1.0 OBJECTIVE

The overall objective of this project was to quantitatively determine the immediate and long-term impacts of blackheaded budworm infestations on immature stands of various age classes.

2.0 WORK COMPLETED

- Assessment of 14 Permanent Sample Plots (PSPs)

  Plots 411 to 413, 420, 422, 448 to 451, 458, 460 to 461, and 463 to 464 were assessed for damage. Defoliation was found to be minimal. Some plots were assessed on a per tree basis while others were assessed on a per plot basis as defoliation was at trace to light levels only.

- Establishment, measurement, assessment and location maps of 12 moderately to severely infested plots in growth type group G. This includes the establishment of 10 plots which will be used later for destructive sampling.

  The two plots in Buckley Cove did not get an associated destructive sampling plot due to scheduling problems. It was decided that the additional financial cost of an extra trip to establish this subplot was not warranted. Destructive sampling can still effectively take place in this stand.

- Establishment, measurement, and location map of one control plot in growth type group G.

- Ecological classification of the above 13 plots.
3.0 METHODS

The project outline (Appendix I) gives the methods used in this project for PSP establishment and measurement.

Trees were assessed for defoliation by dividing the live crown into thirds and rating the upper (u), middle (m) and lower (l) third by the estimated percent foliage removed (e.g. 80-60-40 meaning upper third 80 percent foliage removed, middle third 60 percent, lower third 40 percent). On the taller trees these ratings were labor intensive and binoculars were used to accurately assess defoliation.

4.0 PROBLEMS ENCOUNTERED

Considering the Queen Charlottes, the project went well. The biggest problem was in selecting stands of the species composition and site class required. Generally, stands typed as hemlock-spruce consist of pockets of hemlock and spruce, determined by large microsites. The change of species within these stands was very dramatic, making the transition zone for plot establishment too small in many cases.

A growth type group G stand on a medium site was very hard to find as spruce favours the higher sites. In order to get the spruce component, most of the suitable sites ended up in the higher end of the medium or lower end of the higher site class; however, these sites are very representative of the Queen Charlottes.

5.0 FINDINGS

As most of the plots ended up with higher site indices as was intended, a data base search of MB existing plots indicated that more plots are now available as control plots. These plot numbers are 446, 449, and 450; the MoFL has previously received the data on these. Plots 438 and 447 are possibly a better fit for site class, but they only have a 10 percent spruce component. Therefore, only one control plot was established. However, a considerable amount of time was spent previously on field selection of suitable stands for control plots that mainly ended up with stands of too high a site class.

Stands of age class 3 on medium sites for control plots are hard to find and are mainly located on Western Forest Products' TFL, where most are subject to some degree of defoliation.

On two occasions, we came across existing PSPs that were severely defoliated. One was MoFL sample 13, plot 1 on Sandilands Island (Crown Forest). Two more plots were found on the west side of Louise Island, just south of the narrows. These were also circular plots but had no identification. They were located on MB's TFL but the plots could possibly belong to WFP. Sectioned trees for tree analysis were found around the plots.
6.0 ACKNOWLEDGEMENTS

I would like to acknowledge the assistance received from various organizations. The Canadian Forestry Service, specifically Leo Unger's field assistance for the defoliation ratings, was much appreciated. Further assistance was received from Kerry McGourlick - Western Forest Products, Susan Craven - Crown Forest, and MacMillan Bloedel - Queen Charlotte Division operations.

This study was funded under Section 88 of the Forest Act, as administered by the B.C. Ministry of Forests and Lands, Vancouver Forest Region, Protection Branch.
APPENDIX I

PROJECT OUTLINE
1.0 INTRODUCTION

The western blackheaded budworm, Acleris Gloverana (Walsingham) (Lepidoptera: Tortricidae), in 1986 defoliated an estimated 44 300 ha of western hemlock on the Queen Charlotte Islands (Unger 1986). Of this, approximately 13 800 ha was in second-growth timber less than 100 years of age. Depending on the duration of the attack, from 1 to 3 years, trees have been severely weakened or top-kill, and mortality has been reported as high as 12 percent in 1985 (Unger 1986).

The damage inflicted by the blackheaded budworm can have significant implications for future timber supplies in the Queen Charlottes. Past outbreaks on QCI have occurred every 10 to 12 years and the potential for reoccurring epidemics in the rapidly expanding immature area is great.

Very little information is available on the quantitative losses associated with blackheaded budworm outbreaks. This project attempts to assess these losses through the establishment and remeasurements of permanent sample plots in moderate to severely infested immature stands over a range of age classes. This data will then be evaluated to determine the impact of blackheaded budworm epidemics.
2.0 OBJECTIVES

The overall objective of this proposal are to quantitatively determine the immediate and long-term impacts of blackheaded budworm infestations on immature stands of various age classes.

The field objectives are the following:

- Establishment, measurement and assessment of up to 12 permanent sample plots in moderate or severely infested western hemlock-Sitka spruce stands in growth type group G. A breakdown is shown in Table 1.

Table 1. Breakdown of proposed plot establishment.

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Growth Type Group</th>
<th>Age Class</th>
<th>Site Class</th>
<th># of Plots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>2</td>
<td>medium</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>3</td>
<td>medium</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>G</td>
<td>4</td>
<td>medium</td>
<td>5</td>
</tr>
</tbody>
</table>

- Establishment, measurement and assessment of up to 12 subplots to be used later for destructive sampling.

- Establishment and measurement of up to 4 control plots.

- Collection of ecological site information on all newly established plots.

- Assessment of MacMillan Bloedel's 14 permanent sample plots for damage by the blackheaded budworm.

3.0 METHODS

3.1 Plot Establishment

3.1.1 Stand selection. Stands were selected from the forest cover maps in conjunction with the maps produced by the Pacific Forestry Centre, Forest Insect and Disease Survey 1986, showing the defoliation ratings for the particular areas.

An effort will be made in establishing only one plot for each inventory polygon. However, it may become necessary to establish more than one plot per inventory polygon\(^2\). This way, the minimum sample size requirements will be met with only slightly less representative data.

\(^1\) Includes 4 control plots.
\(^2\) Depending on availability of infested stands.
3.1.2 **Stand location.** The stands are located on the Queen Charlotte Islands on lands managed by MacMillan Bloedel, Crown Forest and Western Forest Products. Generally, age class 4 stands are located on MB's holdings, age class 2 stands on CF's holdings, and age class 3 stands on WFP's holdings. Some minor deviations for the final plot locations can be expected.

3.1.3 **Plot installation.** The plots will be installed to the standards described in the MoFL Inventory Manual, Chapter 8, Section 8.11, "Establishment of Permanent Growth Samples in Natural Stand, 1985—Special Version for Pest Management." Those plots established on MB's TFL 39 will have all living trees, with a dbh of 4.0 cm or greater, tagged and measured in order to incorporate these plots in the MB growth and yield data base.

A subplot, consisting of a minimum of 10 trees that can later be used for destructive sampling, will be established outside each plot. The subplot is to be located at least 20 meters away from the main plot.

3.1.4 **Plot measurement.** All measurements on the plots and subplots will take place according to the standards outlined in Section 8.11 of the MoFL Inventory Manual. Additional data will be collected on:

- number and diameters of dead trees in each plot, including an assessment if they recently died,
- defoliation rating (3-4 classes) on every third tree in the plot,\(^3\)
- extent of top kill on every third tree in the plot.

3.1.5 **Environmental analysis.** Ecological classification will take place on all plots and site information will be recorded.

3.2 **Control Plots**

MacMillan Bloedel has 11 existing permanent sample plots in place on QCI that fit the same stratum as outlined in Table 1 of section 2.0 of this proposal. These can possibly be used as control plots, except for the ones being assessed as moderate to severely defoliated under section 3.3. These plots are all 0.04 ha in size and have been measured anywhere from 6 to 28 years. The MoFL has previously received data on these plots. Table 2 provides a breakdown of these plots.

---

\(^3\) Leo Unger (CFS) has agreed to assist us with the defoliation class ratings and training. He will visit and rate MB's 14 permanent sample plots that are possibly infested, and assist in selecting the stands for plot establishment. Up to 10 mandays of his time will be covered by the CFS. His expenses, however, are included in the budget of this proposal.
Table 2. MB control plots in GTG-G in medium site class.

<table>
<thead>
<tr>
<th>Age Class</th>
<th>Plot Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1859, 1863, 1875,</td>
</tr>
<tr>
<td></td>
<td>1976, 1978</td>
</tr>
<tr>
<td>3</td>
<td>439</td>
</tr>
<tr>
<td>4</td>
<td>412, 413, 461,</td>
</tr>
<tr>
<td></td>
<td>463, 464</td>
</tr>
</tbody>
</table>

All age class 4 plots are in areas of light defoliation. Their suitability as control plots will be assessed in the field.

3.3 Existing Permanent Sample Plot Assessment

A total of 14 permanent sample plots in GTG-G of MacMillan Bloedel are in areas of light to moderate infestation according to the map produced by the Forest Insect and Disease Survey of the CFS, 1986. They will be assessed for damage and rated for degree of defoliation by MB staff and Leo Unger of the CFS.

These plots have all been established between 1958 and 1967, and the MoFL has previously received data on these plots. It is, therefore, of interest to both the MoFL and MB that this assessment takes place. This is a unique opportunity to collect blackheaded budworm impact data on plots that have been measured over a period of 20 years or longer.

It will probably be unnecessary to alter the remeasurement schedule of these plots as the bulk will be remeasured after the 1987 growing season.

4.0 TIMING

Field work is to commence May 19, 1987, and to be completed on or before June 26, 1987.

5.0 REPORT

A final report will be submitted by December 31, 1987.

6.0 REFERENCES


7.0 **BUDGET (as per MoFL allowances)**

- **Mandays**

  Professional 4 MD @ $214 $ 856.00
  Technical 56 MD @ $177 9,912.00 $10,768.00

- **Expenses**

  Supplies: 600.00
  - stakes, paint, flagging,
  - tags, nails

  Travel:
  - Floatplane 4 Trips @ $400 1,600.00
  - Boats 600.00
  - Ferries:
    - Prince Rupert 2 @ $57 114.00
    - Alliford Bay 40.00
  - Flights 2 @ $447.60 895.20
  - Vehicle 23 FD @ $50 1,150.00 4,399.20

  accommodation: 45 FD @ $88.50 3,982.50

  Sub-Total $19,749.70

  + 18% OVERHEAD ALLOWANCE ON $13,118.00 $2,361.24

  **TOTAL** $22,110.94

---

4 The contract price will be reduced for each plot not established due to inavailability of suitable stands.

5 Overhead allowance eligible on mandays, boats, supplies and vehicle.
Regional Manager
Kamloops Forest Region

Attn: D. Hutcheson, Chairman,
Pest Damage Appraisal Advisory Committee (PDAAC)

Vancouver Region
May 13, 1986

Re: Blackheaded Budworm Appraisal Project

Notes from topic meeting, 8 May 1986, Victoria.

In attendance:

PDAAC Committee members:

D. Gilbert, Protection Branch
J. Goudie, Research Branch
S. Taylor, Protection Branch
P. Wood, Vancouver Region

Also in attendance:

R. Alfaro, Canadian Forestry Service
J. Braz, Planning and Inventory Branch
I. Cameron, Research Branch
P. Hall, Protection Branch
D. Heppner, Vancouver Region
S. Omule, Research Branch
J. Viszla, Planning and Inventory

The objective of this meeting was to agree on a final sampling design for the blackheaded budworm outbreak in the Queen Charlotte Islands.

Action items from previous meeting (17 April 1986):

- There is an insufficient number, and diversity, of Western Forest Products' permanent sample plots, in infested areas, to fulfill the requirements of this project (Heppner). Therefore, we need to install our own plots.
DISCUSSION:

Do we need to sample this year?

- It was suggested that it may be possible to measure budworm damage after the infestation has collapsed.
- But we need to know "background" level of mortality and top-kill due to other causes before we can determine budworm damage.
- Use of WFP's permanent plot was considered to be unacceptable for background loses; better to use same plots as being measured for budworm losses.
- Conclusion: Need to sample this year, before 1986 defoliation.

How frequently, and what, do we need to remeasure?

- Need to measure height, diameter, species, previous damage, of living trees in plots.
- Remeasure only mortality and top-kill annually until after population collapses.

How do we measure growth losses?

- Various alternatives discussed; agree to postpone growth reduction measurements, by stem analysis procedures, until 2-3 years after population collapses (to capture recovery period as well). Stem analysis procedure eliminates the need to establish non-affected "control" plots.

What type and size of sampling units?

- Discussion regarding series of small plots for each sample (as per Inventory's Permanent Growth Sample Design) versus a single larger plot per sample. Although a series of plots may capture within stand variation, it was agreed that single plots per sample adequately capture variation within the infestation by way of several replicates per stratum, and are easier to install and remeasure.

- Each plot to be 0.03 ha (min.) to 0.08 ha (max.), to measure approximately 100 trees per sample. We will use Inventory's specifications for plot sizes and size of trees to be measured.

What strata are to be sampled?

- Two age classes: A review of timber types in the 1985 infested area (Heppner), reveals that almost all types are either age class 8 ("mature"), or are 35-45 years old ("immature"). There is also consistency in site quality (height class 4-5 for "mature" stands).
- Only one length of attack duration: Infested in 1985+. This will provide "worst case" impact data. Measurement of various years of attack duration creates too many permutations and combinations for a practical sampling design.
- Two intensities of defoliation: Severe and light. Severity of defoliation to be judged (subjectively) from the air by one party (Heppner/Wood). Independent, and blind (if you know what I mean) assessment from ground to be made by sampling contractor, according to objective criteria (to be developed by Heppner/Alfaro).
- Only one timber type: Hemlock-spruce. There are not enough infested pure hemlock stands for sampling.
- Therefore, only four strata:

  HS, MATURE, SEVERE
  HS, MATURE, LIGHT
  HS, IMMATURE, SEVERE
  HS, IMMATURE, LIGHT

- Number of replicates per stratum: minimum of 3, preferably 5 or more.
- Can replicate in same stand.
- Random location within stand.

ACTION ITEMS:

- Heppner/Wood to ground truth candidate plot locations in O.C.I.
- Viszla to faxcom PSP sampling specs. and example contract to Vancouver Region.
- Heppner/Alfaro to devise method for ground estimating defoliation on a plot basis.
- Heppner/Wood to prepare contract specs. for W.F.P.'s contract.
- Viszla/Braz have volunteered to provide training to successful contractor.

Paul Wood
Pest Management Coordinator

PW/1ab
VAN 1493P
Regional Manager
-- Kamloops Forest Region

Vancouver
April 18, 1986
150-408

Attention: D. Hutcheson, Chairman
Pest Damage Appraisal Advisory Committee (PDAAC)

Reference: Blackheaded budworm appraisal project

Notes from topic meeting, 17 April 86, Victoria.

In attendance:

PDAAC Committee Members:

D. Gilbert, Protection Branch
J. Goudie, Research Branch
P. Wood, Vancouver Region

Also in attendance:

D. Heppner, Vancouver Region
S. Omule, Research Branch

WOOD:

- Description of current and historical (from FIDS maps) budworm outbreaks in the Queen Charlotte Islands.

  Patterns: almost no consistent pattern to outbreaks in terms of extent, locations of stands affected, or severity of defoliation.

- We would like to be able to calculate the damage impact resulting from the current infestation.

- This does not mean we will then have the ability to predict budworm damage in the future, except perhaps in a "ballpark" fashion, because we are lacking the ability to predict extent, location and severity.

- With the combination of this assessment project and good aerial surveys we would hope to be able to:
(a) Delineate areas of mature timber that are in need of salvage or that should be given volume depletions in the inventory data base.

(b) Delineate immature stands that may require rehabilitation.

(c) Perhaps make some crude predictions of impact on LRSY for the Queen Charlotte Islands T.S.A. and TFL's 24 and 39, both on the Charlottes.

(d) When the next outbreak occurs in the Charlottes, we would like to be able to make rough predictions of expected damage to feed into a benefit/cost analysis when considering control operations.

HEPPNER:

Two sampling proposals. Both have the same objective: to determine the percentage and distribution (spatial) of mortality and top-kill, and the percentage of gross growth loss, for mature and immature stands, two timber types (H and HS), by severity of defoliation, and by number of years attacked.

Proposal 1: Use Inventory's "Intensive Forestry Monitoring" sampling design, consisting of:

- sample area .04 to .2 ha, to obtain minimum 100 trees per sample.
- 5 circular plots per sample, all for remeasurement
- stem mapping by bearing and distance from plot center.

Proposal 2: Use Inventory's "Permanent Growth Sample" design, consisting of:

- 6 circular plots per sample,
  - 3 for destructive sampling and
  - 3 for remeasurements
- stems mapping by bearing and distance from plot center

In either case, require stratified design:

2 age classes
\[ \times \]
3 lengths of attack time (85 +, 86 +, not attacked) \[ \times \]
3 intensities of defoliation (S,M,L) \[ \times \]
2 timber types

... 3
DISCUSSION:

- Number of replicates required: 3 per stratum as minimum.

- How do we minimize variation:
  - Sample only "good" sites.
  - Use only pure hemlock (do not have mixed stand yield tables in province yet anyway; Analysis Units for TSA yield analyses are type amalgamations).

  - Ignore "moderate" defoliation; sample "extremes" of light and severe defoliation.

  - Limit age class variability by examining forest cover maps and selecting representative age class limits in "mature" and "immature".

  - Multi year of attack variability too great. (ie. does one year of moderate equal two years of light?, etc.) Suggest measure stands attacked in '85 + only.

- How do we select "non attacked" samples this year before we know extent and locations of coming defoliation:
  - Suggest using Western Forest Product's permanent plots that were attacked in '85 and meet above criteria. Use previous remeasurement(s) for background levels of mortality, top kill and growth rates (radial and height).

- How do we measure growth reduction:

  (a) If use WFP plots, can extrapolate from previous remeasurements, and analyze difference.

  (b) Destructively sample trees immediately outside the buffer strip around the plots and run stem analysis procedures (Alfaro?).

- Foreseeable problems with stat. analysis:
  - None (Omule and Goudie)

Action Items:

- Gilbert to contact Joe Braz, Inventory Branch, for design suggestions, and contract specifications.

- Heppner/Wood to contact John Barker, Western Forest Products, to review their sample plot data for plots within attacked area.

- Omule to review standards of Western Forest Products permanent plots, for BCFS acceptability.

Paul Wood
Pest Management Coordinator
To: Regional Manager  
Kamloops Forest Region  

Attention: Dennis Hutcheson, Chairman  
Pest Damage Appraisal Advisory Committee  

From: Vancouver Region  
Date: January 14, 1987  

Re: Update on the Blackheaded Budworm Impact Appraisal Project

A meeting was held in Victoria on January 12, 1987, to review progress on the western blackheaded budworm project and determine priorities for future work. Those in attendance were:

Peter Hall, Protection Branch  
Jim Goudie, Research Branch  
John Viszla, Planning and Inventory Branch  
Joe Braz, Planning and Inventory Branch  
Dick Heath, Vancouver Region  
Don Heppner, Vancouver Region  
Rene Alfaro, Canadian Forestry Service

WORK COMPLETED TO DATE:

Fifteen growth and yield type plots have now been established in severely infested hemlock-spruce stands. Seven of these were placed in age class 8 mature stands with the remainder in second growth areas. Stand selection was based somewhat in favour of relatively homogeneous forest cover. The company involved, Western Forest Products Ltd., hired a local contractor to carry-out the field work. Audits conducted by district staff indicated their work conformed with Ministry standards. Costs per plot approached $700.00, primarily because of difficult access. No attempt was made to assess crown defoliation from the ground. (assessed from the air)

RECOMMENDATIONS FOR FUTURE PLOT ESTABLISHMENT:

(i) It is recognized that stand variability levels dictate the establishment of additional plots, but there was no consensus on a cost-effective optimum number. We will re-examine this point after a review of Section 88 funds available in 1987/88.

(ii) The Islands are a horrible mix of stand types and there is no way we can sample them all. The large majority of second growth stands are H or H(S, CW), so we are limiting our samples to those strata. No additional G&Y plots will be placed in mature stands, although some mortality sampling will be carried out.
(iii) A sub-sample of trees in each plot will be rated for
defoliation. At this point we are looking at a simple 3-4 class
system. The previous lack of such a procedure means we may have
to consider a cumulative rating at the end of the infestation
rather than a series of annual measurements.

(iv) Ecological classification data will be collected at each plot
including those already established.

(v) If possible, plots will be established in one site type.

(vi) The amount of top-kill will be assessed when the outbreak
collapses, preferably during the period of bud flush.

(vii) Previously established G&Y plots located outside infested stands
will be evaluated for use as controls. They may also be some
older plots within infested areas which may be adapted for our
purposes.

SUMMARY:

MacMillan Bloedel Limited is cooperating in the project and has plans to
establish several plots in their T.F.L. Logistics permitting, we would
like to see them in before March 31, 1987, so they can be paid for with
residual Section 88 funds and be in place before the next period of
defoliation. A decision on further plot establishment will be made
soon. Inventory Branch has volunteered to carry-out the primary data
compilation, but does not have the resources to analyze the results so
we may contract this out or do it "in house".

Dick Heath
Pest Management Coordinator

DDH/lab
VAN 1973P

c.c. Peter Hall, Protection Branch

c.c. Dave Gilbert, Protection Branch

c.c. Stuart Taylor, Protection Branch

c.c. Jim Goudie, Research Branch

c.c. Steve Omule, Research Branch

c.c. John Viszla, Planning and Inventory Branch

c.c. Joe Braz, Planning and Inventory Branch

c.c. Brian Simpson, Queen Charlotte Islands District

c.c. Russ Cozens, Prince George Region

c.c. Peter Ackhurst, Vancouver Region

c.c. Russ Hughes, Vancouver Region

c.c. Don Heppner, Vancouver Region
Mr. Dick Heath, R.P.F.
Pest Management Forester
Vancouver Forest Region
Ministry of Forests and Lands
4595 Canada Way
Burnaby, B.C.
V5G 4L9

Dear Mr. Heath:

Please find enclosed a draft proposal for the collection of black-headed budworm impact data on the Queen Charlotte Islands. The proposal follows the requirements as set out in your letter of March 27, 1987, File: 720-4-3.

A final proposal will be forwarded as soon as all the information on suitable lands has been received and analyzed from Crown Forest and Western Forest Products. According to telephone conversations with Sue Craven, CF and Kerry McGourlick, WFP, there should be enough stands available that meet the criteria.

There might be a problem in finding enough suitable growth type F, pure western hemlock stands. I believe it is possible that plots in this GTG can be established in purer areas of western hemlock within GTG-G stands. The reconnaissance flight of the areas with Leo Unger of the CFS will partly be used to confirm this possibility. There is no significant number of age class 5 stands in TFL 39.

The target date for commencement of the field work is May 19, 1987. We feel it is important not to postpone this beyond this date as measurements should take place before the growing season. Therefore, I would like your response as soon as possible in order to incorporate this into the final proposal.

.../2
I will be away in the field until April 21, 1987 on which day I will try to contact you. In the meantime, if you have any questions, please call Janna Kumi at 753-1112, Local 256.

Yours truly,

MacMILLAN BLOEDEL LIMITED
WOODLANDS SERVICES DIVISION

[Signature]

Rudi van Zwaaij
Land Use Planning Advisory Team

RVZ/bw
encl.