole pine dwarf mistletoe	2 500	1 900	5 900	4 100
armillaria root disease	500	400	4 200	2 900
Total	3 450	2 700	11 400	8 100

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.7.2 Summary of information used to determine growth impacts

TFL: #13

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on ^b Yield (%)
larch dwarf mistletoe	FL, PW, LF, L	G	3.2	90 ^c	15 ^d	-
		M	1.7	90	15	-
		P	1.3	90	15	-
lodgepole pine dwarf mistletoe	Pl	G	4.6	90 ^b	25 ^c	-
		M	3.2	90	25	-
		P	1.8	90	25	-
	Pl mixed stands	G	3.9	90	15	-
		M	2.3	90	15	-
		P	1.2	90	15	-
armillaria root disease	F	G	4.7	-	-	5
		M	2.8	-	-	5
		P	1.2	-	-	5
	FC, FH, FS, FB	G	3.2	-	-	5
		M	2.8	-	-	5
		P	1.2	-	-	5
	FL, PW, LF, L	G	3.2	-	-	5
		M	1.7	-	-	5
		P	1.3	-	-	5
	FPl, FPY, FDecid	G	4.7	-	-	5
		M	2.3	-	-	5
		P	1.2	-	-	5

- a. This number is an estimate of the percentage of the susceptible area that is infected.
- b. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.
- c. Norris, pers, comm., Protection Section, BCFS, Nelson Forest Region.
- d. Refer to Section 7.1.5 for the derivation of these numbers.

4.8 TFL #14 Crestbrook Forest Industries Limited

CONCERNS

Spruce beetle infestations occurred in the McMurdo, Cariboo, and Vowell Creek drainages and were associated with blowdown or slash from fresh logging. The western balsam bark beetle attacked isolated patches of mature and overmature alpine fir throughout the TFL. During a recent yield analysis a 5, 10 and 20% volume reduction was made to age class 9 spruce, age class 8 alpine fir, and age class 9 alpine fir stands respectively to account for the mortality caused by the balsam bark beetle. In addition, this mortality may cause an associated natural enhancement of Armillaria which could have further implications on future yields.

The 2-year-cycle budworm caused heavy defoliation in mature spruce/balsam stands in the McMurdo and Vowell Creek drainages. Heavy defoliation is expected again in 1989, but damage is expected to be minimal.

Two lodgepole pine pathogens present in the TFL are the western gall rust and lodgepole pine dwarf mistletoe. While Armillaria is assumed to occur in the TFL because of general distribution maps, its presence needs to be verified.

ACTIVITIES

Activities conducted in 1986-87 included:

- a mapping flight.
- ground monitoring of the 2-year-cycle budworm and western balsam bark beetle populations, with the aim of conducting salvage programs if the level of attack becomes moderate or severe.
- treatment of mistletoe infected pine stands during the active logging phase with fringe cleaning being carried out in some harvested areas.

Table 4.8.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #14
DATE: Feb. 15, 1988
RATED BY: D. Rounsville
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
lodgepole pine dwarf mistletoe	--	1 400	-	18 500
armillaria root disease	-	500	-	3 700
Total	-	1 900	-	22 200

a. Impacts to LRSY will occur over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.8.2 Summary of information used to determine growth impacts

TFL: #14

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on ^b Yield (%)
lodgepole pine dwarf mistletoe	Pl	G	5.5	10 ^c	25 ^d	-
		M	3.5	10	25	-
		P	2.1	10	25	-
	PlF,PlS	G	4.3	10	15	-
		M	3.4	10	15	-
		P	1.55	10	15	-
	PlDecid	P	1.50	10	15	-
armillaria root disease	F	G	3.28	-	-	5 ^d
		M	2.04	-	-	5
		P	1.4	-	-	5
	FC, FH, FS	G	3.19	-	-	5
		M	3.11	-	-	5
		P	1.8	-	-	5
	FPI, FPY	G	3.6	-	-	5
		M	3.18	-	-	5
		P	1.3	-	-	5
	FL, PW, LF	G	4.0	-	-	5
		M	3.2	-	-	5

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

c. Rounsville, pers. comm., Crestbrook For. Ind. Ltd., Cranbrook.

d. Refer to Section 7.1.5 for the derivation of these estimates.

4.9 TFL #15 WEYERHAEUSER CANADA LIMITED

CONCERNS

Aerial surveys of this TFL located 2,350 hectares of western spruce budworm defoliation and 100 hectares of mountain pine beetle damage. The budworm infestation is in its first year of attack with 80% of the area lightly infested. Lodgepole pine terminal weevil and western gall rust are present in immature lodgepole pine.

Ground surveys have located modest amounts (see table 4.9.2) of lodgepole pine, larch and Douglas-fir dwarf mistletoe in the TFL. Laminated root rot has been identified, through ground checks in the TFL and its impacts should be minor. Distribution maps of armillaria and blackstain root diseases include the licence area; but, to date, the presence of these diseases has yet to be confirmed.

ACTIVITIES

Mountain pine beetle attacks are monitored yearly and salvaged where necessary. Salvage logging for this pest occurred on 18 hectares in 1987, with 13 more hectares planned in the future. Also, normal inventory cruising has consistently noted the incidence of dwarf mistletoe on sample plots.

Table 4.9.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #15
 DATE: Oct. 2, 1987
 RATED BY: D. Peaker and
 S. Taylor

Pest	Impact (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area ^b (ha)
	Gross	Nonsalvageable		
mountain pine beetle	1 400	300	500	100 ^a
Total	1 400	300	500	100

a. Determined from 1987 aerial mapping flights.

Table 4.9.2 Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species.

TFL: #15
DATE: Oct. 2, 1987
RATED BY: S. Taylor and D. Peaker

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible ^c Area (ha)	
	Gross	Net	Gross	Net ^d
mountain pine beetle regeneration delay	30	10	70	20
western spruce ^e budworm	-	-	2 350	(< 2 350)
Douglas-fir dwarf mistletoe	700	650	3 100	2 950
larch dwarf mistletoe	550	500	1 100	1 070
lodgepole pine dwarf mistletoe	750	750	2 550	2 550
laminated root rot	320	290	7 150	6 650
Total	2 350	2 200	16 320	15 590

a. Impacts to LRSY will occur yearly over an extended time frame.

b. All pests, except for mountain pine beetle, are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

c. All areas were obtained from surveys except for laminated root rot.

d. Net areas only exclude environmentally sensitive areas.

e. Impacts were not calculated for this pest due to an absence of historical data on occurrence. Also, net areas were not determined but will be less than the gross value.

Table 4.9.3 Summary of information used to determine growth impacts

TFL: #15

Pest	Species Groups	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on ^b MAI (%)	Effect on Yield (%)
Douglas-fir dwarf mistletoe	F, FP1 FPY, FL, FDecid	G M P	3.5 3.2 0.8	100 100 100	15 15 15	- - -
larch dwarf mistletoe	LF, L	G M P L	3.8 2.85 2.1 1.6	100 100 100 100	15 15 15 15	- - - -
lodgepole pine dwarf mistletoe	Pl, PlF, PlS + PlB, PlDecid	G M P L	3.9 2.8 1.7 1.275	100 100 100 100	15 15 15 15	- - - -
laminated root rot	F, FC+FCy FH, FS, FP1	G M	3.5 1.8	- -	- -	3 ^c 3
rot	FPY, FL, FDecid	P L	0.8 0.6	- -	- -	3 3

- a. Surveyed areas were used, therefore all dwarf mistletoe incidence figures are 100%. This number is an estimate of the percentage of susceptible area that is infected.
- b. See Section 7.1.5 for the derivation of these numbers.
- c. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

Table 4.9.4 Summary of information used to determine mortality and regeneration delay impacts

TFL: #15

Pest	Net/Gross Ratio (%)	Salvage Factor (%)	Total Volume Per Hectare (m ³ /ha)	MAX MAI (m ³ /ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m ³ /ha)
mountain pine beetle	57	67	230	3.1	74	230

- 55 -

4.10 TFL #18 CLEARWATER TIMBER PRODUCTS LIMITED

- No Response -

4.11 TFL #19 CANADIAN PACIFIC FOREST PRODUCTS LIMITED

CONCERNS

Pests found in this TFL include the following:

- Douglas-fir beetles have occasionally caused pockets of mortality, after drought conditions, in the Upper Gold Valley.
- The greenstriped forest looper occurred along the Muchalat and Zeballos Inlets in 1959-1962. In 1960, 10,500 hectares of hemlock and western red cedar were defoliated causing significant mortality.
- The mountain pine beetle was present in 1962-1963 near the Muchalat Inlet along the Houston River.
- seedling weevils are present in endemic numbers and occasionally cause damage which requires supplementary planting.
- western blackheaded budworm. Currently this pest is not causing damage in the TFL, but past outbreaks occurred in 1955-56 and 1972-73 above 600 meters in elevation near the Zeballos, Tahsish and Nomash Rivers, and in the Kyuquot area.
- white pine weevil. This TFL is located in a high-hazard zone for weevils and as such, they have damaged numerous plantations with some areas requiring rehabilitation. There are 3,500 ha of plantations containing Sitka spruce, which consist on average of 20% Sitka spruce, that are susceptible to this pest.

- The damage caused by root diseases has been minimal.
- Hemlock dwarf mistletoe is present in mature and overmature stands, but incidence levels are expected to be reduced in second growth stands (with the exception of some of the oldest second growth stands located in the Burman and Espinosa River valleys) due to improved harvesting and silviculture practices.

ACTIVITIES

Activities conducted in this TFL include:

- clipping and burning of infected Sitka spruce leaders on numerous plantations from 1979-1984 to control white pine weevil. At its peak (1984), the program covered some 450 hectares. Also, areas best suited to Sitka spruce are mostly planted with non susceptible species such as hemlock, cedar and balsam, with the spruce component, if present, being kept below 15%.
- a cooperative research trial that was initiated in 1986 to test whether white pine weevil could be controlled by enhanced clipping with parasite and predator releases. Other trials are planned to test alternate controls.
- removing residual trees and prescribed burning are used to control hemlock dwarf mistletoe.

Table 4.11.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #19
DATE: April 28, 1988
RATED BY: G. Fraser and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	23 600	19 700	70 900	61 500
Total	23 600	19 700	70 900	61 500

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. This pest is considered accounted for in current yield estimations and therefore it's impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.11.2 Summary of information used to determine growth impacts

TFL: #19

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^{b,c} (%)		Effect on ^c MAI (%)	
				Immature	Mature	Pure	Mixed
hemlock	hemlock, pure	G	12.5	10	50	5	3
dwarf	and mixed	M	9.9	20	50	10	6
mistletoe	stands	P	6.7	30	50	25	15

a. MAIs were provided by Canadian Pacific Forest Products Ltd.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

4.12 MANAGED FARM UNIT #19 MACMILLAN BLOEDEL LIMITED

CONCERNS

Pests found in this TFL include the following:

- white pine weevil on Sitka spruce plantations. The MFU is located within a high hazard weevil zone.
- hemlock dwarf mistletoe is present in the mature canopy of many hemlock stands, but decreased incidence levels are expected after harvest in second-growth stands due to improved harvesting and silvicultural practices.
- laminated and annosus root rots are of concern in the TFL.
Consideration of both root rots will be important in the management of second-growth forests.
- a fungus (Rhizina species) was identified as a likely cause of some planted seedling mortality. Rhizina, a poor competitor with other soil fungi, is a mortality factor only on newly burned sites.

ACTIVITIES

Normally, aerial patrols are flown on an annual basis to map pest infestations. Significant problem areas are checked on the ground. All woodland field staff are expected to watch for unusual pest activity in the course of their normal duties and to report such observations to the Divisional Forester for follow up. In addition, MacMillan Bloedel staff maintain close liaison with the CFS and BCFS.

Other activities conducted in the TFL include:

- reducing the occurrence of hemlock dwarf mistletoe in second growth stands through burning and removal of trees following harvest.
- initiation of a study on laminated root rot to hazard rate sites according to their potential in providing conditions where Phellinus causes unacceptable volume and mortality losses. Effective guidelines will be developed which optimize the control of the disease.
- a re-inventory of this MFU is underway and will be completed in 1989. Root rot surveys will be included in this inventory to allow for a more accurate determination of impacts.

Table 4.12.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

MANAGEMENT FARM UNIT: #19
DATE: May 16, 1988
RATED BY: J. Kumi and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible/Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	8 600	-	30 200
laminated root rot	-	56 200	-	82 900
Total	-	64 800	-	113 100

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore their impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.12.2 Summary of information used to determine growth impacts

MANAGEMENT FARM UNIT: #19

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)		Effect on Yield (%)
				Immatured	Matured	Pured	Mixedd	
hemlock dwarf mistletoe	hemlock, pure and mixed stands	15C	3.6	30	50	30	18	-
		18	5.0	27	50	25	15	-
		21	6.6	24	50	20	12	-
		24	8.2	20	50	15	9	-
		27	9.9	17	50	10	6	-
		30	11.8	14	50	7	4	-
		33	13.7	10	50	5	3	-
		36	16.0	10	50	5	3	-
		39	18.0	10	50	5	3	-
		42	20.0	10	50	5	3	-
laminated root rot	F, FH, FC,	20 ^e	1.7	-	-	-	-	2 ^f
		24	2.8	-	-	-	-	4
		29	4.1	-	-	-	-	6
		33	5.6	-	-	-	-	9
		37	7.1	-	-	-	-	10
		42	8.9	-	-	-	-	12
		46	10.7	-	-	-	-	14
		51	12.6	-	-	-	-	15
		55	14.5	-	-	-	-	16
		60	16.6	-	-	-	-	18

- 63 -

a. MAIs were provided by MacMillan Bloedel Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. King's site index at a total reference age of 50.

d. Refer to Section 7.1.5 for the derivation of these numbers.

e. King's site index at a total reference age of 100.

f. Consists of a combined estimate of incidence and effect on MAI, see Section 7.1.4.2.

4.13 TFL #23 WESTAR TIMBER LIMITED

CONCERNS

Currently, the mountain pine beetle and western balsam bark beetle infest 700 and 4 hectares respectively, and the resulting damage is minimal. However, mountain pine beetle populations have expanded over the last 2 years with much of the new activity located near Castlegar and the Monashee Range. The western spruce budworm is causing defoliation west of Nakusp in Block A. Other insect pests, which have caused problems in the past, include the hemlock looper and larch casebearer.

The white pine blister rust has infected all white pine stands causing significant mortality. Infection rates within stands of 50% are common and occasionally reach 75%. Calculated net impacts resulting from other pathogens, which include lodgepole pine and larch dwarf mistletoes, armillaria root disease, and laminated root rot, are 53,500 m³/year. However, selective logging of white pine stands to control white pine blister rust may intensify Armillaria problems.

ACTIVITIES

A white pine management program is in place and includes surveys, salvage, and the development of resistant trees. Salvage operations have been conducted in the past on the spruce beetle and hemlock looper.

Table 4.13.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #23
DATE: Nov. 10, 1987
RATED BY: C. Smith and
S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested area ^a (ha)
	Gross	Nonsalvable		
mountain pine beetle	34 500	18 300	-	700
western balsam bark beetle	-	-	-	4
Total	34 500	18 300	-	704

a. Determined from 1987 aerial mapping flights.

Table 4.13.2 Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #23
DATE: Nov. 10, 1987
RATED BY: C. Smith and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
mountain pine beetle (regeneration delay)	400	200	700	400
larch dwarf mistletoe	28 600	23 700	63 600	52 000
lodgepole pine dwarf mistletoe	26 900	14 400	41 300	20 900
armillaria root disease (ARD) and laminated root rot (LRR)	19 800 (ARD-16 500) (LRR-3 300)	15 400 (ARD-12 800) (LRR-2 600)	108 100	81 200
Total	75 700	53 700	213 700	154 500

a. Impacts to LRSY will occur yearly over an extended time frame.

b. All pests, except the mountain pine beetle, are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.13.3 Summary of information used to determine growth impacts

TFL: #23

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)		
larch	FL,LF	G	4.0	90 ^b	15 ^c	-		
dwarf		M	3.2	90	15	-		
mistletoe		P	2.2	90	15	-		
lodgepole	Pl	G	5.2	90 ^b	25 ^c	-		
pine dwarf		M	3.2	90	25	-		
mistletoe		P	2.1	90	25	-		
	PlDecid	M	2.5	90	15	-		
		P	1.875	90	15	-		
	FP1	G	3.6	90	15	-		
		M	2.3	90	15	-		
		P	1.3	90	15	-		
							ARD ^d	LRR ^d
armillaria	F	G	4.3	-	-	5	1	
root		M	2.5	-	-	5	1	
disease		P	1.4	-	-	5	1	
and	FC,FCy	G	4.6	-	-	5	1	
laminated	FH,FS	M	2.9	-	-	5	1	
root rot		P	1.8	-	-	5	1	
	FP1,FPy	G	3.6	-	-	5	1	
	FDecid	M	2.3	-	-	5	1	
	Py	P	1.3	-	-	5	1	
	FL	G	4.0	-	-	5	1	
		M	3.2	-	-	5	1	
		P	2.2	-	-	5	1	

- This number is an estimate of the percentage of susceptible area that is infected
- Norris, pers. comm., Protection Section, BCFS, Nelson Forest Region.
- Refer to Section 7.1.5 for the derivation of these numbers.
- Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

Table 4.13.4 Summary of information used to determine mortality and regeneration delay impacts

TFL: #23

Pest	Net/Gross Ratio (%)	Salvage Factor (%)	Total Volume per Hectare (m ³ /ha)	MAX MAI (m ³ /ha/yr)	Culmination Age (yrs)	Volume at Culmination Age (m ³ /ha)
mountain pine beetle	53	0	200.0 ^a	3.2	66	210.2

a. Morris, Pers. comm., Protection Section, BCFS, Nelson Forest Region.

4.14 TFL #24 WESTERN FOREST PRODUCTS LIMITED

CONCERNS

Pests found in this TFL include the following:

- western blackheaded budworm (WBHB). In addition to the current (1987) outbreak of 3,540 hectares, previous ones have occurred in 1958-60 and 1972-73. Presently, long-term damage to the TFL is unknown.
- die-back fungus (Siroccocus strobilinus) has been observed (survey-1978) as a casual factor of double leadering in Sitka spruce plantations.
- spruce aphid was observed in 1983 and increased activity was noted in 1984. High aphid populations have caused scattered mortality and moderate to severe defoliation in planted seedlings on both immature and mature Sitka spruce trees throughout the TFL.
- seedling weevils are present in endemic populations that increase after harvest and can cause significant mortality pockets on plantations.
- hemlock dwarf mistletoe is present in mature and overmature stands, but decreased incidence levels are expected after harvest in second growth stands due to improved harvesting practices.

ACTIVITIES

The licensee maintains general surveillance of the TFL for evidence of pest attacks. Cooperation with the CFS and the staff conducting the annual forest Insect and Disease Surveys is maintained.

Other activities conducted in this TFL include:

- aerial treatments to control WBHB (1960 - operationally with DDT and experimentally using Bacillus thuringiensis).
- establishment of permanent sample plots, in conjunction with a BCFS study, to measure the effects of WBHB on timber values.
- planting in pockets of mortality that have been attacked by seedling weevils. More specific control actions are recommended in Hepner, undated.
- reducing the occurrence of hemlock dwarf mistletoe in second growth stands through prescribed burns and the removal of infected residuals following harvest.

Table 4.14.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #24
DATE: April 11, 1988
RATED BY: J. Leesing and
S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Nonsalvable		
western ^a blackheaded budworm	-	-	-	3 540 ^b
Total	-	-	-	3 540

- a. This pest is considered accounted for in current yield estimations and any impacts would be considered yield gain opportunities to be obtained after appropriate treatments.
- b. From 1987 CFS Forest Insect and Disease Survey. Consists of the following areas (ha); 897 light and 2,643 moderate intensity of attack.

Table 4.14.2 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #24
DATE: April 11, 1988
RATED BY: J. Leasing
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	3 800	-	19 300
Total	-	3 800	-	19 300

a. Impacts to LRSY will occur yearly over an extended time frame.

b. This pest is considered accounted for in current yield estimations and therefore its impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.14.3 Summary of information to determine growth impacts

TFL: #24

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^{b,c} (%)		Effect on ^c MAI (%)	
				Immature	Mature	Pure	Mixed
hemlock	hemlock	G	13.6	10	50	5	3
dwarf	pure and	M	9.7	20	50	10	6
mistletoe	mixed stands	P	4.3	30	50	25	15

a. MAIs were provided by Western Forest Products Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

4.15 TFL #25 WESTERN FOREST PRODUCTS LIMITED

CONCERNS

Pests found in this TFL include the following:

- western blackheaded budworm (WBHB). Currently (1988), another outbreak appears to be starting and long-term damage from this pest is unknown.
- seedling weevils are present in endemic populations that increase after harvest and can cause significant mortality pockets on plantations.
- white pine weevil. Monitoring of Sitka spruce plantations on the TFL area has revealed only light damage, possibly due to the generally cooler climates prevalent in the area, and planting alternative species is a common practice. Currently, 100 hectares is lightly (<5%) infested and only blocks 2 & 3 appear to be located in a high-hazard weevil zone.
- hemlock dwarf mistletoe is present in mature and overmature stands, but decreased incidence levels are expected after harvest due to improved harvesting practices.

ACTIVITIES

The licensee maintains general surveillance of the TFL for evidence of pest attacks. Cooperation with the CFS and the staff conducting the annual Forest Insect and Disease Surveys is maintained.

Other activities conducted in the TFL include:

- operational aerial treatments (1957) using DDT against the WBHB.
- planting in pockets of mortality that have been attacked by seedling weevils. More specific control actions are recommended in Hepner, undated.
- reducing the occurrence of hemlock dwarf mistletoe in second growth stands through prescribed burns and the removal of infected residuals following harvest.

Table 4.15.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #25
DATE: April 11, 1988
RATED BY: J. Leasing and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	22 300	8 100	90 000	41 800
laminated root rot	-	9 400	-	10 800
Total	22 300	17 500	90 000	52 600

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore their impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.15.2

Summary of information used to determine growth impacts

TFL: #25

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)		Effect on Yield (%)
				Immature ^c	Mature ^c	Pure ^c	Mixed ^c	
hemlock dwarf mistletoe	hemlock,	G	13.6	10	50	5	3	-
	pure and	M	9.7	20	50	10	6	-
	mixed stands	P	4.3	30	50	25	15	-
laminated root rot	D.fir, pure	G	11	-	-	-	-	-
	and mixed	M	8	-	-	-	-	-
	stands	P	3	-	-	-	-	-
<div> <div> <div>Southern</div> <div>TSA'sd</div> </div> <div> <div>Northern</div> <div>TSA'sd</div> </div> </div>								
<div> <div>14</div> <div>7</div> </div>								
<div> <div>10</div> <div>5</div> </div>								
<div> <div>4</div> <div>2</div> </div>								

a. MAI's were provided by Western Forest Products Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

d. Consists of a combined estimate of incidence and effect on MAI, see Section 7.1.4.

4.16 TFL #26 DISTRICT OF MISSION

CONCERNS

There is little evidence of insect problems in this TFL, but pathogens including minor evidence of root rots and hemlock dwarf mistletoe have been found. This mistletoe is the predominant pest with the heaviest infestations occurring in scattered clumps of residual trees that were left over from logging in the 1930's and 1940's.

ACTIVITIES

Annual aerial overview are undertaken in conjunction with the BCFS and the CFS. The hemlock dwarf mistletoe problem is being reduced through normal harvesting with the removal of residuals.

Table 4.16.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #26
DATE: June 17, 1988
RATED BY: B. Webster
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	250	200	3100	3050
Total	250	200	3100	3050

a. Impacts to LRSY will occur yearly over an extended time frame.

b. This pest is considered for in current yield estimations and therefore its impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.16.2 Summary of information used to determine growth impacts

TFL: #26

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^{a,b} (%)		Effect on ^b MAI (%)
				Immature	Mature	
hemlock	hemlock,	M	4.5	20	50	10
dwarf	mixed	G	5.5	10	50	3
mistletoe	stands	M	5.5	20	50	6
		P	2.7	30	50	15

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Refer to Section 7.1.5 for the derivation of these numbers.

4.17 TFL #30 NORTHWOOD PULP AND TIMBER LIMITED

CONCERNS

Canadian Forestry Service aerial surveys (1987) indicated negligible mortality (4 Douglas-fir and 11 white spruce trees) due to insect pests. However, tomentosus root rot and Ips perturbatus are a problem on white spruce throughout this TFL, with I. perturbatus typically appearing after spruce beetle attacks. Another white spruce pest, the white pine weevil, causes multiple leaders and growth impacts in immature spruce on good sites, where trees up to 4 meters in height are infested. The Douglas-fir beetle occurs as a secondary pest near laminated root rot areas in Douglas-fir stands.

ACTIVITIES

Douglas-fir stands on good sites are replanted after harvest with lodgepole pine and white spruce, to reduce impact by laminated root rot. Active pest management has been used in the past to control spruce beetle outbreaks with surveys, trap trees, pheromone containment, and salvage logging all being employed. In 1987, only blowdown areas were surveyed due to the absence of other mortality agents.

Table 4.17.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #30
DATE: Nov. 23, 1987
RATED BY: M. Spike and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
laminated root rot	300	300	1 800	1 800
tomentosus root rot	15 600	14 800	112 700	103 900
Total	15 900	15 100	114 500	105 700

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.17.2 Summary of information used to determine growth impacts

TFL: #30

Pest	Species Group	Site Class	MAX MAI (m ³ /ha/yr)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield(%)
laminated root rot	F, FS, FB FPl	G, M, P	3.8	-	-	5 ^b
tomentosus root rot	S, B	G	3.9	30 ^c	12 ^c	-
	S	M	2.5	30	20	-
	S	P	1.3	30	20	-
	SP1	G, M, P	3.5	30	12	-
	SDecid	G, M, P	3.7	30	12	-

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Consists of a combined estimate of incidence and effect on MAI, see Section 7.1.4.

c. Refer to Section 7.1.4.3 for the derivation of these estimates.

4.18 TFL #33 FEDERATED COOPERATIVES LIMITED

CONCERNS

Aerial surveys conducted by the CFS delineated approximately 800 hectares of western spruce budworm attack, but most of this attack is lightly infested and causing no mortality. The mountain pine and spruce beetles are currently not present in the TFL, but minor spruce beetle problems periodically surface and are associated with windthrow. Low levels of western balsam bark beetle are suspected of causing scattered balsam mortality in mature stands. As a result, a 5% volume reduction to the mature balsam (age 121 +) has been allowed for in the Annual Allowable Cut calculations.

Two pathogens on Douglas-fir, armillaria root disease and laminated root rot, are present in the TFL but do not appear to be causing noticeable pockets of mortality. Also, white pine blister rust is present, but is not considered a problem as white pine is a minor species (less than 5% of licence volume) and harvesting is active in the forest types where it is found.

ACTIVITIES

Currently pest activities do not warrant special attention and problem areas are handled through harvesting.

Table 4.18.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #33
DATE: Dec. 17, 1987
RATED BY: G. Holfeld and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
western spruce budworm ^c	-	-	800	< 800 ^d
armillaria root disease (ARD) and laminated root rot (LRR)	1 360 (ARR-680)	1 340 (ARR-670)	3 180	3 130
tomentosus root rot	10	10	60	60
Total	1 370	1 350	4 040	3 990

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.
- c. Impacts were not calculated for this pest as most of the attacked area was lightly infested.
- d. Net areas were not determined and will be less than this value.

Table 4.18.2 Summary of information used to determine growth impacts

TFL: #33

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)
armillaria	F	G	3.8	-	-	6 ^b
root disease		M	3.4	-	-	6
and laminated		P	1.6	-	-	6
root rot	FC + FCy, FH,	G	4.0	-	-	6
	FS	M	3.2	-	-	6
		P	2.1	-	-	6
	FP1, FPy,	M	2.6	-	-	6
	FDec	P	2.4	-	-	6
	FL, PW,	G	4.2	-	-	6
	LF, L	M	4.0	-	-	6
		P	2.2	-	-	6
tomentosus ^c	F	G	3.8	1.5 ^d	20 ^d	-
root rot		M	3.4	1.5	20	-
		P	1.6	1.5	20	-

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

c. Occurs on the spruce component of pure Douglas-fir stands, i.e. only 5% of pure Douglas-fir stands are considered susceptible.

d. Refer to Section 7.1.4.3 for the derivation of these numbers.

4.19 TFL #35 Weyerhaeuser Canada Limited

CONCERNS

The aerial overview survey of this TFL located 16 800 hectares of western spruce budworm defoliation, including 3 200 hectares of moderate and severe infestation. However, this pest is not a major concern due to even-aged management practices in the Douglas-fir stands.

Future problems resulting from the mountain pine beetle should be minimal due to improved access and the scattered nature of susceptible stands. The western balsam bark beetle is prevalent in Balsam stands; but, due to overstocking in immature stands and Balsam being only a minor component of the TFL's cut, this pest is a minor concern.

Armillaria and black stain root diseases are dominant pathogens and appear to be a problem once trees lose vigour.

ACTIVITIES

Activities conducted in 1986-87 include:

- an aerial overview survey, and
- the placement of pheromone traps, ground probes, and single tree treatments to control the mountain pine beetle. Salvage logging did not occur in the TFL, but one area outside the TFL's North East boundary was logged.

Table 4.19.1 Estimated growth impacts (impacts to the long-run sustained yeild)^a and areas occupied by susceptible species

TFL: #35
DATE: Dec. 18, 1987
RATED BY: L. Laithwaite
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
western spruce budworm ^c	-	-	16 800 ^d	< 16 800 ^e
armillaria root disease (ARD) and laminated root rot	2 400 (ARD-1 200) (LRR-1 200)	2 200 (ARD-1 100) (LRR-1 100)	9 300	9 000
tomentosus root rot	30	30	270	260
Total	2 430	2 230	26 370	26 060

- Impacts to LRSY will occur yearly over an extended time frame.
- These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.
- Impacts were not calculated for this pest due to an absence of historical information on occurrence.
- This area was derived from surveys and consists of 13,600 and 3,200 hectares respectively of light, and moderate to severe intensities of attack. Attack from 1984 to 1986, respectively, was 593, 5,063 and 12,613 hectares.
- Net areas were not determined and therefore will be less than this value.

Table 4.19.2 Summary of information used to determine growth impacts.

TFL: #35

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)
armillaria root disease and laminated root rot	F	G	3.5	-	-	6 ^b
		M	1.9	-	-	6
		P	0.8	-	-	6
	FS	G	3.2	-	-	6
		M	2.6	-	-	6
		P	1.4	-	-	6
	FP1	G	3.3	-	-	6
		M	1.8	-	-	6
		P	1.0	-	-	6
tomentosus ^c root rot	F	G	3.5	1.5 ^d	20 ^d	-
		M	1.5	1.5	20	-
		P	0.8	1.5	20	-

- a. This number is an estimate of the percentage of susceptible area that is infected.
- b. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.
- c. Tomentosus occurs on the spruce component of pure Douglas-fir stands, i.e., only 5% of pure Douglas-fir stands are considered susceptible.
- d. Refer to Section 7.1.4.3 for the derivation of these estimates.

4.20 TFL #37 CANADIAN FOREST PRODUCTS LIMITED

CONCERNS

Pests found in this TFL include the following:

- during 1978 the hemlock sawfly damaged balsam trees in the Schoen Creek drainage. This outbreak was part of a larger infestation which collapsed in 1981.
- the Douglas-fir beetle was responsible for significant damage in 1953-1954 to many mature Douglas-fir stands in the Nimpkish Valley.
- populations of the pine butterfly have been periodically monitored since 1965. While egg counts in some areas have suggested the possibility of epidemic larvae populations, natural controls have prevented larvae build ups. No extensive concentrations of this pest have been noted since 1974.
- in 1956, an infestation of western blackheaded budworm (WBHB) threatened all of the stands in the northern part of the Nimpkish Valley. Infestations appeared again in 1972, in the Pinder Peak area, and in 1974 populations dwindled below endemic levels.

- heavy white pine weevil damage was found throughout the TFL, except for the Beaver Cove area, during a survey conducted in 1967. The Beaver Cove area was surveyed again in 1985 and results indicated minimal damage. This pest is not expected to cause significant damage in the TFL due to the relative absence of spruce or spruce leading types.
- Warren's rootcollar weevil is a minor problem in the CwHb zone, near Atluck Lake, where plantations were planted in the fall with container stock.
- patches of hemlock dwarf mistletoe occur in immature hemlock stands and originate from logged-over areas which have not been burned. Such patches are centered around severely infected residual trees. Studies conducted near Woss Lake by the CFS indicated that moderately and severely infested trees had 24% and 42% less volume respectively than healthy trees.
- isolated patches of root pathogens (laminated root rot, annosus and armillaria root diseases) occur in immature stands. Of these three, laminated root rot causes the greatest concern.
- very few western white pine reach a merchantable size in the TFL because of white pine blister rust. Western white pine has a rapid growth rate, is adaptable to a variety of growing sites, and is relatively resistant to root pathogens.
- deer cause problems by browsing planted coniferous seedlings.

ACTIVITIES

The licensee periodically trains and conducts ground and aerial surveys to assess pest problems. Other activities conducted in the TFL include:

- salvage of dead and dying Douglas-fir trees, attacked by the Douglas-fir beetle, has been conducted to reduce further degradation losses.
- WBHB monitoring and a cooperative spray program was conducted on the 1956 infestation area. This program included aerial treatments of DDT to determine its effectiveness.
- the licensee follows Ministry standards and guidelines for the prevention or control of white pine weevil including surveys in 1967 and 1985, leader clipping, and planting nonsusceptible tree species in high-hazard areas.
- hemlock dwarf mistletoe prevention/control is usually handled through normal harvesting and silvicultural practices such as felling residuals and prescribed burns.
- root rot centers are identified and accounted for in management prescriptions prior to the implementation of juvenile spacing or commercial thinning activities.

- pruning of western white pine occurred on 177 ha (1984) and 156 ha (1985) as a means of controlling the white pine blister rust. Also, 20 trees out of 300 have been chosen from the license area as part of a cooperative program to select blister-rust-resistant white pine trees. Seed from these trees has been collected and are being tested by the CFS for resistance. Resistant progenies will be planted for further testing.
- a number of methods have been tried over the years to prevent deer browsing: applying chemical repellents; providing alternative forage; fencing; and covering the leaders of seedlings with milk cartons, plastic tubes (Vexar), or plastic netting.

Table 4.20.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #37
DATE: April 28, 1988
RATED BY: Julius Kapitany
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	18 100	10 300	115 500	60 200
laminated root rot	30 300	22 400	46 000	34 600
Total	48 400	32 700	161 500	94 800

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.20.2 Summary of information used to determine growth impacts

TFFL #37

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence (%)	Effect on ^a MAI (%)	Effect on Yield (%)
hemlock dwarf mistletoe	H, HPL, HDec	G	12.0	Immature ^b 10	b	-
		M	6.0	50	3	-
		P,L	2.3	20	6	-
	HF, HC, HB, HS	G	10.5	30	15	-
		M	6.2	10	3	-
		P,L	4.3	20	6	-
laminated root rot	FC, FCY, FH, FS	G	11.4	30	15	-
		M	8.1	50	3	-
		P	3.2	20	6	-
		G	10.3	30	15	-
		M	7.2	10	3	-
		P	3.2	20	6	-
	F, FPL, FDec, PW	L	1.2	30	15	-
		G	11.4	Immature ^b 10	b	-
		M	8.1	50	3	-
		P	3.2	20	6	-
		G	10.3	30	15	-
		M	7.2	10	3	-
laminated root rot	FC, FCY, FH, FS	G	11.4	Immature ^b 10	b	-
		M	8.1	50	3	-
		P	3.2	20	6	-
		G	10.3	30	15	-
		M	7.2	10	3	-
		P	3.2	20	6	-

- a. This number is an estimate at the percentage of susceptible area that is infested.
- b. Refer to Section 7.1.5 for the derivation of these numbers.
- c. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

4.21 TFL #38 WELWOOD OF CANADA LIMITED

CONCERNS

Pests found in this TFL include the following:

- Douglas-fir beetle. A small infestation (30 hectares) of this pest exists in a low-vigor Douglas-fir stand near the mouth of Shovelnose Creek.
- the white pine weevil has severely attacked 200 hectares of Sitka spruce plantations, which have not been rehabilitated, in lower Ashlu and Squamish Rivers.
- hemlock dwarf mistletoe is present in significant amounts on most mature and overmature stands, but decreased incidence levels are expected at harvest in some second growth stands due to normal harvesting and silvicultural practices.
- estimates of impacts due to laminated root rot are provided because it has been identified in nearby TSA lands.

ACTIVITIES

TFL staff regularly monitor the incidence and levels of pest damage during the course of their normal duties. In addition, communication is maintained with BCFS staff on aerial and ground surveys.

Past control measures for the Douglas-fir beetle have included trap-tree and thinning operations, but the current infestation will be handled through normal logging activities. Corrective action for the white pine weevil involves planting non susceptible species and no Sitka spruce has been planted since 1977.

Normal harvesting and silvicultural practices used to reduce the impact of hemlock dwarf mistletoe include felling infected residuals (three meter knock down clause) and prescribed burns.

Table 4.21.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #38
 DATE: April 12, 1988
 RATED BY: R. Beaumont
 and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	4 600	3 800	18 900	15 900
laminated root rot	6 200	6 000	13 600	12 900
Total	10 800	9 800	32 500	28 800

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore represent gain opportunities to be obtained after appropriate treatments.

Table 4.21.2 Summary of information used to determine growth impacts

TFL: #38

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)	Effect on Yield (%)
				Immature	Mature		
hemlock	H	G	8.4	10 ^c	50 ^c	5 ^c	-
dwarf		M	4.9	20	50	10	-
mistletoe		P	2.8	30	50	25	-
		L	2.1	40	50	30	-
		HF, HC, HB	8.4	10	50	3	-
		HS, HDecid	5.9	20	50	6	-
		P	3.6	30	50	15	-
		L	2.7	40	50	20	-
laminated	F	G	10.9	-	-	-	11 ^d
root rot		M	7.7	-	-	-	6
		P	3.5	-	-	-	2
		L	1.5	-	-	-	-
		FH, FC	9.8	-	-	-	12
		M	7.6	-	-	-	6
		P	3.8	-	-	-	3
		L	1.5	-	-	-	-

a. MAIs were provided by Weldwood of Canada Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these numbers.

d. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.

4.22 TFL #39 MACMILLAN BLOEDEL LIMITED

CONCERNS

Pests found in this TFL include the following:

- an infestation (1963) of the greenstripped forest looper resulted in heavy defoliation over a large area of young mature stands on the flat lands of the eastern portion of Graham Island. Population levels declined naturally in 1965.
- hemlock sawfly outbreaks have occurred as follows:
 - . in 1962, an outbreak extended over 2 400 hectares near Kelsey Bay but declined naturally in 1963.
 - . in 1978, 500 hectares were affected near Keta Lake causing severe defoliation of amabilis fir and western hemlock. This population collapsed in 1980 after larval hatch declined due to cool, wet weather. Mortality to amabilis fir was significant and secondary attack by bark beetles occurred on severely defoliated trees.

- the western blackheaded budworm (WBHB) was active in three areas, as follows:
 - . 1951 - 1955, prior to TFL formation in the Port Hardy area;
 - . in the Port Alice and Benson Lake area during 1941-1945 and in the early 1970's until 1973;
 - . in the Queen Charlottes Block during 1930-1932, 1943-1945, 1953-1955, 1957-1960, 1972-1975, and 1984-1987. Currently (1987), some mortality is expected in areas where heavy defoliation has occurred after years of successive attack. The current infestation includes combined defoliation by both the WBHB and sawfly.

- the white pine weevil was identified (1966) on planted Sitka spruce in the Port Hardy, Port McNeill, and old TFL 7 areas. Blocks I, II, IV, and V of old TFL 39 and all of old TFL 7 are located in high-hazard weevil zones.

- hemlock dwarf mistletoe is widely distributed in the mature canopy of many hemlock stands, but decreased incidence levels are expected at harvest in some second growth stands due to improved harvesting and silvicultural practices.

- laminated root rot is found on the mainland section of the TFL (Stillwater Division). Annosus root rot is believed to be widely spread throughout the old growth forests of the licence area, but its impact on second growth forests is unknown-though considered light. Consideration of laminated root rot will be important in the management of second growth forests.

- the presence of white pine blister rust may preclude consideration of white pine in stand management.

ACTIVITIES

Aerial patrols are flown on an annual basis to identify pest problems. All woodland field staff are expected to watch for signs of unusual pest activity in the course of their normal duties and to report such observations to the Divisional Forester for follow-up. In addition, MacMillan-Bloedel staff maintain close liaison with the CFS and BCFS.

Other activities conducted in the TFL include:

- aerial treatments; an experimental aerial spray (1964) of phosphamidon was applied against the greenstriped forest looper on the Queen Charlotte Islands. Four aerial spray programs were conducted against the WBHB. A spray program (1957) using DDT was conducted in the Port Hardy area. A similar program (1960) was also carried out in the Alliford Bay area of the Queen Charlotte Islands. Experimental trials with Bacillus thuringiensis and fenitrothion were applied in 1973 on the Port Alice and Benson Lake infestations.
- salvage logging occurred on over 500 hectares in the Kelsey and Menzie Bay Divisions where hemlock sawfly activity caused significant tree mortality.

- developing guidelines regarding the use of Sitka spruce to limit the effect of the white pine weevil. Also, this pest is regularly monitored to determine and assess damage. Regeneration of Sitka spruce sites favours tree species that are not susceptible to the weevil. MacMillan Bloedel is assisting the CFS with weevil research trials.
- reducing the occurrence of hemlock dwarf mistletoe in second growth stands through burning and removal of residual trees following harvest. Also, in juvenile stands, all infected trees are cut as a sanitation measure.
- a second growth (21+ yrs.) inventory of this TFL is ongoing and will include root rot information to allow for a more accurate determination of impacts.
- preserving white pine trees that are resistant to the white pine blister rust during spacing operations.

Table 4.22.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #39
DATE: May 16, 1988
RATED BY: J. Kumi and
S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Nonsalvable		
western ^a blackheaded budworm	-	-	-	5 805 ^b
Total	-	-	-	5 805

- a. This pest is considered accounted for in current yield estimations and any impacts would be considered yield gain opportunities to be obtained after appropriate treatments.
- b. From 1987 CFS Forest Insect and Disease Survey. Consists of the following areas (ha); 1 106 light, 3 404 moderate and 1 290 severe intensity of attack.

Table 4.22.2 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #39
DATE: May 16, 1988
RATED BY: J. Kumi and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	74 700	-	261 900
laminated root rot	-	25 100	-	49 600
Total	-	99 800	-	311 500

a. Impacts to LRSY will occur yearly over an extended time frame.

b. These pests are considered accounted for in current yield estimations and therefore their impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.22.3

Summary of information used to determine growth impacts

TFL #39

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^{b,c} (%)		Effect on ^c MAI (%)		Effect on Yield (%)	
				Immature	Mature	Pure	Mixed		
hemlock dwarf mistletoe	hemlock pure and mixed stands	15 ^d	3.6	30	50	30	18	-	
		18	5.0	27	50	25	15	-	
		21	6.6	24	50	20	12	-	
		24	8.2	20	50	15	9	-	
		27	9.9	17	50	10	6	-	
		30	11.8	14	50	7	4	-	
		33	13.7	10	50	5	3	-	
		36	16.0	10	50	5	3	-	
		39	18.0	10	50	5	3	-	
		42	20.0	10	50	5	3	-	
laminated root rot FC	F, FH, FC	20 ^e	1.7	-	-	-	-	1	
		24	2.8	-	-	-	-	2	
		29	4.1	-	-	-	-	3	
		33	5.6	-	-	-	-	5	
		37	7.1	-	-	-	-	5	
		42	8.9	-	-	-	-	6	
		46	10.7	-	-	-	-	7	
		51	12.6	-	-	-	-	8	
		55	14.5	-	-	-	-	8	
		60	16.6	-	-	-	-	9	

a. MAIs were provided by MacMillan Bloedel Limited.

b. This number is an estimate of the percentage of susceptible area that is infested.

c. Refer to Section 7.1.5 for the derivation of these numbers.

d. King's site index at a total reference age of 50.

e. King's site index at a total reference age of 100. See Section 7.1.4.2.

f. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.2.

4.23 TFL #41 EUROCAN PULP AND PAPER COMPANY

CONCERNS

Sporadic infestations of spruce budworm (Choristoneura orae) has caused light defoliation to the tops of balsam trees in the Wedeene area of the TFL. However, the budworm population collapsed in 1986 after damaging 300 hectares. The white pine weevil has caused scattered leader damage in Sitka spruce plantations. It is currently infesting one plantation, but damage is negligible due to the low incidence and severity of attack.

Hemlock dwarf mistletoe has been noticed in mature and overmature stands, but is difficult to detect in immature stands. Root diseases have not been identified in the TFL.

ACTIVITIES

Aerial surveys for pest damage have occurred periodically as infestations arise. (The last flight took place in 1986.) The effects of white pine weevil and hemlock dwarf mistletoe have been reduced by the following silvicultural/harvesting practices:

- regeneration activities on Sitka spruce sites favours the establishment of hemlock and cedar;
- 3 meter knock down clauses; and
- large clearcuts in the Kitimat valley.

Table 4.23.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #41
DATE: June 22, 1988
RATED BY: D. Keating
and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	14 700	-	46 500
Total	-	14 700	-	46 500

a. Impacts to LRSY will occur yearly over an extended time frame.

b. This pest is considered accounted for in current yield estimations and its impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.23.2 Summary of information used to determine growth impacts

TFL: #41

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^{a,b} (%)		Effect on ^b MAI (%)
				Immature	Mature	
hemlock dwarf mistletoe	H, HPl, HDecid	G	12.3	10	50	3
		M	6.4	20	50	6
		P	3.2	30	50	15
	HF, HC, HCy, HB, HS	G	12.3	10	50	3
		M	7.0	20	50	6
		P	3.8	30	50	15
		L	2.9	40	50	20

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Refer to Section 7.1.5 for the derivation of these numbers.

4.24 TFL #42 TANIZUL TIMBER LIMITED

CONCERNS

The mountain pine beetle has severely attacked a total of 600 hectares of lodgepole pine throughout the TFL and is the major pest problem.^a

Historically, the spruce beetle has been a concern but it was not identified in 1987 aerial surveys. Porcupines are a threat in 30 year old pine stands attacking trees less than 27 m in height.

Tomentosus root rot and lodgepole pine dwarf mistletoe have been identified in the license area.

ACTIVITIES

The 5 year harvesting plan has been changed to redirect logging into mountain pine beetle infested areas. Large-scale fall and burn operations for this pest are being conducted at the west end of the TFL with small-scale operations being conducted in isolated areas.

a. Since the publication of this report, the mountain pine beetle has increased dramatically in 1988 particularly in the Stuart to McKelvey Lakes area.

Table 4.24.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #42
 DATE: Nov. 24, 1987
 RATED BY: R. MacDougall
 and S. Taylor

Pest	Impacts ^a (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Nonsalvable		
mountain pine beetle	7 000	1 300	4 900	600 ^b
Total	7 000	1 300	4 900	600

a. These figures represent red attack only, but ground probe data indicates that the green/red attack ratio is approximately 2 - 2.5 to 1.

b. Determined from BCFS aerial surveys and ground probes.

Table 4.24.2 Estimated growth and regeneration delay impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #42
 DATE: Nov. 24, 1987
 RATED BY: R. MacDougall
 and S. Taylor

Pest	Impacts/Opportunities (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
mountain pine beetle (regen. delay)	140	100	260	200
lodgepole pine ^b dwarf mistletoe	3 400	3 100	15 100	13 700
tomentosus ^b root rot	2 500	2 400	15 000	14 600
Total	6 040	5 600	30 360	28 500

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore its impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.24.3 Summary of information used to determine growth impacts

TFL: #42

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)
lodgepole	Pl	G, M	2.6	35	25
pine dwarf		P	1.5	35	25
mistletoe					
tomentosus	S	G	3.9	30 ^b	20 ^b
root rot		M	2.4	30	20
		P	1.0	30	20
	SF, SB	G	3.9	30	12
		M	2.2	30	12
	SP1, SDec	G	3.6	30	12
		M	2.1	30	12
		P	0.9	30	12

a. This number is an estimate of the percentage of susceptible area that is infected.

b. Refer to Section 7.1.4.3 for the derivation of these numbers.

Table 4.24.4 Summary of information used to determine mortality and regeneration delay impacts

TFL: #42

Pest	Net/Gross Ratio (%)	Salvage Factor	Total Volume per hectare (m ³ /ha)	MAX MAI (m ³ /ha/yr) (%)	Culmination ^a Age (yrs)	Volume at Culmination Age (m ³ /ha)
mountain pine beetle	90	50-South West 80-Central + NE part of TFL	N/A	2.9	69	199.4

4.25 TFL #43 SCOTT PAPER LIMITED

CONCERNS

Fortunately, Populus species are quite hardy and can withstand most minor attacks by forest pests. While no major pest problems are known to occur on TFL lands there is a wide range of minor ones.

Insects found include the forest tent caterpillar, wood borers (poplar), leafhoppers, sawflies (deciduous), and the willow shoot sawfly. In addition, the gypsy moth is a concern due to the proximity of the Chilliwack outbreak, but has not been noticed in the TFL. Currently, the forest tent caterpillar and satin moth are causing defoliation in one upland plantation near the TFL.

Pathogens occurring in this TFL include rusts (deciduous). One of them, Septaria musvia, causes considerable damage in other provinces and has potential to become an important problem in this TFL.

Deer, beavers and voles all caused damage, with voles being the greatest concern. Deer cause most of their damage in late summer to early fall on first and second year plantations. In third year plantations, these trees are usually too large to be effectively browsed. Beavers periodically cause problems on stands adjacent to river channels.

ACTIVITIES

One problem in coordinating control activities is the lack of local information on pests of Populus species. Information is usually obtained from the Eastern United States and Ontario.

The control strategy with the most promise involves selecting hybrid poplars with pest resistance. Other activities include:

- damage assessments of the forest tent caterpillar and satin moth by the BCFS and CFS staff;
- treatments to control Saperda calcarata in nurseries (1984);
- vole habitat removal on some plantations, but this method offers poor potential for wild sites;
- using salt licks, blood meal and cannons to deter and relocate deer during critical periods. However, as recent hybrids grow quickly these methods may not be employed again;
- using leave strips of timber, fencing and piling slash to manage beaver populations.

4.26 TFL #44 MACMILLAN BLOEDEL LIMITED

CONCERNS

Pests found in this TFL include the following:

- a serious infestation (1945 - 1946) of hemlock looper killed an estimated 1.6 million cubic meters of timber on 13 400 hectares in the southern portion of Block II.
- the western blackheaded budworm defoliated 24 700 hectares in 1971 and 1972. Studies of the infested areas included egg sampling to predict future populations. Fortunately, WBHB egg populations declined and no mortality was identified the next year.
- during 1988, seedling weevils caused 35-50% mortality over 200 ha in the Franklin Division.
- the white pine weevil has been identified on Sitka spruce plantations as a result of two surveys conducted in 1967 and 1982. The TFL is located within a high-hazard weevil zone.
- by 1965, the impact of a foliage disease (Dothistroma pini) became apparent in exotic pine plantations. Plantations of Pinus radiata were completely killed; P. pinaster severely infested; and P. muricata moderately attacked.

- hemlock dwarf mistletoe is present in the mature canopy of many hemlock stands, but decreased incidence levels are expected after harvest in second growth stands due to improved harvesting and silvicultural practices.
- laminated root rot is widespread particularly in Blocks I and III and will prove to be a significant factor, along with annosus root rot, in future management considerations. Armillaria root disease is also widespread, but is generally of little concern past the age of 25 years.

ACTIVITIES

Aerial patrols are flown on an annual basis to supplement CFS Insect and Disease Surveys. Ground checks are made of significant problem areas identified from the survey. All woodland field staff are expected to watch for unusual pest activity in the course of their normal duties and to report such observations to the Divisional Forester for follow-up. In addition, MacMillan Bloedel staff maintain close liaison with the CFS and BCFS.

Other activities conducted in the TFL include:

- providing a study area at Franklin River for a CFS experiment on chemical control of the white pine weevil. At Kennedy Lake Division, weevil-infested leaders were clipped and removed as a control measure during the years 1970 - 1978.

- planting in pockets of mortality which have been attacked by seedling weevils.
- reducing the occurrence of hemlock dwarf mistletoe in second growth stands through burning and removal of residual trees following harvest.
- initiation of a study on laminated root rot to hazard rate sites according to their potential in providing conditions where Phellinus causes unacceptable volume and mortality losses. Effective guidelines will be developed which optimize the control of the disease.
- a second growth (21+ years) inventory of this TFL is ongoing and will include root rot information to allow for a more accurate determination of impacts.

Table 4.26.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #44
 DATE: May 16, 1988
 RATED BY: J. Kumi and
 S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	40 300	-	131 300
laminated root rot	-	62 300	-	81 900
Total	-	102 600	-	213 200

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore their impacts represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.26.2

Summary of information used to determine growth impacts

TFL: #44

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)		Effect on Yield (%)
				Immatured	Matured	Pured	Mixed ^d	
hemlock dwarf mistletoe	hemlock, pure and mixed stands	15 ^c	3.6	30	50	30	18	-
		18	5.0	27	50	25	15	-
		21	6.6	24	50	20	12	-
		24	8.2	20	50	15	9	-
		27	9.9	17	50	10	6	-
		30	11.8	14	50	7	4	-
		33	13.7	10	50	5	3	-
		36	16.0	10	50	5	3	-
		39	18.0	10	50	5	3	-
		42	20.0	10	50	5	3	-
laminated root rot	F, FH, FC	20 ^e	1.7	-	-	-	-	2 ^f
		24	2.8	-	-	-	-	4
		29	4.1	-	-	-	-	6
		33	5.6	-	-	-	-	9
		37	7.1	-	-	-	-	10
		42	8.9	-	-	-	-	12
		46	10.7	-	-	-	-	14
		51	12.6	-	-	-	-	15
		55	14.5	-	-	-	-	16
		60	16.6	-	-	-	-	18

a. MAIs were provided by MacMillan Bloedel Limited.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. King's site index at a total reference age of 50.

d. Refer to Section 7.1.5 for the derivation of these numbers.

e. King's site index at a reference age of 100. See Section 7.1.4.2.

f. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.2.

4.27 TFL #45 - FLETCHER CHALLENGE CANADA LIMITED

CONCERNS

Aerial surveys conducted by the CFS in 1987 did not locate any significant pest outbreaks in the TFL. Nonetheless, pests found include:

- the cooley spruce gall aphid which has been a minor problem on young plantations of spruce and Douglas-fir in the Knight Block;
- portions of pine stands have been killed by the mountain pine beetle which migrated from the interior down the Klinaklini River Valley. Currently, these infestations are not accessible and pose no threat to operable timber;
- the white pine weevil has severely infected all Sitka spruce stands, (approximately 2 300 hectares). Licensee foresters estimate that this pest reduces MAIs by 40 - 50%.
- prevalent throughout most hemlock stands is the hemlock dwarf mistletoe. The exception is young plantations (0-20 years) where normal harvesting and silvicultural activities have reduced its incidence. In particular, this pest can be a problem on steep slopes because of the increased rate of spread; dry and poor sites; and spaced stands, where light to moderate infestations (≤ 4 on the six class rating system) have been noted.

- A potential pest problem on Douglas-fir stands is laminated root rot. To date, it has only been observed in small pockets on spaced stands where up to 20% of the area is affected.

ACTIVITIES

Monitoring of pest conditions is conducted by Divisional Forestry staff with emphasis on old growth stands. Other activities occurring include:

- planting Sitka spruce sites with species that are not susceptible to the white pine weevil; and
- normal harvesting and silvicultural practices, such as prescribed burns and removal of residuals, which restrict the spread of hemlock dwarf mistletoe.

Table 4.27.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #45
 DATE: May 10, 1988
 RATED BY: J. Nichols
 and S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	3 800	2 100	33 200	22 400
Total	3 800	2 100	33 200	22 400

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.27.2 Summary of information used to determine growth impacts

TFL: #45

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)	Effect on ^c MAI (%)
hemlock	H	G	12.3	10	5
dwarf		M	6.4	20	10
mistletoe		P	2.3	30	25
		L	1.7	40	30
	HF,HC, HB, HS	G	12.3	10	3
		M	7.0	20	6
		P	3.8	30	15
		L	2.9	40	20
	HDecid	G	12.3	10	3
		M	6.4	20	6

- a. MAIs were provided by the Company
- b. This number is an estimate of the percentage of susceptible area that is infected.
- c. Refer to Section 7.1.5 for the derivation of these numbers. In the absence of a breakdown of immature and mature areas, the immature figures were used.

4.28 TFL #46 - FLETCHER CHALLENGE CANADA LIMITED

CONCERNS

Aerial surveys conducted by the CFS in 1987 did not locate any significant outbreaks in the TFL. Nonetheless, pests found include:

- defoliators such as the western blackheaded budworm and greenstriped forest and hemlock loopers, which have appeared in the past but are of minor significance.
- the white pine weevil which has infested to varying degrees of severity all Sitka spruce stands. The impacts appear to be greater on plantations than natural stands. Licensee foresters estimate that this pest has reduced MAIs by 30% in areas of severe attack.
- a minor problem on hemlock stands is the hemlock dwarf mistletoe, less than 10% of second growth stands appear to be visibly infected.
- laminated root rot is considered a problem on dry sites, up to 20% of east coast sites are affected.

ACTIVITIES

Monitoring of pest conditions, with emphasis on old growth stands, is conducted by Divisional Forestry staff in conjunction with normal duties. Good access and regular over-flights of all blocks favours early detection of pest problems. Other activities conducted in the TFL include:

- planting Sitka spruce sites with species that are not susceptible to the white pine weevil;
- normal harvesting and silvicultural practices, such as prescribed burns and removal of residuals, are used to reduce hemlock dwarf mistletoe incidence; and
- leaving healthy, immature trees during juvenile spacing projects in the hope that natural resistance to western gall rust develops.

Table 4.28.1 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #46
DATE: May 10, 1988
RATED BY: J. Nichols and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	3 000	-	41 900
laminated root rot	-	21 600	-	36 800
Total	-	24 600	-	78 700

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.28.2 Summary of information used to determine growth impacts

TFL #46

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)	Effect on MAI (%)	Effect on ^c Yield (%)
hemlock dwarf mistletoe	H	G	12.0	10 ^d	5 ^d	-
		M	6.0	20	10	-
		P	2.3	30	25	-
	HF, HC, HB, HS	G	10.5	10	3	-
		M	6.2	20	6	-
		P	4.4	30	15	-
	HDecid	G	12.0	10	3	-
		M	6.0	20	6	-
laminated root rot	F	G	10.3	-	-	11
		M	7.2	-	-	6
		P	3.2	-	-	3
	FH, FC	G	11.4	-	-	12
		M	8.1	-	-	7
		P	3.2	-	-	4

-
- a. MAIs were provided by the Company
- b. This number is an estimate of the percentage of susceptible area that is infected.
- c. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.
- d. Refer to Section 7.1.5 for the derivation of these numbers. In the absence of a breakdown of immature and mature areas, the immature figures were used.

4.29 TFL #47 FLETCHER CHALLENGE CANADA LIMITED

CONCERNS

Pests found in this TFL include the following:

- western blackheaded budworm (WBHB)/hemlock sawfly. Infestations in the Moresby Block are down to one-third of the area infested in 1986. This block has a history of outbreaks and current infestations (1987) cover 3,200 hectares with the sawfly causing most of the defoliation.
- hemlock dwarf mistletoe is present in varying intensities on second growth, mature and overmature timber, but decreased incidence levels are expected after harvest in immature stands due to improved harvesting and silviculture practices.
- root rot centers of laminated root rot, armillaria and black stain root diseases have been identified on Block 13 of the Courtenay/Nanaimo Lake Management Unit. Presently, armillaria root disease is not considered a serious problem, but laminated root rot occurs on TSA lands surrounding the other blocks and estimates of its impact are included in table 4.29.2.

ACTIVITIES

The licensee will seek assistance in pest identification, appraisal of damage, and training from available resource agencies, when necessary. Infestations are monitored on a routine basis.

Hemlock dwarf mistletoe is usually handled through normal harvesting and silvicultural practices such as the three meter knockdown clause and prescribed burns. In addition, prioritized harvesting and felling of infected residuals (in sanitation and juvenile spacing projects) are used to minimize impacts.

In 1983, laminated root rot surveys were conducted in five stands using methods developed by the CFS. Early harvest combined with planting alternative species are planned for severely infested areas.

Table 4.29.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #47
 DATE: April 18, 1988
 RATED BY: F. Leslie and
 S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Net		
western ^a blackheaded budworm/hemlock sawfly	-	-	-	3 200 ^b
Total	-	-	-	3 200

- a. This pest is considered accounted for in current yield estimations and any impacts would be considered yield gain opportunities to be obtained after appropriate treatments.
- b. From 1987 CFS Forest Insect and Disease Survey. Located on Queen Charlottes in Block 18.

Table 4.29.2 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #47
 DATE: April 18, 1988
 RATED BY: F. Leslie and
 S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
hemlock dwarf mistletoe	-	16 300	-	111 400
laminated root rot	-	45 700	-	55 600
Total	-	62 000	-	167 000

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.

Table 4.29.3 Summary of information used to determine growth impacts.

TFL: #47

Pest	Species Group	Site Class	MAX MAI ^a (m ³ /yr/ha)	Incidence ^b (%)		Effect on MAI (%)	Effect on Yield (%)
				Immature	Mature		
hemlock	H	G	9.4	10 ^c	50 ^c	5 ^c	-
dwarf		M	7.3	20	50	10	-
mistletoe		P	3.5	30	50	25	-
	HF, HC, HB,	G	10.4	10	50	3	-
	HS, HDecid	M	7.0	20	50	6	-
		P	4.7	30	50	15	-
laminated	F, FC	G	10.2	-	-	-	13 ^d (6.5) ^e
root rot		M	7.3	-	-	-	8 (4)
		P	3.8	-	-	-	3
	FH	G	10.4	-	-	-	12
		M	7.0	-	-	-	8
		P	4.7	-	-	-	3

a. MAIs were provided by the Company.

b. This number is an estimate of the percentage of susceptible area that is infected.

c. Refer to Section 7.1.5 for the derivation of these estimates.

d. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4

e. These figures apply to Douglas-fir stands in Block 17.

4.30 TFL #49 FLETCHER CHALLENGE CANADA LIMITED

CONCERNS

The Mountain pine beetle (MPB) is a prominent concern in the TFL, although in recent years its activity has been minimal. The western balsam bark and spruce beetles are found in minor amounts with spruce beetle populations expanding in the Sandberg Creek area. Aerial surveys located 2,100 hectares of western spruce budworm (WSBW) defoliation including 900 hectares of moderate and severe infestation. Laminated root rot, armillaria root disease, and lodgepole pine dwarf mistletoe are the major pathogens found in the TFL. Located in the northern and southern ends of the TFL respectively are black stain root disease and Douglas-fir dwarf mistletoe.

ACTIVITIES

Aerial surveys were conducted in the northern half of the TFL with BCFS staff. Salvage logging on 150 hectares is planned and should remove most of the MPB's current damage. Continued development of access into susceptible stands coupled with aerial detection, pheromone baiting, and MSMA treatment should reduce the impacts of future MPB attacks. A salvage program, in the form of trap tree harvests, was conducted for spruce beetle and surveying is in progress to evaluate the results.

Control efforts for lodgepole pine dwarf mistletoe are incorporated with normal harvesting practices, i.e., removal of residual trees and the 3 meter knockdown clause.

Table 4.30.1 Estimated mortality impacts, salvage potential and infested areas caused by current pest activity

TFL: #49
 DATE: Dec. 16, 1987
 RATED BY: G. Wellburn,
 K. Fay and
 S. Taylor

Pest	Impacts (m ³ for 1987)		Salvage Potential (m ³ for 1987)	Infested Area (ha)
	Gross	Nonsalvable		
mountain pine beetle ^a	4 650	500	4 150	100
Total	4 650	500	4 150	100

a. Includes green and red attack. These figures were derived by the Vernon Forest District, and include the area and volume of actual attack.

Table 4.30.2 Estimated growth impacts (impacts to the long-run sustained yield)^a and areas occupied by susceptible species

TFL: #49
DATE: Dec. 16, 1987
RATED BY: G. Wellburn,
K. Fay, and
S. Taylor

Pest	Impacts/Opportunities ^b (m ³ /yr)		Susceptible Area (ha)	
	Gross	Net	Gross	Net
western spruce ^c budworm	-	-	2 100 ^d	< 2 100 ^e
Douglas-fir dwarf mistletoe	-	300	-	35 900
lodgepole pine dwarf mistletoe	-	15 700	-	82 600
armillaria root disease (ARD) and laminated root rot (LRR)	-	7 600 (ARD-3 800) (LRR-3 800)	-	37 300
tomentosus root rot	-	70	-	12 600
Total	-	23 670	-	170 500

- a. Impacts to LRSY will occur yearly over an extended time frame.
- b. These pests are considered accounted for in current yield estimations and therefore represent yield gain opportunities to be obtained after appropriate treatments.
- c. Impacts were not calculated for this pest due to an absence of historical information on occurrence.
- d. This area was derived from surveys.
- e. Net areas were not determined and will be less than this value.

Table 4.30.3 Summary of information used to determine growth impacts

TFL: #49

Pest	Species Group	Site Class	MAX MAI (m ³ /yr/ha)	Incidence ^a (%)	Effect on MAI (%)	Effect on Yield (%)
Douglas-fir	F	G,M,P	1.8	3	25	-
dwarf	FP1	G,M,P	1.6	3	15	-
mistletoe	FPy	G,M,P	1.3	3	15	-
lodgepole	Pl	G,M,P	3.0	35	25	-
pine dwarf	PlF	G,M,P	2.5	35	15	-
mistletoe	PlS, PlB	G,M,P	3.1	35	15	-
	FP1	G,M,P	1.6	28	15	-
armillaria	F	G,M,P	1.8	-	-	6 ^b
root disease	FS	G,M,P	3.4	-	-	6
and laminated	FP1	G,M,P	1.6	-	-	6
root rot	FPy	G,M,P	1.3	-	-	6
tomentosus ^c	F	G,M,P	1.8	1.5 ^d	20 ^d	-
root rot						

- a. This is an estimate of the percentage of susceptible area that is infected.
- b. Consists of a combined estimate of incidence and effect on MAI. See Section 7.1.4.
- c. Occurs on the spruce component of pure Douglas-fir stands, i.e., 5% of pure Douglas-fir stands are considered susceptible.
- d. See Section 7.1.4.3 for the derivation of these estimates.

- 139 -

4.31 TFL #51 WESTAR TIMBER LIMITED

- No Response -

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<u>7. APPENDICES</u>	<u>Page</u>
7.1 Detailed Methods for Calculating Pest Impacts.....	145
7.1.1 Bark Beetles (mountain pine, spruce and Douglas-fir).....	145
7.1.1.1 Cariboo Approach.....	146
7.1.1.2 Non-Cariboo Approach.....	147
7.1.2 Western balsam bark beetle.....	148
7.1.3 Douglas-fir Tussock Moth.....	148
7.1.3.1 Growth Impacts.....	148
7.1.3.2 Mortality Impacts.....	149
7.1.4 Root Diseases.....	149
7.1.4.1 Laminated Root Rot and Armillaria Root Disease..	149
7.1.4.2 Laminated Root Rot (Vancouver Forest Region)....	151
7.1.4.3 Tomentosus Root Rot.....	152
7.1.5 Dwarf Mistletoes.....	153
7.1.6 White Pine Weevil.....	155
7.1.7 Western Spruce Budworm (WSBW).....	157
7.1.8 Regeneration Delay Impacts.....	159
7.1.9 Porcupine.....	160
7.2 Glossary.....	161
7.3 Common and scientific names for major pests found in B.C.....	164
7.4 Provincial TSA/TFL index map.....	165

7.1 Detailed Methods for Calculating Pest Impacts

This section describes the methods used for calculating all pest impacts presented in this document. Also included are some methods (western balsam bark beetle, Douglas-fir tussock moth, western spruce budworm, and the white pine weevil) which were not used in impact calculations but will be useful in the future as survey information improves or these pests become a serious concern.

7.1.1 Bark Beetles (mountain pine, spruce and Douglas-fir)

The methods described herein were used to make estimates of timber impacts due to the mountain pine, spruce, and Douglas-fir beetles. One of two types of approaches (Cariboo, Non-Cariboo) were used for calculating mortality impacts, depending on the information available. Both approaches use the results of aerial mapping, which delineates red attack, as a first reference. This reference may then be supplemented with ground surveys.

To use the Cariboo approach, bark beetle infestations should be mapped onto forest cover type maps and the area of the individual forest types with attack should be calculated. Gross volumes should be calculated from these areas using prescribed methods (Taylor, 1982) and these volumes should be used as inputs into this approach.

To use the Non-Cariboo approach, infested areas should be mapped by intensity of attack into ten percent severity classes. Therefore, the input into the Cariboo approach is volume and the Non-Cariboo approach, area. Regardless of the approach that is used, the impacts which should be calculated are nonsalvable impacts (m^3), salvage potential (m^3)^a, gross impacts (m^3 , impacts over the total crown land base) and regeneration delay impacts (m^3 /year).

Common to both approaches are the regeneration delays to be used. These delays only include additional delays directly attributable to the respective pest.

Regeneration delays have been suggested by Hall^b and Cozens^c, (pers. comm.):

mountain pine beetle	15 years
spruce beetle	10 - 25 years
Douglas-fir beetle	15 years

-
- a. Salvage estimates (m^3) may be 25% less than reported due to some wood deterioration occurring between the time of attack and harvest. This unavoidable waste would then make the non-salvable impact greater by this difference.
 - b. Protection Branch, BCFS, Victoria.
 - c. Protection Section, BCFS, Prince George Forest Region.

7.1.1.1 Cariboo Approach - This approach may be used to calculate impacts where detailed information on attacked stands is available. Use this approach as follows:

Step I Determine the gross infested volume based on current surveys of red attack areas. Volumes used in this approach must have been derived by:

- determining the area of attack polygons; then
- applying the appropriate reduction factors^a; and
- referring to volume-over-age curves for each distinct forest type.

Step II Determine the net operable land/gross land ratio by referring to inventory reports^b. 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 TSA/TFL definitions of merchantability, operability, and environmental sensitivity must be followed in making the deductions.

Step III Estimate the nonsalvageable and salvage factors as follows. The salvage factor is the proportion of the infested area on the net land base, which will be salvaged in the future, with the residual portion (also on this land base) being the nonsalvageable factor.

Step IV Place the values obtained in Steps I through III into the following formula:

$$\text{Nonsalv. Impact (m}^3\text{)} = \text{Gross Infested Vol. (m}^3\text{)} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Nonsalv. Factor}$$

Step V To determine the salvage potential, place the salvage factor into the formula in Step IV as follows:

$$\text{Salvage Pot. (m}^3\text{)} = \text{Gross Infested Volume (m}^3\text{)} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Salvage Factor}$$

Step VI To determine regeneration delay impacts, two areas must be calculated as follows:

$$\text{(A) Net Regen. Delay Area (ha)} = \text{Gross Area (ha)} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \text{Nonsalv. Factor}$$

$$\text{(B) Gross Regen. Delay Area (ha)} = \text{Gross Area (ha)} - (\text{net area (ha)} \times \text{salvage factor})$$

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 calculate regeneration delay impacts separately place the areas determined in either A or B above, along with the appropriate estimate of regeneration delay (Section 7.1.1) into the formula in Section 7.1.8

a. The appropriate reduction factors can be found in Taylor, 1982. A more detailed explanation on obtaining gross volumes can also be found in this report
b. Inventory area summaries for susceptible species and ages are required.

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 impact 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 severity classes of 10 percent increments. The Net Op. Land Area/Gross Land Area ratio is determined from inventory reports.

Step II Subjectively determine the total volume (m³ for all tree species) per hectare for attacked stands by estimating the average forest type label for infected stands over this large undifferentiated area (i.e., species, composition, age, height, and site). This should be determined for individual severity classes and then refer to volume-over-age curves (using the appropriate utilization level).

Step III Use a midpoint of 0.02 for the 0-5% severity class^b, 0.1 for the 5-14% class, 0.2 for the 15-24% class, 0.3 for the 25-34% class, etc., for the 95-100% class use a midpoint of 0.97.

Step IV Estimate the nonsalvageable and salvage factor using the same technique that was previously discussed.

Step V Determine the nonsalvageable impact by placing the values obtained in Steps I through IV into the following formula:

$$\text{Nonsalv. Impact (m}^3\text{)} = \text{Net Op. Infested Area (ha/severity class)} \times \text{Total Vol/ha (m}^3\text{/ha)} \times 0.3 \times \text{Nonsalv. Factor (intensity midpoint)}$$

This example estimates the nonsalvageable impact for an attack in the 25 to 34% severity class. This procedure must be repeated for attacks of different severity.

Step VI To determine the salvage potential place the salvage factor (discussed in Step III of the Cariboo Approach) into the following formula:

$$\text{Salvage Pot. (m}^3\text{)} = \text{Net Op. Infested Area (ha)} \times \text{Total Vol/ha (m}^3\text{/ha)} \times 0.3 \times \text{Salvage Factor (intensity midpoint)}$$

-
- a. If the distribution of the gross infested area is disproportionately large (i.e., disproportionately 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.
 - b. Currently in British Columbia, the intensity of bark beetle attacks is aerially mapped into severity classes of 10 percent increments.

Step VII To determine the gross impact, place the gross infested area (from Step I) into the following formula:

$$\begin{array}{ccccccc} \text{Gross Impact} & = & \text{Gross Infested Area} & \times & \text{Total Vol/ha} & \times & 0.3 \\ (\text{m}^3) & & (\text{ha}) & & (\text{m}^3/\text{ha}) & & (\text{intensity} \\ & & & & & & \text{midpoint}) \end{array}$$

This calculation must be repeated for the different severity classes.

Step VIII To determine the regeneration delay impacts, follow the procedure outlined in Step VI of the Cariboo Approach.

7.1.2 Western balsam bark beetle - timber impacts from this insect cannot accurately be determined from either aerial sketch maps or colour photos for two reasons:

- red stems are usually found in small clumps that are scattered throughout the stand. Sketch mapping is extremely difficult both in outlining the infested area and in determining the percent of stems killed; and
- red needles may remain on dead trees for about five years which makes the estimation of annual mortality rates difficult.

However, if ground survey data is available then this insect's impact can be calculated using methods similar to the other bark beetles. The results will only be as good as the efforts expended on surveys. Regeneration delays for this insect have been estimated at 5-10 years (Ebata^a, pers. comm.).

7.1.3 Douglas-fir tussock moth - the timber impacts resulting from this insect consist of growth and mortality effects on Douglas-fir, which are calculated separately. Short-term impacts are expressed for the outbreak (m³/outbreak) and represent the defoliation and recovery periods within that time frame. Both these components increase proportionally with repeat defoliation (successive years of attack).

7.1.3.1 Growth Impacts

Step I To determine the infestation area, annual survey maps must be available for the outbreak period. All survey maps should be compared together, and the areas defoliated in successive years determined and separated into the following categories; areas (ha) defoliated once, areas defoliated twice in two years, and those areas which have been defoliated thrice in three years. Areas which have been defoliated for four or more years, successively, will probably have considerable mortality.

- Step II Determine the net operable area/gross land area ratio as previously discussed.
- Step III Determine the effect on growth from Table A-I for each category described in Step I. Use the Total Growth Effect column, as this includes the cumulative growth effects which occurred during defoliation and recovery. Divide by 100, to turn this number into a decimal fraction, before inserting it into the formula in Step V.
- Step IV Determine the MAX MAI.
- Step V Substitute the values determined in Steps I through IV for each category separately, into the following formula, and then sum the results to arrive at the total growth effects for that outbreak:

$$\text{Growth Impact} = \text{Infestation Area} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \frac{\text{Effect on MAI}}{\text{MAI}} \times \text{MAX MAI}$$

(m³/outbreak) (ha) (proportion per outbreak) (m³/yr/ha)

7.1.3.2 Mortality Impacts

- Step I Determine the infestation area as discussed in Step I above, except calculate only for severely defoliated areas.
- Step II Determine the net operable gross land area ratio as previously discussed.
- Step III Determine the effect on mortality by referring to Table A-I. Divide by 100, to turn this number into a decimal fraction, before inserting it into the formula in Step V.
- Step IV Determine the susceptible volume per hectare, for susceptible species only, by estimating the average infested stands forest-type label (i.e., species, composition, age, height, and site).
- Step V Place the values determined in Steps I through IV, for each category separately, and then sum the results to arrive at the total mortality effects for that outbreak.

$$\text{Mortality Impact} = \text{Infest. Area} \times \frac{\text{Net Op. Land Area}}{\text{Gross Land Area}} \times \frac{\text{Mortality Effect}}{\text{Effect}} \times \text{Suspect. Vol}$$

(m³/outbreak) (ha) (proportion per outbreak) (m³/ha)

7.1.4 Root Diseases

7.1.4.1 Laminated root rot and Armillaria root disease

Effects of these diseases are expressed as an impact to the LRSY. Data used in calculating these effects are based on the Vancouver Forest Region root rot surveys (1982-1983) in second growth stands. Various assumptions have been made with the scale of the impact and susceptible area for other regions; an approach necessitated by the lack of good information. Follow the steps described below to calculate these effects.

- Step I Determine the susceptible area from Inventory reports based on the input provided in Table 2.1. (Inventory type groups and leading species used to generate susceptible stand areas).

Table A-I Factors used to determine Douglas-fir tussock moth growth and mortality impacts

Number of Years of Successive Defoliation	Total Effect on Growth ^{a,b} (%/outbreak)	Effect on Mortality ^c (%/outbreak)
1	30	59
2	120	64
3	280	64

a. R. Alfaro, pers. comm, Agriculture Canada, CFS, Pacific Forestry Centre.

b. This number represents the cumulative growth effect (%) on MAI for the outbreak period, i.e. it includes the years of defoliation and recovery for each category, eg. the total growth effect for a three year outbreak is 280%, this is comprised as follows:

- for the defoliation period 30% first year, 60% second year and 100% third year,
- for the recovery period 60% first year and 30% the second year.

c. Alfaro et al 1987.

Step II Determine the effect on yield^a for coastal armillaria root disease by using the figure 0.01 for all sites (Beale^b, pers. comm.). This figure is based on the Vancouver Forest Regions root disease surveys. For interior forest regions use 0.05 (Muir^c, pers. comm.) as a guideline for both diseases, 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 MAI.

Step IV Place the values obtained in Steps I through III into the following formula:

$$\text{Impact (m}^3\text{/yr)} = \text{Susceptible Area (Net) (ha)} \times \text{Effect on MAI} \times \text{MAX MAI (m}^3\text{/yr/ha)}$$

Repeat this formula using the gross susceptible area to determine gross impacts.

7.1.4.2 Laminated Root Rot (Vancouver Forest Region)

This method is based on a survey of root disease incidence and severity conducted in the Vancouver Forest Region (Beale 1987). One equation was developed to fine tune the net down factors for managed stand yield curves in an effort to more accurately account for growth impacts of laminated root rot in the yield analysis.

Step I Assemble the following information for the area under study.

Leading Species	F					FH					FC				
Site Index ^d	15	25	35	45	55	15	25	35	45	55	15	25	35	45	55

MAI (m ³ /yr/ha)															
Gross															
Area (ha)															
Net															
Rotation Age (yrs)															

- The effect on yield consists of a combined estimate of incidence and effect on MAI.
- Protection Section, BCFS, Vancouver Forest Region.
- Protection Branch, BCFS, Victoria.
- Use Bruce's Site Index Curves at 100 years (total age) for coastal Douglas-fir stands. If SI 50 is provided then this number may be factored up by multiplying by 1.341.

Step II Place the values for site index and rotation age into the following equation:

Southern TSAs (Arrowsmith, Soo, Strathcona and Sunshine):

Estimated
area visibly = $[-0.436 - 0.0146 (\text{age}) + 0.00108 (\text{age}) (\text{Bruce's SI } 100)] / 20$
infected
(proportion) (total age)

Northern TSAs (Kingcome, Mid-coast):

Use the above equation for these TSAs, but half the result.

Assume that these results-for the proportion of area infected-equate to the percent reduction in yield^a. This value can then be placed in the equation in step IV under effect on yield if laminated root is assumed unaccounted for in the yield estimation process. Otherwise proceed to Step III.

Step III This result is an estimate of the reduction from a potential to an actual yield in an unaccounted situation represented in Step II. Since the majority of incremental pest impacts are accounted for even in managed stand yield curves (Mitchell, pers. comm.)^b, this result must be changed to reflect the yield gain opportunities when going from an empirical to an actual yield:

$$\frac{\text{area visibly infected (Step II)}}{1.0 - \text{area visibly infected (Step II) (proportion)}} = \text{Effect on Yield}$$

This value can then be placed in step IV.

Step IV Place the remaining values determined in Step I and those from either Step II or III into the equation below:

$$\begin{array}{ccccc} \text{Net or Gross} & & \text{Net or Gross susceptible} & & \text{Effect on} & \text{MAI} \\ \text{Impact/Opportunity} & = & \text{Area} & \times & \text{Yield} & \times (\text{m}^3/\text{ha}/\text{yr}) \\ (\text{m}^3/\text{hr}) & & (\text{Ha}) & & (\text{proportion}) & \end{array}$$

7.1.4.3 Tomentosus root rot

These pest effects are expressed as an impact to LRSY. The impact and incidence information are based on local studies in the Prince George Forest Region and are assumed to apply to other regions.

a. A similar assumption was used in the yield analysis for the Sunshine and Soo TSAs.

b. Research Branch, BCFS, Victoria.

- Step I Determine the susceptible area from Inventory Reports, based on the input provided in Table 2.1 (Inventory type groups and leading species used to generate susceptible stand areas).
- Step II Determine the incidence of infected susceptible stands by using 0.30 (Lewis,^a pers. comm.).
- Step III Determine the effect on MAX MAI by using 0.20^b for pure spruce stands and 0.12 for mixed stands.
- Step IV Determine the MAX MAI.
- Step V Place the values specified in Steps I through IV into the following formula:

$$\text{Impact} = \text{Net Susceptible Area} \times \text{Incidence} \times \text{Effect on MAI} \times \text{MAX MAI}$$

(m³/yr) (ha) (m³/yr/ha)

Repeat this formula using the gross susceptible area to arrive at gross impacts.

- 7.1.5 Dwarf mistletoes - the effects of these pests are expressed as an impact to LRSY. Follow the steps outlined below to calculate hemlock, lodgepole pine, Douglas-fir, and larch dwarf mistletoe timber impacts.

- Step I Determine the susceptible area from Inventory reports based on the input provided in Table 2.1 (Inventory type groups and leading species used to generate susceptible stand areas).
- Step II Determine the incidence of infected susceptible stands and effect on MAI by referring to Table A-II. Use these figures as a guide only; localized estimates are likely to provide better results. Divide by 100 to turn these numbers into a decimal fraction before inserting them into the formula in Step IV.
- Step III Determine the MAX MAI.
- Step IV Calculate the impact by substituting the values obtained in Steps I through III into the following formula.

$$\text{Impact} = \text{Net Susceptible Area} \times \text{Incidence} \times \text{Effect on MAI} \times \text{MAX MAI}$$

(m³/yr) (ha) (m³/yr/ha)

Repeat this formula using the gross susceptible area to arrive at gross impacts.

-
- a. Student, Oregon State University. Lewis' work in the Prince George Forest Region (1987) indicates that 34% and 30%, respectively, for all aged and second growth stands (less than 20 years) were infected. This figure corresponds with the 28% quoted in Van der Kamp and Merler, 1984.
- b. This figure comes from Van der Kamp and Merler, 1984, and applies to the 40-60 year age group. For the purposes of this document it is assumed to apply to other age groups.

Table A-II Data used to derive dwarf mistletoe impacts

Species dwarf mistletoe	Site Class	Stand Maturity	Incidence (allowable range) (%)	Impact (effect on MAI %)	
				Stand Composition Pure	Mixed
lodgepole pine	All	All	35 ^a (20-45)	25 ^b	15 ^b
Douglas-fir	All	All	3 ^a (2-43)	25 ^b	15 ^b
larch	All	All	2 ^a (1-5)	25 ^b	15 ^b
hemlock	G	mature ^c [immature ^d]	5 (15-60) [10]	5 ^e	03 ^f
	M	mature ^c [immature ^d]	5 (15-60) [20]	10	06
	P	mature ^c [immature ^d]	5 (15-60) [60]	25	15

- a. Van Sickle, pers. comm. Agriculture Canada, CFS, Pacific Forestry Centre. (Based on a 1 100 km roadside survey).
- b. Muir, Pers. Comm. Protection Branch, BCFS, Victoria.
- c. Beale, Pers. Comm. A professional estimate based upon an examination of 1000 growth and yield plots.
- d. Beale, pers. comm., Protection Section, BCFS, Vancouver Forest Region; and Kumi, pers. comm., MacMillan Bloedel Ltd., Nanaimo. These numbers are professional estimates and reflect two assumptions: 1) that the incidence in immature stands is reduced from mature stands because of normal harvesting and silvicultural practices; and 2) that incidence and effect on MAI decreases as site quality increases. Both these assumptions require further studies for verification.
- e. Thomson et al. 1985. This study's impact for moderate infections (23%) has been adjusted upwards to 30% to reflect the use of empirical yield data. Further adjustments are professional estimates of Beale, J. and Kumi, J. and have been made to reflect the decreasing effect on MAI of increasing site quality. Again, this assumption requires further study for verification.
- f. These numbers are 60% of the pure stand values.

7.1.6 White pine weevil - this pest can cause a variety of impacts including growth loss, top-kill and tree deformation. Two methods are explained in this section for estimating these impacts: the first is based on simulation runs of the Spruce Weevil Attack Trial model and the second calculates impacts resulting from converting Sitka spruce sites to less productive tree species. A summation of the results from both methods will provide an approximation of the weevil impacts for a particular land area.

- A) Spruce Weevil Attack Trial Model (SWAT) - this method is founded on simulation runs of a SWAT developed by R. Alfaro^a. This model is based on Sitka spruce growth and attack data from Southern Vancouver Island. In these simulations an unattacked plantation is grown to a specified rotation age based on site index and diameter increment equations. Total tree volume (stump to 10 cm top diameter) is then calculated, as well as the number and volume of 15, 10 and 5 meter logs that are obtained from the plantation at rotation.

Different infestation scenarios with varying duration and intensity of attack (percentage of trees attacked per year) are then simulated on the unattacked plantation. Attacks result in growth reduction and stem defects of different severity (Alfaro 1982, 1989a). Severe defects such as major crooks and forks prevent full utilization of the logs (they must be cut out).

Based on Alfaro (1989b), severity of weevil attack can be classified based on the percentage of trees attacked as:

Light:	1-10%
Moderate:	11-20%
Severe:	> 20%

Based on the SWAT simulations the percentage yield reduction (volume of logs) for a rotation of 60 years, in a plantation with a Site index of 38 m at age 100, attacked between ages 5 and 30 are:

Severity	Percent yield reduction to volume/ha at rotation age
Light:	11%
Moderate:	34%
Severe:	53%

These loss factors are calculated at the mid-point of the severity class (light = 5%, moderate = 15%, and severe = 25%)

Calculate an impact as follows:

- Step I Determine the area of infestation and separate into the previously described severity classes. Note: presumably stands over 40 years may have undergone weevil attack but the intensity of these infestations will be difficult to estimate. Therefore it is recommended that these stands be separated from those currently undergoing attack.
- Step II Determine the expected volume at rotation age (m³/ha).
- Step III Select the appropriate impact factor (reduction to volume/ha at rotation age) and divide by 100.

Step IV Place the values into the following formula, calculate separately for each severity class and sum the results, for impact at rotation age.

$$\begin{array}{ccccccc} \text{Impact} & = & \text{infested area} & \times & \text{volume at} & \times & \text{yield reduction} \\ (\text{m}^3 \text{ at} & & (\text{ha}) & & \text{rotation age} & & \text{to vol./ha} \\ \text{rotation age}) & & & & (\text{m}^3/\text{ha}) & & (\text{proportion}) \end{array}$$

If the user wishes to calculate impacts under conditions other than the average used for the above factors then additional loss factors are available from the Pest Management Forester.^a Also, separate runs of this program can be done if required provided SWAT is calibrated for local conditions.

To conduct separate runs of this program, at other than average conditions, the following information should be available:

- total area (ha) of Sitka spruce attack divided into different site indexes or classes, and species composition (pure versus mixed stands).
- for discrete areas of attack provide:
 - = area (ha) and site index;
 - = rotation age;
 - = expected number of Sitka spruce stems and volume/ha at rotation age;
 - = assemble the above information for all areas of discrete attack. If unsurveyed areas exist, indicate whether this information applies to it and provide the area (ha).

B) Alternative Species Impacts

- Obtain some stand characteristics (MAX MAIs for all species and the species composition) both before and after stand conversion.
- Estimate the areas involved using survey information or local knowledge. These areas include both those which have been converted because of weevil threat and those rehabilitated after a severe attack.
- Place this information into the following formula:

$$\begin{array}{ccccc} \text{Weevil Impact} & & [(\text{MAI} \times \text{COMP.} + \dots) & - & (\text{MAI} \times \text{COMP.} + \dots)] \times \text{Area} \\ (\text{m}^3/\text{yr}) & & (\text{stand characteristics} & & (\text{stand characteristics} & & (\text{ha}) \\ & & \text{before conversion}) & & \text{before conversion}) \end{array}$$

Note: MAIs - in m³/yr/ha
 COMP. - proportion of individual tree components in the stand i.e. [(MAI x 0.8 Sitka spruce) + (MAI x 0.2 western hemlock)]

- 7.1.7 Western Spruce Budworm (WSBW) - the methods described in this section have been simplified from those presented in Thomson and Alfaro (1986). These methods are derived from work conducted during the 1969-1977 and 1981-1984 outbreaks. It is assumed that future outbreaks will have similar characteristics, i.e., duration, area, attack intensity and impacts.

Step I Areas can be stratified by defoliation history based on either current or previous outbreaks. If the previous outbreak is used, then the annual area of defoliation is known. However, if the present outbreak is used, then the defoliation history is known only to the current date and the future development must be estimated^b. Impacts should only be calculated on severe and moderately defoliated lands, negligible impacts are assumed on areas of light defoliation.

A table should be developed which provides an annual estimate of defoliated area. An example of a five year outbreak follows:

<u>Infestation Year</u> <u>Within One Outbreak</u>	<u>Severe and Moderately</u> <u>Attacked Areas (ha)</u>
1st	5 000
2nd	10 000
3rd	25 000
4th	35 000
5th	5 000

A WSBW infestation tends to expand from an epicenter repeatedly defoliating the core year after year. The result is a proportional relationship between damage and successive years of defoliation. This behaviour is applied to the hypothetical five year outbreak to derive the following information:

<u>Attack Area</u> <u>(Ha)</u>	<u>Number of Successive Years</u> <u>of Defoliation</u>
5 000	5
5 000	3
15 000	2
10 000	1

- a. Protection Branch, BCFS, Victoria.
b. Once the outbreak has subsided and a defoliation history is available, these estimates could be recalculated using the actual areas of attack.

Step II Impact factors for outbreaks are presented in Table A-III. These factors are based on medium sites, a rotation age of 90 years, and inventory information from FIZ G and D. Impact factors for 1, 2, and 3 outbreaks/rotation were derived by averaging the factors in tables 1, 3, 5, and 7 of Alfaro and Thomson (1986)^a. It is assumed that, since a stand is preconditioned to budworm attack during the first outbreak, the subsequent second and third outbreaks will suffer half and one-quarter of the damage respectively. Therefore, a stand with three outbreaks/rotation will suffer 187 percent (after compounding) of the impacts presented in Alfaro and Thomson (1986).

Historical information suggests that two outbreaks per rotation is a reasonable assumption for areas of infestation in the Kamloops, Okanagan, Merritt, 100 Mile House and Williams Lake TSAs, while three outbreaks per rotation can be assumed for the Lillooet and Fraser TSAs, R. Alfaro^b, pers. comm.

Pick the appropriate impact factor from Table A-III.

Table A-III Impact factors for WSBW

(Proportional effect on volume/ha at rotation age)

No. of Outbreaks Per rotation	No. of successive yrs. of defoliation per outbreak					
	1	2	3	4	5	6
1	0.03	0.06	0.10	0.14	0.21	0.26
2	0.04	0.09	0.15	0.21	0.30	0.39
3	0.08	0.17	0.28	0.39	0.57	0.73

-
- a. These tables apply to attacked stands that are less than the rotation age and an average age of 50 was selected to represent the attacked stand's age.
- b. Agriculture Canada, CFS, Pacific Forestry Centre

Step III Determine an undamaged stand volume at rotation age, i.e., assume WSBW outbreaks have not occurred over the rotation. This estimate can be obtained from managed stand yield data.

Step IV Determine the net/gross land area ratio as previously discussed.

Step V Place the values derived in Steps I through IV in the following formula:

Undamaged	Impact		Defoliated		Net/	Impact (m ³)
Vol. at Rot.	X Factor	X	Area	X	Gross	= over the
Age (m ³ /ha)	(Portion)		(Ha)		Ratio	rotation

Example: based on attacked areas presented in Step I. Assume a stand volume at rotation age of 200 m³/ha, 3 outbreaks/rotation, and a Net/Gross Ratio at 0.8 for this example.

No. of Succ. Yrs. of Defol.	Undamaged Vol. (m ³ /ha)		Impact factor (portion)		Area (ha)		N/G Ratio		Impact over the rotation
Five	200	X	0.58	X	5 000	X	0.8	=	464 000
Three	200	X	0.22	X	5 000	X	0.8	=	176 000
Two	200	X	0.13	X	15 000	X	0.8	=	312 000
One	200	X	0.06	X	10 000	X	0.8	=	96 000
									1 048 000 m ³

7.1.8 Regeneration Delay Impacts^a - these impacts can be calculated for bark beetle infestations and will be expressed as an impact to LRSY (m³/year). Calculate as follows:

Step I Determine the MAX MAI 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) methods when making this determination.

Step V Take the numbers determined in steps I through IV and place them into the following formula:

$$\text{Regen. Delay Impact} = \frac{\text{MAX MAI}}{(\text{m}^3/\text{yr.})} \times \frac{\text{Volume at Cul. Age (m}^3/\text{ha)}}{(\text{Cul. Age} + \text{Regen. Delay (yr.)})} \times \frac{\text{Susceptible Area}}{(\text{ha})}$$

-
- a. Regeneration delay impacts for root diseases will not be calculated as assessment techniques are not well developed.
 - b. For bark beetles this area is either the nonsalvageable area for net regeneration delays or net salvageable area subtracted from the gross land area for the gross regeneration delay.

7.1.9 Porcupine - the effects of this pest are expressed as an impact to LRSY and are only calculated for select areas in the Prince Rupert Forest Region. The areas of concern are spaced hemlock and spruce stands where the porcupine has severely cropped-1% annually for 10 years-the best trees. Impacts are calculated with the assumption that this trend will continue, and that the effect is a 100% loss of growth at the stand level, i.e. these stands will not reach rotation age.

Step I Determine the area of severely damaged stands-1% annually for 10 years-from surveys or local knowledge.

Step II The effect on MAI is 100% for the hemlock or spruce component of these stands. i.e. if the hemlock or spruce component comprises 60% of this area, then use 0.6 in the equation below.

Step III Determine the MAX MAI.

Step IV Calculate the impact by substituting the values obtained in Steps I through III into the following equation.

$$\begin{array}{l} \text{Impact} \\ (\text{m}^3/\text{yr}) \end{array} = \begin{array}{l} \text{Surveyed Area} \\ (\text{ha}) \end{array} \times \begin{array}{l} \text{Effect on MAI} \end{array} \times \begin{array}{l} \text{MAX MAI} \\ (\text{m}^3/\text{yr}/\text{ha}) \end{array}$$

7.2 GLOSSARY

Accounted-For Pests - these pests usually cause insidious impacts as a result of growth reductions and can be referred to as OPPORTUNITIES to increase yields, pending some management action. These pests are accounted for in two ways depending on the type of survey (inventory or research/experimental) that was used to derive the yield curves.

Allowable Annual Cut (AAC) - the rate of timber harvest from a specified area of land. AACs are determined by the Chief Forester for TSAs and TFLs in accordance with Section 7 of the Forest Act and, for Management Farm Units, in accordance with the plan (TSA Plan or TFL Management and Working Plan) and are subject to reassessment at least every five years.

Crown Land - has the same meaning as in the Land Act, but it does not include land owned by an agent of the crown.

Culmination Age - the age at which a forest stand, for a stated diameter limit and utilization standard, achieves its maximum average rate of volume production. The age at which the mean annual increment (MAI) is a maximum.

Effect on MAI - the estimated effect of a specific pest on the stand's MAX MAI.

Effect on Yield - consists of a combined estimate of incidence and effect on MAI for a specific pest.

Forest Type - refers to a particular timber type designated by a label such as F 831-M (Species, Age, Height, Stocking, and Site).

Gross Impact - impacts occurring on the total crown forest land base.

Growth Impact - same as Growth Loss in Doliner and Borden 1984, except that growth loss can be used to describe a not accounted-for pest and growth opportunity an accounted-for pest. Growth impact is used in this report to describe both situations, usually at the stand level.

Impact - (Doliner and Borden 1984). In this report, impacts refer to effects of pests on the timber resource.

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 (LRSY) - a measure of land productivity derived from the MAI including proposed management options that are developed for a particular land base. Roughly speaking, LRSY can be thought of as the Maximum Sustained Yield of a land base, usually net land base, adjusted upwards or downwards by the imposition of management objectives and constraints on the land base.

Mean Annual Increment (MAI) and Maximum MAI - stand volume divided by stand age. The stand age at which the MAI assumes its maximum value (MAX MAI) is called the culmination age.

Mortality Impact - (Doliner and Borden 1984). Same as Mortality Loss in Doliner and Borden 1984 except that mortality loss can be used to describe a not accounted-for pest and mortality opportunity, an accounted-for pest. Mortality impact is used in this report to describe both situations, usually at stand level.

Net Operable/Gross Land Area Ratio - a ratio derived from Planning-Inventory tables which are used to net down gross land areas or volumes.

Net Land Base - the portion of the total land area of a management unit that is considered to contribute to, and be available for, long-term timber supply. The net land base is defined for a scenario by reducing (or "netting down"-usually for nonmerchantable, environmentally sensitive, and nonoperable areas) the total (or "gross") land base in a manner consistent with the management assumptions for that scenario. The definition of net land base in each TSA/TFL analysis is a very critical aspect of the yield calculation. However, as this land is calculated separately for each scenario within the analysis and this document is updated periodically, the possibility exists that these land bases may be different. If this occurs, the next update of this document will try to reflect these differences.

Not-Accounted-For Pests - these pests usually cause sudden noticeable mortality or growth impacts in infested stands. The impact of pests in this category on future harvests depends on the stand's current age-class distribution and future harvesting regimes. These pests are not deducted in yield estimates.

Nonsalvable Impacts - the volume of timber killed, usually by bark beetles in this report, over a specified net land base and for a particular year that is not harvested. This report assumes that anticipated salvage takes place.

Regeneration (Regen) Delay Impacts - include impacts to the LRSY, which are calculated for bark beetle infestations. Regeneration delays represented in this document only include additional delays directly attributable to the respective pest. To arrive at the total regeneration delay, and additional time span is needed to allow for normal crop establishment.

Salvage Factor - an estimate of the proportion of area with current attack that will be salvaged.

Salvage Potential - similar to salvage factor except this estimate is provided in m³.

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.

Site Index - a measure of site productivity. Site indices are based on tree height as a function of stand age and are usually expressed graphically as site index curves. A number of site index curves have been developed for British Columbia's major commercial tree species: for example, standard MOF (all species), Goudie (lodgepole pine and interior spruce), Bruce and King (coastal Douglas-fir), etc.

Susceptible Area - the combined stand areas that may be infested by a particular pest. This report has attempted to narrow this area down to areas where major pest impacts are likely to occur e.g. stands with a Douglas-fir component of 60% or greater for laminated and armillaria root diseases.

Timber Supply Analysis - the assessment of future timber supplies over long planning horizons (typically 0-200 years). Timber supply analyses are carried out using forest planning models for the different scenarios identified in the TSA (or TFL) planning process.

Timber Supply Area (TSA) - an integrated resource management unit established in accordance with Section 6 of the Forest Act as a revision to and consolidation of the former Public Sustained Yield Units. The TSA is the land unit with respect to which TSA planning is carried out.

Tree Farm License (TFL) - means a TFL entered into under Part 3, Division (5) (Forest Act) or under the former Act and includes a forest management license entered into before January 1, 1958.

Volume at Culmination Age - volume of a stand at MAX MAI.

7.3 Common and Scientific Names for Major Pests found in British Columbia (Benoit, 1985 and Hawksworth et al, 1985)

<u>Common Name</u>	<u>Scientific Name</u>
annosus root rot	<u>Heterobasidion annosum</u>
annual spruce budworm	<u>Choristoneura orae</u>
armillaria root disease	<u>Armillaria spp.</u>
balsam fir sawfly	<u>Neodiprion abietis</u>
balsam woolly aphid	<u>Adelges piceae</u>
beaver	<u>Castor canadensis</u>
black stain root disease	<u>Ceratocystis wageneri</u>
rhizina root disease	<u>Rhizina undulata</u>
conifer seedling weevil	<u>Steremnius carinatus</u>
Cooley spruce gall aphid	<u>Adelges cooleyi</u>
deer	Genus: <u>Odocoileus</u>
dothistroma needle blight	<u>Scirrhia pini</u>
Douglas-fir beetle	<u>Dendroctonus pseudotsugae</u>
Douglas-fir dwarf mistletoe	<u>Arceuthobium douglasii</u>
Douglas-fir tussock moth	<u>Orgyia pseudotsugata</u>
Douglas-fir caterpillar	<u>Malacosoma disstria</u>
greenstriped forest looper	<u>Melanolophia imitata</u>
gypsy moth	<u>Lymantria dispar</u>
hemlock dwarf mistletoe	<u>Arceuthobium tsugense</u>
hemlock looper	<u>Lambdina fiscellaria</u>
hemlock needleminer	<u>Epinotia tsugana</u>
hemlock sawfly	<u>Neodiprion tsugae</u>
indian paint fungus	<u>Echinodontium tinctorium</u>
laminated root rot	<u>Phellinus weirii</u>
larch casebearer	<u>Coleophora laricella</u>
larch dwarf mistletoe	<u>Arceuthobium laricis</u>
leafhoppers	Genus: <u>Cicadellidae</u>
lodgepole pine dwarf mistletoe	<u>Arceuthobium americanum</u>
lodgepole terminal weevil	<u>Pissodes terminalis</u>
mountain pine beetle	<u>Dendroctonus ponderosae</u>
pine butterfly	<u>Neophasia menapia</u>
porcupine	<u>Erethizon dorsatum</u>
red ring rot	<u>Phellinus pini</u>
rusts (deciduous)	Genera: <u>Malampsora</u> and <u>Melampsoridium</u>
sawflys (deciduous)	<u>Pontania</u>
sirococcus tip blight	<u>Sirococcus strobilinus</u>
spruce aphid	<u>Elatobium abietinum</u>
spruce beetle	<u>Dendroctonus rufipennis</u>
spruce budmoth	<u>Zeiraphera canadensis</u>
tomentosus root rot	<u>Inonotus tomentosus</u>
two-year-cycle budworm	<u>Choristoneura biennis</u>
Warren's rootcollar weevil	<u>Hylobius warreni</u>
vole	Genus: <u>Clethrionomys</u>
western balsam bark beetle	<u>Dryocoetes confusus</u>
western blackheaded budworm	<u>Acleris gloverana</u>
western gall rust	<u>Endocronartium harknessii</u>
western spruce budworm	<u>Choristoneura occidentalis</u>
white pine blister rust	<u>Cronartium ribicola</u>
white pine weevil	<u>Pissodes strobi</u>
wood borers	<u>Cryptorhynchus lapathi</u>
(poplar-and-willow borer)	<u>Saperda calcarata</u>
(poplar borer)	

7.4 PROVINCIAL TSA/TFL INDEX MAPS