

**SITE DISCREPANCY ASSESSMENT
FOR THE ARROW TIMBER SUPPLY AREA**

by

**Laing & McCulloch
Forest Management Services
Smithers, British Columbia**

**British Columbia Ministry of Forests
Victoria, British Columbia
Forest Service Internal Report**

PM-PB-81

Submitted December 1988

Not for Publication

March 1991

(The contents of this report may not be cited in whole or part without the written approval of the Director, Protection Branch, Ministry of Forests, 31 Bastion Square, Victoria, British Columbia V8W 3E7)

FOREWORD

This report is one of a series of internal reports distributed by Forest Protection Branch, B.C. Ministry of Forests, to record accomplishments and interim or provisional results for the information of staff, colleagues, and others.

In the Canada-British Columbia Forest Resources Development Agreement (FRDA) 1985 to 1990, over 100 pest control projects were directly funded by the province and administered by protection staff. To facilitate application of the results, and development of improved forest health management strategies, the contractors reports have been edited and distributed as internal reports. Accordingly, any opinions and recommendations expressed are those of the contractor, and not necessarily those of the ministry or the FRDA management committee.

For details or more information about the report or project, please contact forest health staff at Protection Branch or at the forest region offices.

J. Muir, RPF
Acting Manager
Forest Health
Forest Protection Branch

The guidelines for internal reports outlined in the Protection Manual were adhered to as closely as possible. All manuscripts were altered to comply with a common format, but entire reports were not rewritten to conform to a standardized outline.

Most Executive Summaries were the work of Graham Hawkins of MoF Inventory Branch (formerly with Pacific Coast Forest Biology). All word processing was accomplished by Catriona Kaufman of Top Kat Services. Will Gordon of R. White Woods inc. prepared all maps and figures.

R. White, editor
R. White Woods inc.

EXECUTIVE SUMMARY

The objectives of the study were to locate 100 stands that were identified as "discrepancy sites" on the forest cover maps, measure site class, and determine the proper inventory label, and reasons for any apparent discrepancy.

Field procedures focused on identification of pest problems and other reasons for site class discrepancies. Forest cover maps were received for the following types of inventory labels: deciduous species leading, coniferous species leading and site class was poor, coniferous species other than western redcedar or true fir were leading and site class was medium, labels where coniferous species were leading, and site class was good but crown closure was less than 50%. A total of 20, 20, 37 and 25 sites were sampled in the respective categories by running survey strips through each area. Three sampling points were used per site. At each point, the following was determined: ecosystem associated, site index, presence of pathological insects or other problems, age, height, gross volume/ha, total merchantable stems, soils, topography. Pest incidence was recorded by code. Regeneration information was also obtained for younger stands (age class 1 or 2). All information was summarized per polygon (site) and collated by discrepancy code for a final summary. A type label was then changed only if there was a change in the type group, leading species, site class, or height or age class of more than one level. A change in MAI (mean annual increment) for discrepancy sites was only calculated if the stand was satisfactorily restocked. Old labels were then removed from forest cover maps, where applicable, and polygons were color-coded as to the reason for the discrepancy. Discrepancies were coded as: unknown, due to *Armillaria*, black stain, due to other pests or other causes. Sampling was restricted to small areas of the polygon and variations in site index per polygon were noted; therefore, data were interpreted as useful only for general trends.

No discrepancy was measured on 65% of all sites sampled. Of the 35% with discrepancies, 31% of the discrepancies were due to pests, 49% due to other causes and 20% due to unknown cause(s). A total of only 11% of the sites had a discrepancy due to pests, even though pests were present in 36% of the sites. Pest incidence appeared to be strongly correlated with previous logging disturbances. *Armillaria* appeared to be the most common pest; larch disease and white pine blister rust, and bark beetles were also common. Discrepancies were most often explained by suppression or thin soils, but pests had a greater impact than these factors. Laminated root rot was not noted to any extent. Total potential gains in MAI were 583m³/ha in the next rotation following implementation of pest treatments. The frequency of erroneous labels indicated a requirement for updated forest cover maps. The survey system was found to be relatively low cost, although accuracy was lower than for conventional disease surveys. In addition, volume loss measurements were superior with this technique than with conventional disease surveys.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	ii
1 INTRODUCTION	1
2 METHODS	2
3 RESULTS	7
4 DISCUSSION	9
5 CONCLUSIONS	10

APPENDICES
(not included)

A	Project Methodology Terms of Reference (Schedule B)
B	Tree Species Site Index by Ecosystem Association (Example)
C	Pest Ledger (Example)
D	Pest Impact Summary Table
E	Pathology Laboratory Results

TABLES

1	Site Discrepancies and Associated Problems	12
2	Estimated MAI	13
3	Site Class Discrepancy by TSA: Nelson Region	14

1 INTRODUCTION

In 1988 a contract was undertaken to conduct a site discrepancy survey. All field work was conducted in September, and the final report was completed in December 1988.

The objective of the project was to examine stands that apparently had a substantial difference or discrepancy between site quality indicated by inventory measurements and by ecological classification criteria.

More specifically, the objectives were to:

1. measure the inventory site class within approximately 100 stands and compare each to the predicted site class based on ecological classification (ecosystem associations);
2. determine the reason for any discrepancy;
3. determine any potential loss or gain in productivity (mean annual increment or timber volume per hectare per year) associated with discrepancies;
4. identify any errors in inventory labels within sampled stands and their effect on mean annual increment (MAI);
5. identify stands with pest problems; and
6. predict any volume losses resulting from pests.

2 METHODS

The regional pathologist, Nelson Forest Region, provided 1:20 000 scale forest cover maps indicating potential sites for sampling based on four types of inventory labels:

- a. stands with deciduous species leading;
- b. stands with coniferous species leading and the site class poor;
- c. stands with coniferous species other than western redcedar or subalpine fir leading and site class medium;
- d. stands with coniferous species leading, site class good, and crown closure less than 50%.

Only sites with less than 30% slope and reasonable access were chosen. In total, 20, 20, 37, and 25 stands were sampled in categories a, b, c, and d, respectively.

At each site, a two-man crew hand compassed and chained from an easily identified tie point to the stand. Traverse notes were taken and type changes mapped along the line.

The crew established three sampling points, usually 50m apart. If the stand was less than five hectares in size, sampling points were only 20m apart.

At each sample point one crewman would:

- a. complete a prism sweep (eight to ten trees/plot - normally BAF 5) recording tree species and tree count (dbh was not measured);
- b. choose a codominant tree from the leading species and measure height and age;
- c. calculate gross volume/ha,¹ total merchantable stems/ha (greater than 17.5cm dbh) and total stems/ha greater than 17.5cm dbh;
- d. estimate average height and diameter of other trees in the stand and determine the forest inventory label; and

¹ Volume calculated as one-third codominant tree height x number of stems in the sweep x BAF (basal area factor).

- e. determine site class based on the height and age of the codominant tree using MoF site index equations and tables.²

At the same time the other crewman would:

- a. identify the ecosystem association;
- b. record the site index of the major species using the "Site Index by Tree Species by Ecosystem" tables produced for the Nelson Forest Region; and
- c. examine trees for insect, disease or other stand problems, and record those problems.

All data at each sampling point were recorded on the Reid-Collins Ground Call Card (RCA-MIO). When the sample point occurred in age class 1 or 2 stands, regeneration information was also recorded on a standard regeneration card (F.S. 627). In such cases no prism sweep was conducted, volume was not calculated, and no site index was calculated. Traverse notes between sample points were recorded.

In addition to the basic stand data described above, aspect, per cent slope, slope position, terrain, drainage, soil texture, humus order and depth, and soil order were also recorded. Finally, pest incidence levels and stand management recommendations were noted. Pest incidence was coded as follows:

- 1 = < 2% of tree affected
 2 = 2-6% affected
 3 = 7-14% affected
 4 = 15+% affected

For each site, a pest ledger was filled out. The pest ledger summarized, for each polygon (stand), physiographic characteristics, ecological classification, predicted and measured site class, the new inventory label, volume or stocking per hectare, and primary and secondary reasons for any discrepancies.

Additionally, the best treatment for the stand was also briefly described. All numerical summaries were determined as arithmetic means of the tree sample points within the stand. For example, problems were summarized as:

Arme	and	Thin Soils
2		1
4		2

² MoF Inventory Branch, Field Pocket Handbook (1980), Site Index Equations and Curves.

where:

- Arme and Thin Soils are the primary and secondary reasons for discrepancy (pests, such as Arme, were coded using the first two letters of the generic name and the first two letters of the specific name [Arme = *Armillaria mellea*]); and
- 2 | 4 is the pest incidence level code within the prism plot (left of the vertical line) and within the stand as a whole (right of the vertical line).

Upon completion of the field work, all data were compiled using Lotus 1-2-3 application software. A pest impact summary table was produced containing the following information on each stand:

- map sheet and polygon
- area (from the MoF attribute list)
- average age
- average stems per hectare for stands less than 41 years old
- average volume per hectare for stands greater than 40 years old
- the old map sheet label and the field-confirmed new label as well as associated MAI per hectare for each label, the total MAI for the polygon for each label and the difference in total MAI resulting from the label change (when there was no label change, no calculations were performed)
- the confidence class of the new label where:
 - I = Confident that the new label represents the entire polygon
 - II = Moderately confident that the new label represents the entire polygon
 - III = Confident that the new label represents a small portion of the polygon but uncertain about the rest of the polygon
- pest incidence code for polygon (1, 2, 3, or 4)
- discrepancy code for the polygon where:
 - A = a discrepancy site, cause unknown
 - B = a discrepancy site because of pests
 - C = a discrepancy site due to other causes
 - D = not a discrepancy site but pests evident in the leading species
 - E = not a discrepancy site but pests evident in species other than the leading species
 - F = not a discrepancy site
- the total and per hectare MAI for the polygon, using the field-confirmed (new) label, for the site class predicted for the ecosystem association and for the measured site class (from the pest management ledger)

- the difference (discrepancy) in total MAI for the polygon resulting from the difference in site class (where no difference occurred, no calculations were performed)
- the current total MAI for the polygon using the new label and measured site class, the total MAI for the polygon in the next rotation assuming a decrease in site class of one level (e.g., good to medium), and the resultant difference in total MAI. (This calculation was conducted only for stands in which pests were a problem and the incidence level was two or more in the leading species.)

This information was then collated by a discrepancy code, and numerical information was summarized for each code.

During the process of summarizing label and MAI information, several assumptions were made:

1. unless field-confirmed, crown closure in the new label was assumed to be the same as in the old label;
2. a type label was changed only if there was a change in: type group, leading species, site class, or height or age class of more than one level;
3. an area was labelled NSR if it was less than 41 years of age and had less than 300 stems/ha, or if it was greater than 40 years of age and the calculated volume was less than 80m³/ha;
4. when the stand was NSR, the contribution to MAI was assumed to be zero (unless the stand was greater than 40 years and had greater than 300 stems/ha, including non-merchantable stems);
5. to be labelled a discrepancy site, more than one-third of the sample points had to be in discrepancy;
6. a change in MAI for discrepancy sites was only calculated if the stand was SR, and was calculated regardless of age class if the site class predicted by ecosystem association was different than measured site class;
7. a change in MAI in the next rotation was calculated even if the stand was not SR if the pest incidence code was two or greater and the discrepancy code was B or D; and
8. information on white pine blister rust was not recorded in the field nor was it incorporated in volume calculations since it was assumed to be present everywhere. No stands were sampled in which white pine was leading.

Two types of were produced: a plot location/label change map and a pest incidence map. Pest locations and the transect line were marked in pencil on 1:20 000 forest cover maps. The association polygon was outlined in red felt pen and where label changes occurred, the old label was crossed-out and the new label noted. The confidence code for the new label was also stated.

A second set of 1:20 000 forest cover maps were also produced showing pest incidence level. Each sampled stand was colored by discrepancy code and the incidence level code was stated within a small circle in red felt pen. The color coding was as follows:

A - discrepancy due to Arme	solid gray
B - discrepancy due to Vewa	solid yellow
- discrepancy due to Arca	solid pink
- discrepancy due to Other Pests	solid green
C - discrepancy due to Other Cause	solid brown
D - no discrepancy, Arme evident in leading species	outline yellow
- no discrepancy, Vewa evident in leading species	outline pink
- no discrepancy, Arca evident in leading species	outline green
- no discrepancy, other pests evident in leading species	outline blue
E - no discrepancy, Arme evident in species not leading	Cross hatch in yellow
- no discrepancy, Vewa evident in species not leading	Cross hatch in pink
- no discrepancy, Arca evident in species not leading	Cross hatch in green
- no discrepancy, other pests evident in species not leading	Cross hatch in blue
F - no discrepancy	Outline in black felt pen

3 RESULTS

Detailed results of the survey are tabulated in Appendix 1.

As shown in Table 1, there was an apparent or indicated discrepancy 87% of the time because of either a label problem, silvicultural problem, or a pest management problem affecting site productivity (MAI).

Label changes from the original were required in 36% of the stands checked, and these resulted in a net positive MAI increase of 9.8%.

A silvicultural treatment, such as stocking control or NSR rehabilitation, was needed in 19% of the stands, and was estimated to contribute - if treatment was done - a 31% increase in MAI.

A pest management treatment, such as root removal to control *Armillaria ostoyae* or species conversion to control black stain root disease problems, was needed in 33% of the stands. Disease treatments, if done, would result in an estimated 22% increase in MAI.

Table 2, which was constructed to specifically avoid double counting of benefits, indicates the proportional amounts of MAI increases possible. No attempt was made to "net down" percentage increases since the benefits could as easily be larger as smaller (i.e., in a small patch of forest land farmed for between two to three years in 1928/30 near Sicamous, the trees are growing much faster than would be expected for that ecosystem).

In total, the MAI of the discrepancy strata could be raised by 63% over what is recorded in the inventory at present.

A number of general field observations are also worthy of mention. The most important of these was that pest incidence appeared to be strongly correlated with previous logging disturbance. The incidence of *Armillaria* root disease was pronounced in selectively logged stands. It is also probable that selective logging in stands heavily infected with mistletoe can have detrimental consequences.

Another qualitative observation is that although *Armillaria* was the most common pest, it was very difficult to determine if it was a primary or secondary agent. It was frequently associated with cut or damaged trees, dead suppressed trees, and beetle killed trees. In such circumstances, it was difficult to ascertain if it was saprophytic or pathogenic.

Larch mistletoe was also widespread but did not always result in a site class discrepancy. It appeared that incidence levels had to be very high (dwarf mistletoe rating

five or six) before a major impact on height growth became apparent. No attempt was made to determine the period of time a stand had been infected.

A final observation was that white pine blister rust was common throughout the study area. Unfortunately, no resistant stands were noted, and few trees were unaffected.

4 DISCUSSION

Several limitations in procedures and data might limit the application of the results of this study. These limitations are serious enough; however, the conclusions should be broadly indicative. Limitations include:

1. A typical codominant tree of the leading species was not always available within the prism plot. Because site index was based solely on this tree, a surveyor would sometimes be required to measure a tree outside the plot. Therefore, the ecosystem associations (upon which predicted site class is based) for the plot could be different than the ecosystem association at the measured codominant tree.
2. Three plots per stand were often insufficient to account for the variability in species distribution and site conditions within a stand. As a result, site indices and pest problems were occasionally recorded for one leading species at one sampling point but for a different species at the other two sampling points. Averaging these site indices would be meaningless.
3. Site index predicted by ecosystem association is often based on rather weak data (often only one or two plots) and as a result, the confidence interval can be as much as 60% of the mean (e.g., ICHa1/03 for Se).
4. Predicting the volume loss due to label changes for an entire polygon on large areas could be erroneous since only a small portion of the polygon was sampled.

5 CONCLUSIONS

The results of this pilot study indicated that the technique of field checking apparent discrepancy sites would be useful for locating problem areas, and for prioritizing their treatment.

Secondly, the "site discrepancy survey" technique would appear to be a very useful planning tool for a forest management strategy that would ultimately boost the productivity of Timber Supply Areas (TSAs) and could be an important factor in alleviating the falldown effect.

Thirdly, were a district to become involved in a "steady state inventory update," which also involved silviculture and pest management assessments, a catalogue of treatment areas, appropriately prioritized, could be developed and for which costs and benefits (MAI/AAC) could be estimated. From this, targets could be established and budgets allocated in a systematic, planned and business-like manner. The cost of the site discrepancy survey/steady state inventory could be as low as \$30 000-\$50 000 annually.

Table 3 illustrates the proportion of forest land by site class in each Timber Supply Area based on forest inventory data or data derived from ecosystem research.

The results show the relative amount of site discrepancy between districts, and - in very broad terms - the opportunities for increasing timber productivity in each TSA.

Given that the site discrepancy survey appears to have a good probability of working, the author recommends that:

1. A further test be conducted of the site discrepancy survey technique, on at least 500 strata using improved field methodology, and with participation of regional Inventory, Silviculture, and Protection to ensure that the survey design is practical and statistically sound.
2. Participation of at least one volunteer district to examine a supply block using the site discrepancy survey techniques.
3. Branch, region and district sources of funding a contract be examined. Contract supervision should be done by district personnel.

Conceptually, the author would propose a process/infrastructure for steady state inventory as follows:

1. Site discrepancy survey be conducted by contract. Contractor have inventory, silviculture and pest management skills on his crew. Funding from district

budget, and ideally a target for proportion of TSA to be examined is established (i.e., five to ten per cent of TSA annually).

2. Pest Management/Inventory/Silviculture personnel maintain a catalogue of opportunities and prioritize each of the problem strata. Prioritization guidelines can be established by region/district.
3. Each high priority strata would have an action plan developed denoting:
 - a. strategy;
 - b. tactics to be used to implement strategy;
 - c. cost estimates; and
 - d. time line of activity.
4. Treatment program based on budget allocations and ability to fit in with SBFEP or special funding.
5. Treatment program would be integrated with pest management and the silvicultural plan for the TSA.

TABLE 1 SITE DISCREPANCIES AND ASSOCIATED PROBLEMS

Attribute	Stand (Inventory Label) Type				Total
	All Conifers P - Site	All Conifers (except C, H) M - Site	All Conifers G - Site < 50% Crown Cover	Deciduous	
Stands Examined	20	36	23	23	102
Labels Confirmed	1	6	4	2	13
Label Problem	10 (1)*	13	6	8	37 (1)
Silvicultural Problem	4	3 (1)	5	7	19 (1)
Pest Problem	4 (1)	14 (1)	8	7	33 (2)

* (1) or (2) indicate stands with two problems.

TABLE 2 ESTIMATED MAI

Map	Old Label (existing anticipated yield) m ³ MAI		New Label (anticipated yield without treatment) m ³ MAI	Pest Treatment Yield (due to Pest Management) m ³ MAI		Silviculture Yield (due to Silviculture Treatment) m ³ MAI	
004	911.8	(30%)	480.1	1 023.2	(543.1)	1 185.2	(162.0)
014	1 091.7	(112%)	1 696.4	2 100.5	(404.1)	2 312.8	(212.3)
021	1 326.0	(35%)	1 634.9	1 766.4	(131.5)	1 788.7	(22.3)
022	843.3	(39%)	845.9	1 117.2	(271.3)	1 172.6	(55.4)
023	2 893.9	(53%)	3 624.1	3 887.9	(263.8)	4 419.1	(531.2)
024	2 587.8	(116%)	2 696.0	3 509.0	(813.0)	5 597.6	(2 088.6)
034	878.8	(35%)	584.1	709.9	(125.8)	1 182.5	(472.6)
	10 533.3		11 561.5 (+9.8%)	14 114.1 (+22% of new label)	(2 552.6)	17 658.5 (+31% of new label)	(3 544.4)

TABLE 3 SITE CLASS DISCREPANCY BY TSA: NELSON REGION

DISTRICT	SITE CLASS											
	GOOD			MEDIUM			POOR			LOW/NP		
	EA	INV	SD	EA	INV	SD	EA	INV	SD	EA	INV	SD
* Cranbrook (-52)	24	5	-19	56	23	-33	4	28	+24	16	44	+28
Invermere (-24)	14	3	11	55	31	-24	3	21	+18	28	45	+17
Golden (-18)	25	7	-18	25	16	-9	4	12	+8	46	65	+19
Revelstoke	18	8	-10	33	19	-14	3	12	+9	46	61	+15
* Boundary (-61)	67	6	-61	21	47	+26	7	25	+18	5	22	+17
* Arrow (-56)	66	10	-56	9	37	+28	6	17	+11	19	36	+17
* Kootenay LK (-43)	52	9	-43	13	27	+14	6	20	+14	29	44	+15
Bold type = SD greater than 15%; SD = Site Discrepancy %; EA = Ecosystem Association % of TSA; INV = Inventory % of TSA												