

Focus on Key Business Attributes

In times of rapid change and uncertainty, focus is essential. Our emphasis on developing and implementing activities to sustain or improve forest health has been a mainstay. Forest health is one of the key components of ensuring timber supplies, an important consideration in forest practices, and a major opportunity for new forestry investments.

Staff at a recent provincial forest health specialist meeting demonstrated considerable enthusiasm and interest in tackling and resolving a wide variety of forest health-related issues including policy development to ensure prompt milling of bark beetle-infested logs; Forest Practices Code quality assurance audits; training to assist implementation of code requirements; development of stand density diagrams to manage forest health issues; determining pest losses for timber supply analyses; improving root disease management practices; and devising better methods for sanitation cutting or harvest of bark-beetle infested trees.

Although there is considerable work yet to be done, we are making substantial progress in demonstrating what is achieved by undertaking forest health management activities. That has been very worthwhile and satisfying for us both personally and in our role as stewards of forest resources in British Columbia.

- J. Muir, Forest Practices Branch, Victoria.

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FOREST HEALTH PROGRESS

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EDITOR'S NOTE

Forest Health Progress is a bi-annual report to the Forest Health Committee of British Columbia on issues, proposals, projects and results by Ministry of Forests staff. Brief, informal and informative articles are welcome from all staff.

Contributions labelled with an appropriate subject heading should be submitted via electronic mail to S. Turcotte, Forest Practices Branch for the spring (May) and winter (December) meetings of the Forest Health Committee.

Authors of individual articles should be contacted for any clarification, as the contents do not necessarily constitute official statements of the Ministry of Forests.

- J. Muir, Forest Practices Branch, Victoria.

EXECUTIVE SUMMARY

This issue of Forest Health Progress comprises brief accounts on forest insect, disease and animal damage. Reports include: a method to estimate volumes of dead trees (p.4); surveys indicate 111 000 ha of insect infestations in the Fort St. James Forest District (p.5); discussion of forest health, ecosystem management and economics (p.6); status of aerial overview surveys and a new collection form (p.8); development of new damage agent and condition codes (p.9); forest health training for vegetation inventory sampling (p.10); high-resolution remote sensing for forest health conditions (p.11); and installation of a CD-ROM forest health guidebook training package and a trials data base on the ministry computer FTP site (p.12).

Insect management includes: beetle-proofing trials at Invermere (p.14); beetle management procedures in the Morice Forest district (p.14); research on spruce beetle emergence (p.16); and balsam woolly adelgid surveys in the Vancouver Forest Region (p.17).

Disease management includes use of a list server (p.18) and Internet and bulletin boards (p.19); spread of laminated root rot pathogen in coastal spaced stands (p.21); armillaria root disease surveys at Invermere (p.22); analysis of forest-level treatment opportunities for armillaria root disease at Castlegar (p.22); tomentosus root rot impacts in the Bulkley timber supply area (p.23); development of new root disease survey technique for use in young stands (p.25).

Animal damage issues include: updated deer browse barrier costs and methods (p.27); and a publication on predator habitat enhancement (p.28).

Reports of several recent meetings are also included.

- J. Muir, Forest Practices Branch, Victoria.

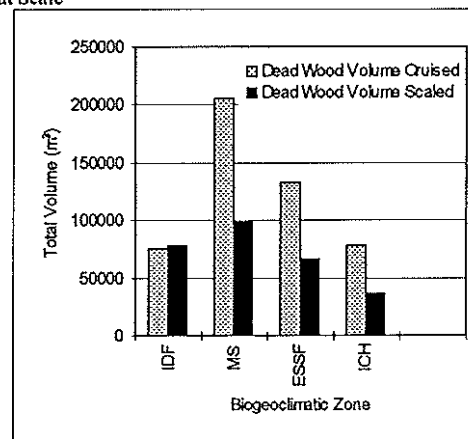
REGIONAL INSECT AND DISEASE CONDITIONS

Estimate of the Volume and Species of Dead Trees in Biogeoclimatic Subzones of the Kamloops Timber Supply Area. A project was initiated to quantify the volume and utility of dead timber in order to improve the accuracy of provincial timber supply reviews. Also, the identification of volumes and utility of dead timber for forest products, wildlife habitat and biodiversity objectives were included. Species of dead trees and volume per hectare in each biogeoclimatic subzone will provide information about the impact of forest health agents. These impacts will aid in the development of landscape level forest health strategies and tactics for future harvesting and silviculture plans. This information will be useful for management of loss attributed to forest health agents such as defoliators, bark beetles and root disease.

The procedure developed for a biogeoclimatic subzone utilized relational databases of weight scales and timber cruises. The impact of management strategies and alternate harvesting techniques on the volume of dead wood (pest impact) in each biogeoclimatic subzone will be monitored, evaluating the efficacy of each strategy.

Volumes by species of dead trees in each biogeoclimatic subzone were calculated by summarizing cruise reports from the last eleven years. The volume of dead timber in the scale was calculated using six years of scale return data. Dead wood calculated in the cruise was subtracted from the volume of dead wood scaled. Local expertise will identify the major forest health agents in each subzone and their relative contribution to the total dead wood volume. Figure 1 illustrates the results for major biogeoclimatic zones in the Kamloops Forest District. Analyses will soon be completed for the Clearwater Forest District, after data are loaded into the relational data base.

Figure 1: Dead Wood in Cruise Compared to Dead Wood at Scale



Complete analysis of all biogeoclimatic subzones in the Kamloops TSA will be ready in June 1997.

- J. Henigman, Forest Practices Branch, Victoria,
D. Piggin and D. Lux, Kamloops Forest District, Kamloops.

Forest Health in the Fort St. James Forest District. The aerial survey we conducted in July/August of 1996 presented the following numbers:

BEETLE TYPE	1996 AREA (ha)
IBD	2876.40
IBM	32,359.20
IBS	3,522.80
IBB	52,435.50
WP	227.10
DMP	59.4
OTHER (WEEVIL)	12.20
severe 2 year cycle budworm	20,200
TOTAL	111,692.60

A consultant was hired to develop a proactive, effective approach to bark beetle management of Douglas-fir near the town of Fort St. James. The objective of the beetle management plan is to outline the basic direction; bark beetle biology and forest ecology, management strategies and tactics, hazard and risk rating and prioritization of activities. From this information a priority rating for applied control measures will be developed

We have given out Beetle Polygon maps, susceptibility maps and waiting on operability maps to First Nations and our Licencees. These management tools are an essential component in any bark beetle management plan

1997 is the fifth year MOF is working with the University of Calgary, using pheromone baited 12 unit Lindgren funnel traps to assess and reduce local Douglas-fir beetle populations.

Forest Health has been working on getting the Forest Health evaluation incorporated into the 1998 Forest Development Plans.

Our district is proposing to develop a bark beetle strategy team of Licencees and MOF staff, that will provide a clear direction to Foresters developing operational plans.

We are also in the process of proposing small scale salvage timber sale licences for the fall of 1997.

- K. Baker, Fort St. James Forest District, Fort St. James.

FOREST HEALTH - GENERAL

Economics, Forest Health and Ecosystem Management. Recently, a group of articles was presented on the subject of ecosystem management in the **Forum**, Vol. 4, published by the Association of B.C. Professional Foresters. The articles are very useful in helping understand what ecosystem management means to different people (the article authors) and how it can be applied to real commercial forests. One representative definition of ecosystem management cited in the Forum articles (page 7) is:

“...the careful and skillful use of ecological, economic, social and managerial principles in managing ecosystems to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products, values and services over the long term. (Overbay 1992, reprinted in the Forum, Vol. 4).”

Two disciplines not discussed in the articles which have close affinities to ecosystem management are economics and forest health. In my opinion several important relationships are developing between these three disciplines.

First Economics

Economics describes the business and science of human resource management. There are always strong linkages to supply, demand and cost. In applying economics to ecosystem management, it is difficult to assign costs to the work. I suspect that many of the original advocates of ecosystem management prefer it that way, fearing that the practical world of economics will steal the "true purpose". Although their fears may have foundation, the use of economics will ultimately benefit ecosystem management.

Economic principles must be applied to ecosystem management for it to flourish as a valid way of practising forestry. In applying the principles, one is forced to identify specific measurable goals and treatments. These must be costed, and over time, people will discover how to achieve the same or greater goals for reduced cost. Forest companies have traditionally done a very good job of reducing costs. And, this a good thing.

Legislating ecosystem management standards is likely necessary and in the interest of society. This sort of legislation is usually made easier once specific measurable goals are identified.

Ecosystem management treatments, once included as part of a forest company's cost of doing business, will cease to be seen as losses to profits. The treatments can be planned for, be integrated with other parts of commercial forestry, and will become less expensive via technical improvement and economies of scale. Legislation related to ecosystem management can easily be adapted to enhancing the profits of companies achieving ecosystem management goals and penalizing those that do not.

What of forest health?

Forest health originated in pest control as a service to the forest owner. Its current objective is now much more than this, but still its purpose is economic. Two definitions of forest health are:

A condition of forest ecosystems that sustains their complexity while providing for human needs. It is a useful communications device in helping people understand the current condition of the forest. Forest scientists and managers, working with their customers can identify, define, and determine ranges of desired conditions for a set of measurable characteristics in each forest ecosystem that can be useful in helping evaluate the condition of the forest at any time, in relation to those desired conditions. Objective indicators of forest ecosystem condition can be specified and measured, but forest health assessments contain subjective value judgements which must be clearly recognized. (O'Laughlin *et al*, 1994)¹.

Entails well being and "well functioning" of attributes and processes of forest ecosystems, as well as minimal detrimental effects or tolerable levels of disturbance from insects, diseases, animals and other influences (usually residents or components of forests). It also must be assessed in the context of resource management in broad terms, including management for a variety of uses, products and values (Benskin and Muir, 1994)².

Both definitions advocate a basic purpose of forest health to ultimately meet the resource management objectives of the forest manager and of society. Nevertheless, it is also integral to the definitions to ensure that forest ecosystems are sustaining.

When one compares definitions of forest health and of ecosystem management, it is apparent that there is little difference. The current objectives of the disciplines are essentially the same even though their origins differ.

Much effort is currently being put into finding techniques that will achieve ecosystem management goals. These techniques have not been easily forthcoming and a popular approach involves adaptive management. The experience of forest health as an economic objective appears to be relevant to the emerging science of ecosystem management. I recommend that surveys and treatment methods developed for forest health (described in Forest Practices Code guidebooks) be investigated as options to be adapted for ecosystem management purposes.

For information on forest health and its relationship with ecosystem management, please contact the author at 250 356 5886.

- J. Henigman, Forest Practices Branch, Victoria.

¹O'Laughlin, J., Livingston, R.L., Thier, R., Thornton, J., Toweill, D.E. and L. Morelan. 1994. Defining and Measuring Forest Health. *J. Sustainable For.*, Vol. 2: 65 - 86.

²Benskin, H. and J. Muir. 1994. What is Forest Health. Presentation to the Southern Interior Silviculture Committee Workshop, March 15-16, 1994, Penticton, B.C.

New Aerial Overview Surveys. With the down-sizing of the Canadian Forest Service (CFS), the former Forest Insect and Disease Survey (FIDS) was eliminated and reorganized as the Forest Health Network (FHN) with the objective of monitoring forest health conditions such as effects of acid rain. This has left a void and uncertainty about the FIDS aerial overview surveys, their data records and related diagnostic and insect-rearing services.

Although a formal agreement is not in place, we understand that the CFS will continue to provide herbarium and insectary services for ministry staff to submit specimens and collections, and that data bases will be maintained and reports prepared on request to the extent possible. The ministry will undertake aerial overview surveys and provide maps or data to the CFS to maintain the data bases, and provide overall data for the national forestry data base. Aerial overview surveys have considerable value for ministry resource management by providing a consistent provincial overview of insect and disease occurrences which form the basis for planning treatment programs, and evaluating the performance of the ministry and licensees. Currently, aerial overview surveys are the only province-wide means of determining pest damage to forest resources for adjustments to the forest resources inventory.

To undertake this new survey activity, a proposal to develop a standardized aerial overview survey was made to and supported by Forest Renewal B.C., and a new training package will be presented in pilot sessions at various locations in July 1997. The goals are to train staff and accredit potential contractors to undertake the overview surveys. Ministry staff and contractors have performed detailed aerial and ground surveys for bark beetles and some other insects and diseases for many years, but an overview survey to determine a broad array of potential or actual damage is a new challenge to many. The 1997 surveys also depend on securing new funding either through Forest Renewal B.C. or other sources.

One area of uncertainty that still persists is overall coverage of provincial parks. Local areas where insect infestations are known, probably will be surveyed by the ministry. Apparently CFS/FHN personnel will try to visit parks and provide advice to the extent that their travel and duties permit.

- J. Muir, T. Ebata and P. Hall, Forest Practices Branch, Victoria.

Field Insect and Disease Collection Form. A new Forest Service form (FS 466 HSP 96/8) was designed for submitting insect and disease samples to the Canadian Forest Service Pacific Forestry Centre, Victoria. The form is available through ministry offices. Users are requested to review the form procedures, data and layout for field use and records, and to forward any comments or suggestions to J. Muir, FAX 387-2136 or e-mail JAMUIR@MFOR01.for.gov.bc.ca. A sample copy is reproduced in the Tabulations and Graphics section.

- J. Muir, Forest Practices Branch, Victoria.

Damage Agent and Condition Codes. Although we have experienced several recent changes to the ministry damage (pest) codes used in the silviculture information systems and inventory programs, and some discrepancies persist, we are making considerable progress on developing a harmonized set of codes. The current list of ministry damage codes can be found on the Integrated Silviculture Information System (ISIS) or the Management Licensee Information System (MLSIS). A subset has been listed on the ministry form FS 747 (96/11) for field use.

Currently, damage codes consist of three-letters that embed several categories or meanings. For example, "DRA" is used for armillaria root disease caused by the fungus *Armillaria ostoyae*. The "D" represents disease, and the "R", root, with the "A" indicating the name of the disease. Similarly, insects are represented as "I", and so on.

Substantial confusion resulted from a proposal by the Forest Productivity Council, including representatives of forest health and inventory, for a new set of codes which were implemented by some business areas. A major deficiency of the council proposal was that it removed "A" which had been used for animal damage and re-applied it to abiotic damage (frost, flooding, etc.), with the result that some codes were used for different agents, e.g., "Ab" designated bear damage originally, but in the new proposal, "Ab" designates damage from a prescribed fire.

There also has been confusion from the use of damage codes to represent damage to individual trees and the prior use of single-letter codes on forest cover maps to indicate substantial damage to stands of trees in certain areas (map polygons). Single-letter codes also are used in silviculture information systems to indicate history of substantial disturbances that resulted in openings or stands that required treatment.

To reconcile these problems, representatives of the major business areas met in January 1997 and resolved to develop a better set of codes. The objectives are a more flexible set of codes that can be updated without major impacts in the various ministry business areas, particularly the ministry forest cover maps and attribute data base. The authors were delegated by the working group to develop a draft proposal. The goal is to have a proposal circulated to business areas within the ministry by June 1997, so that the new codes can be developed in time for the next opportunity for changes or implementations to data bases and systems, possibly by April 1998.

Our preliminary ideas for new codes include:

- designation of insects, fungi, plants, animals and other damaging agents by their scientific names, possibly an eight-letter set of the first four letters from the generic and specific epithets;
- designation of categories of damage agents, levels and/or types of damage (tree, stand, forest-level), and other subsets for use by individual business areas; and
- development of a ministry policy and/or procedure for definition, updates and maintenance of codes by a designated data custodian (Director, Forest Practices Branch).

Damage codes are an important issue to resolve for use in several business areas within the ministry's forest practices (silviculture), resource inventory and research programs, and there is a need to resolve differences and develop a better set of codes as soon as possible.

- J. Muir, Forest Practices Branch, and
T. Fulton, Information Systems Branch, Victoria.

A Forest Health Training Package for Vegetation Inventory Plot Samplers. This package, recently developed by contractor Heidi Derhousoff, is a prototype which we hope to improve during this year.

During recent years about 30-40 people per year have been taking Vegetation Inventory training courses leading to certification as a qualified plot sampler. Until now forest health training has usually been provided ad hoc by regional forest specialists without any standardized support material. No comprehensive identification information has been available. Plot sampling has suffered by poor pest damage recognition and by inconsistent or inaccurate data collection.

Plot samplers are required to identify and tally forest health factors in all Vegetation Inventory plots. The protocol used by the samplers is presented in the regularly updated publication entitled *Vegetation Resources Inventory Sampling Procedures*. The protocol requires that all damage agents (more than just economic pests) occurring on all trees in plots be identified and correctly tallied onto field cards. Where appropriate, the factor damage severity and mortality condition must also be recorded (using the Forest Productivity Council of B.C. standard). This task requires the samplers to be very proficient at insect and disease sign and symptom identification. Few surveyors have this capability.

With direction from us, our contractor was able to design a set of supplementary guides to assist plot samplers to quickly and conveniently use existing pest identification manuals to identify damage factors in the field. The existing manuals that were brought together for the samplers included:

- Field Guide to Pests of Managed Forests in B.C. (Fink *et al*, 1989);
- Bark Beetles of B.C. (Ministry of Forests insert);
- Common Tree Diseases of B.C. (Allen *et al*, 1996);
- Key to Injury of Conifer Trees by Wildlife in B.C. (Alton *et al*, 1986); and
- Tree and Shrub Insects of the Prairie Provinces (Ives and Wong, 1988).

In most cases, identifications can be made using only those publications designed as field handbooks. The other publications can be used in the office using field samples. The manuals, together, allow the identification of almost all damage factors likely to be encountered on any tree found in B.C. forests. The only exceptions are insects of deciduous trees for which we do not yet have a manual.

Also included in the package of guides is an extensive list of all damage agent codes that must be entered onto the Vegetation Inventory forms.

This training package will be used for the first time this May. We hope to improve the package by integrating the identification information in the five publications into one practical, field-handbook for plot samplers. Hands-on training material for the students, such as a collection of disease conks and representative samples of tree damage symptoms, will also be gathered for the classes.

For more information on Vegetation Inventory plot sampler training, please contact the author at 250 356-5886.

- J. Henigman, Forest Practices Branch, Victoria.

High-Resolution, Remote-Sensing in Prince George Forest Region. Itres Research Ltd. was contracted by Val Fletcher and Robin Brown, Forest Practices Branch to test the compact airborne spectrographic imager (CASI) for the evaluation of forest health in several areas in the Prince George Forest Region. I contributed maps of the test sites and conducted the ground truthing. Credit is due to Phil Zacharatos, Regional Staff Manager, Forest Resources and Practices, Prince George Forest Region for his unwavering support; to Jeff Beale, Operations Manager, Dawson Creek Forest District for encouraging me to participate in this project; and to Rob Price, Itres Research Ltd., for superb technical and analytical support.

CASI measures radiation from 400 to 1000 nanometers of the electromagnetic spectrum. CASI is a portable instrument that can be installed in a variety of aircraft such as small jets, twin and single engine aircraft and helicopters. It is fully programmable and calibrated, with a swath width of 512 pixels and resolution of 0.5 meters to 10 meters. We utilized a pixel size of 0.6 meters (totally awesome!).

CASI shows great promise for landscape level forest health detection. Its spatial and spectral resolution enable assessment of forest health conditions at the stand level and down to the individual tree level. The specific objective of this proof of concept pilot project was to test CASI'S ability to accurately detect tree health and stand health parameters on sites that varied in forest cover type, age class and forest health issues present. (Before continuing, it should be understood that any remote sensing product is relied upon as an ancilliary data set to be used in conjunction with the Forest Cover database and ground data collection by trained crews. Causal agents are always determined in the field.)

Four areas with specific forest health issues were selected and flown in 1996, one in the spring and three in the fall. The spring flight was over a 1200 ha mixedwood (spruce/aspen) area in the Dawson Creek Forest District selected for its abundance of stands with moderate to severe levels of tomentosus root rot infection. This area will be ground truthed in spring 1997. The other three areas were in the Prince George Forest District. They included a 10 year old lodgepole pine progeny trial (at km 104, Bowron Forest Service Road), a 25 year old spruce plantation (including a 1.5 hectare stem mapped rate of spread plot), and an 80 year old interior spruce stand (Km 44, Beaver Forest Service Road) which includes a 10 year old commercial thinning/root disease trial (5 ha stem mapped).

Preliminary results look very promising for detection of above ground symptoms of tomentosus root rot in older immature and mature spruce stands. The reflectance pattern for severe and moderate crown symptoms was statistically different from the healthy and light symptom class. Snags with branches were easy to detect. In unthinned stands, disease centres were easily delineated by small canopy gaps bordered by stressed trees with one or two snags in the centre. Healthy trees were noted between the disease centres. Red attack caused by western balsam bark beetle was also identified at the Beaver Forest Service Road site (we will wait until summer to see if there has been any green attack). Testing this spring at the Beaver site will include sampling roots for evidence of tomentosus root rot staining and decay on approximately 100 randomly selected trees.

One of the more exciting components of the project involved receiving analyses and transformations of the digital data from Rob Price at Itres Research. Requests for modifications were often processed during our telephone conversations and within minutes I received a digital file and plotted them to scale on the HP650c. Moving digital information can be extremely easy and efficient. Itres Research now has the ability to fully georeference the CASI imagery to the forest cover and TRIM digital files for accurate overlay capabilities.

As you may have guessed, I am also advertising the Western International Forest Disease Work Conference to be held in Prince George this September. The commercial thinning/root disease trial will be one of the field stops on the tour and a CASI presentation will be featured. Anyone interested can also call me to arrange a tour of the CASI field sites.

Current plans for ground truthing more CASI imagery at other sites for other forest health issues in the Prince George Forest Region include a 7,000 ha area flown in 1996 near Fraser Lake for lodgepole pine dwarf mistletoe, and a proposed site near Valemount which includes a 100 ha armillaria root disease centre.

- R. Reich, Prince George Forest Region, Prince George.

Forest Health Software Available on Ministry FTP Site. Ministry of Forests staff have access to two recently developed software packages on the internal FTP server located at:

`Ftp/Branches/Forest_Practices/MOF_internal/!Publish/Forest Health/`

Copy the files: TREEDR.EXE, TDREADME.TXT, FHT20.MDB and FHT20.LDB

The first program is Forest Practices Branch and Malaspina College's Tree Doctor - an interactive diagnostic tool that combines textual information on identification and management of forest pests with digitized pictures of the pests and their damage. This

program provides the most up-to-date management recommendations from the Forest Practices Code Forest Health guidebooks.

The program is in two parts. The first part runs on a PC hard drive and can be downloaded from the FTP site. The second part containing the graphic images must be run only from a CD-ROM. You can order a copy of the CD-ROM free of charge from John Muir (250-387-8740 or JAMUIR@MFOR01.for.gov.bc.ca).

To install the program follow these instructions or copy and open the file TDREADME.TXT. The file TREEDR.EXE is a self-extracting compressed file. Within file manager, copy the file to an empty directory then double-click on it or use the FILE/RUN/treedr.exe process. The files will decompress and when finished, double click on the file SETUP.EXE. This will install TREEDOC onto your hard drive. To set up the CD-ROM, you will need to tell the program which drive letter it has been assigned on your machine. This can be done by pressing the "CD-ROM setup" button on the "Welcome" screen.

The second program is the Forest Health Trials database (FHT2.0) that was announced in the last edition of Forest Health Progress. This MS Access 2.0® database contains nearly all of the existing Ministry of Forests forest health (formerly pest management) trials, surveys and studies that could be found in branch, region and some district files during an intensive search last summer by UNBC Natural Resources Management cooperative education student, Andra Bismanis.

Since the completion of Andra's work-term, it became apparent that there were some programming problems that needed "professional" help to fix. In March 1997, a computer consultant was hired to re-format the database to Information Services Branch database standards, clean-up the data, and make the search features more efficient and user-friendly. The version FHT2.0 available from the FTP site is intended to be a "living database" and allows free access to all ministry users to input, update and store their trial and other forest health specific data summaries. Please feel free to use the database and input new or edit existing trial information. This database provides free information exchange about the results, methodology and status of forest health trials for the exclusive use by Ministry of Forests staff. Comments are welcome.

- T. Ebata, Forest Practices Branch, Victoria.

FOREST INSECTS

Beetle Proofing Project at Hall Lakes Recreation Area, Invermere Forest District. In 1989, we set up four stands for beetle proofing. The first trial involved thinning from above. The project failed because heavy windthrow and rain followed a snowfall took out most of the remaining trees. The project was successful in that no new beetle attack occurred. However, the stem diameter was below the mountain pine beetle's preferred tree size of 22 cm dbh.

The second trial appears to be working very well. We established 2-5 ha control blocks and 1-10 ha treatment block. We spaced the treated stand at approximately 5 m x 5m for a residual stocking level of 500 stems per ha. Harvesting was done as a thinning from below, removing any attacked trees first, then spacing down to 500 stems per ha. Basal area measurements vary from 16 to 22 m² from a stand starting at 38m². Mountain pine beetle activity was recorded by year for the past six years. The treatment areas and one control block have been resurveyed this winter. The treated area contains 11% attacked trees with the control block containing 32% attack. The report should be completed in the next two months. From this treatment we have developed a rough guide for selecting stands to beetle proof and identify which ones may fail.

The third project we are working on with T. Shore, Canadian Forest Service, is a mountain pine beetle expert system. It may be best to talk to him about this. What we have done is taken the previous expert system (from Penticton) which develops management strategies such as maintain low or do nothing to the ground level on how to maintain the mountain pine beetle population at a low level and what to do with the no treatment stands (i.e. unsalvaged loss calculations for the TSA). This is aimed at the field people who do the ground surveys and make the recommendations. The expert system provides the field people with some base line information on bark beetles and stand management needs combined with the Shore/Safranyik hazard rating system and links to the provincial forest health database. The project is not complete and requires more work and inter-agency cooperation if it is to be successfully completed. A draft guide has been prepared and an "Alpha" level computer structure has been devised.

- E. Begin, Invermere Forest District, Invermere.

Morice Beetle Management System (Developed by Ted Bresser). It has now been 18 months since the "Bresser" management system for bark beetles and the terms of reference for a joint Ministry of Forests/Environment and licensee approach to beetle management were established. Since then, we have taken giant leaps in interpreting the *Forest Practices Code of British Columbia Act* and implementing tactics to minimize spread of bark beetles and impacts on forest values.

Forest Cover (FCI) files were used to map on Geographic Information System (GIS) stand composition, age class and site index in order to determine the hazard (susceptibility) of stands to specific bark beetles. This prioritized removal of the stands with the greatest risk of losing volume.

Risk was determined for mountain pine beetle by using annual global positioning system (GPS) overview data to identify the infestation centres. Ministry of Forests and licensee staff also utilized the same helicopter flights to discuss strategies for new infestations, including use of pheromone baiting and MSMA, as well as planning heli-pad locations and future silviculture systems.

Shortly after the overview flights, 1:50,000 clear copies of differentially corrected GPS way points (up to 6200 annually) were overlaid on the hazard and constraint maps (i.e. FENs, VQOs, wildlife, sensitive areas, soils, etc.). This exercise determined priorities for removal and provided direction to licensees for forest development planning. For further consultation with First Nations, the public and other private and government agencies, 1:20,000 paper overview maps were also used to circle and identify the tentative treatments for each infestation.

These maps, the bark beetle data base (pilot project) and beetle management unit plan were used to track the bark beetle management activities. This allows for a more timely approach to respond to bark beetles as it prioritizes areas to circle probe (checking all pine trees within 100 m of any red topped pine or current attack tree) and layout and traverse for harvest using GPS mapping.

Blanket salvage permits issued under authority of Section 17 of the *Forest Practices Code Operational Planning Regulations* are utilized for first time entries, while larger, longer-term cutting permits are established over high hazard pine types at risk. Wherever possible, every effort is made to maintain patches of non-susceptible timber and advanced regeneration. This exercise streamlines the approval process, giving four extra months for brood removal operations. In the past, we had to wait for probe data which compressed the harvesting operations to late winter, depending on weather and snow conditions.

Bark beetle management summaries are then issued to the forest health officer around the end of November identifying plans for harvest and fall and burn operations. Harvest status reports are then due the following spring along with pheromone baiting plans.

Using the GIS allows downloading of GPS files and easy mapping of overview data, pheromone lines, MSMA treatments, forest development plans or other information needed.

A similar system is used for western balsam bark beetle in the ESSF zone, although sketch mapping is still used, and the only management tactic utilized so far is harvesting.

Although spruce bark beetle populations have crashed for the short-term, blowdown trees are still cleaned up annually to suppress spruce beetle populations.

- T. Bresser, Morice Forest District, Houston.

Adult Spruce Beetle Emergence for Hibernation. The objectives of this 3-year research project were: 1) to assess if the degree of adult spruce beetle emergence for hibernation could be predicted by climatic factors, and 2) to assess if such emergence could be prevented by felling infested trees at an optimal time. Determining the relationship between the percent emergence and weather would be used to develop a model to predict beetle emergence. This would be incorporated into relevant decision-support systems.

The information would allow ranking of areas for more efficient sanitation logging in the second winter after attack and would assist in maximizing yields from forests by minimizing attacks in adjacent susceptible stands. The feasibility of felling infested spruce in advance of harvesting in order to prevent emergence of immature adults, thereby improving the efficacy of subsequent sanitation logging would also be evaluated.

The experimental design and methodology were reported in the December, 1996, issue of *Forest Health Progress*. Table 1 depicts the first year emergence results at Chunamon Bay. There was a significant difference between the percentage of adults that emerged for hibernation from standing trees (39.8%) compared to felled trees (9.5-18.5%). There was no significant difference in emergence hibernation between the early- or late-felled trees. Table 2 shows results from Petoy Creek. There was also a significant difference between the percentage of emergence from standing trees (60.2%) versus felled trees (7.0-13.0%). Statistical analysis was not possible at the Kerry Lake site because a grizzly bear vandalized 73% of the emergence traps. (Tables 1, 2, and 3 are shown in the Tabulations Section, this issue).

Table 3 indicates that in the ESSF biogeoclimatic zone, in Mackenzie, in 1996, 40-60% of immature adults emerged for hibernation from standing trees, while only 7-19% emerged from felled trees. Given this, it may be possible to recommend that spruce which were attacked the previous year and not sanitation logged the first winter, be felled the following summer to reduce the number of emerging immature adults before the next winter logging period. Felling infested trees before the first winter may reduce emergence for hibernation further. This may lead to a separate study.

Weather station data are presently being analyzed and correlated to the percent emergence at each site. It is not expected that any meaningful correlations between weather and emergence will be possible until at least two more years of data have been collected.

Interim results of this research were presented to the *1997 Western Forest Insect Work Conference* in Prince George, April 15, 1997, with some licensees in attendance. A summary of the results will appear in the conference proceedings. Further extension presentations on this research will be made to staff and licensees of the Mackenzie and Prince George Forest Districts in the spring of 1997.

- R. Hodgkinson, Prince George Forest Region, S. Lindgren, University of Northern B. C., Prince George; and A. Stock, Nelson Forest Region, Nelson.

Balsam Woolly Adelgid Continues to Spread. Surveys conducted in the summer of 1996 discovered balsam woolly adelgid (BWA) beyond its previously known range. BWA has now been found throughout the Squamish Forest District up to and adjacent to the boundary of the Lillooet Forest District. The Whistler area has especially high populations of this adelgid. Fortunately, branch samples collected from the Lillooet Forest District just across the boundary from the Squamish Forest District (the upper Hurley River and the upper Cayoosh Creek areas negative for BWA.

In the Chilliwack Forest District, BWA has now been found in the northern reaches of the district on both sides of the Fraser River (in the Nahatlatch River and Mowhokam Creek drainages). BWA was also found in the Uztlius Creek drainage within a kilometre of the boundary of the Merritt Forest District. Extensive areas of young *Amabilis* fir plantations exist on the Merritt side of the boundary, but our surveys have not yet found BWA there.

To date, BWA has not been found along the Coquihalla Highway corridor, along Highway 3 to Manning Park, in the Skagit Valley, nor in the upper Chilliwack River Valley.

Aerial surveys of old-growth forests along the Chilliwack/Merritt Forest District boundary are planned for this summer. We will also be surveying on Vancouver Island, north of Campbell River and on the mainland, north of West Thurlow Island.

- Don Heppner, Vancouver Forest Region, Nanaimo.

FOREST DISEASES

Armillaria@internet. An e-mail discussion forum has been established to serve the needs of the Armillaria Research Working Group (ARWG). Search for ways to carry on our business in the face of travel restrictions and other budget restraints has led to the creation of the ARWG Forum.

The ARWG Forum is an inexpensive (<\$200/year) list server (i.e. automated, centralized distribution list) which provides an ongoing opportunity for persons interested in armillaria research and issues to communicate their questions, observations and concerns with other members on the list.

The ARWG Forum is an unmoderated list, i.e. submissions to the list are distributed without "censorship" or editing to the entire list. It is not an instrument for disseminating any official ministry policy; that would be done through one of the ministry's bulletin boards.

Membership in the ARWG is open to anyone interested in issues regarding armillaria root disease. Likewise, the ARWG Forum is open to anyone who wishes to subscribe. Current subscribers include personnel from the Ministry of Forests, Canadian Forest Service, FERIC, industry, and universities (and some "retired" forest health folks as well!). The strength of such a forum is the diversity of its membership and it is valuable as a means of transcending organizational barriers and drawing on a wider pool of knowledge and experience than is present in any one organization. Although the term "subscriber" suggests that there may be a fee, subscribers do not pay to be on the list.

Since inception in February 1997, numerous messages have been submitted on the topic of the impact of armillaria root disease associated with partial cutting. To date, subscriber response to the existence of the Forum has been uniformly positive.

Being a subscriber does not mean that piles of e-mail are received. Generally, the pattern of e-mail traffic is periods of non-activity interspersed with short bursts of high activity as subscribers respond to questions or requests for information.

Prospective participants can subscribe by sending an e-mail message (a blank one is fine) to [ARWGForum-request@islandnet.com]. On the "Subject" line type the word "**subscribe**" (without the quotation marks). Shortly after sending the message you will receive an automated reply confirming that you have been added to the list. To contribute a message to the forum, address your notes to ARWGForum@islandnet.com. If you have any trouble getting subscribed or have other questions, please contact John McLaughlin, telephone (250) 387-8737 or by e-mail: jamclaug@mfor01.for.gov.bc.ca.

- J. McLaughlin, Forest Practices Branch, Victoria.

Improving Communication on the Internet and Bulletin Boards. The increasing complexity of forest management is pushing us to the very edge of our science and art as we attempt to make correct decisions, often with inadequate information (even with numerous Forest Practices Code Guidebooks to turn to!). Forest health specialists are often called upon to give advice on "wicked" problems, those that have no clear "correct" solution and have political or other non-biological factors that appear to outweigh the ecological factors. We often find that the information we need will not be available for several years, until current studies are completed.

The need for more knowledge is being addressed in a number of ways. In some forest districts, management teams representing a wide range of interests and expertise have been formed. Still, specialized forest health information may be inadequate. The bottom line is that no one person can know enough to address all aspects of their work. Enhanced communication among forest health specialists and those they serve can alleviate some of the uncertainty and can raise our overall level of knowledge and ability to provide useful, consistent advice.

Opening new channels of communication also provides benefits such as reducing duplication of effort, clarifying rumours and defining our current state of knowledge, thus providing a basis for further research and adaptive management.

There are a number of vehicles of communication available to us, each with its own role and value. They include official ministry bulletin boards (e.g. BBSILV), ministry distribution lists maintained by the Information Services Branch, informal ministry distribution lists created by participants, and discussion forums set up on the Internet. Short descriptions of these follow:

BULLETIN BOARDS

features:

1. must be approved by ISB
2. require an administrator who decides what to post
3. time-limited postings
4. input from users is sent to the bulletin board administrator who then edits, rejects or posts input to the bulletin board.
5. accessed voluntarily

primary function:

Dissemination of approved information to a wide audience within the ministry.

ISB-MAINTAINED DISTRIBUTION LISTS

features:

1. must be approved by ISB
2. requires an administrator who will process requests to subscribe/unsubscribe
3. serves as communication conduit through which anyone in the Ministry can communicate with a specific group of people within the Ministry

primary function:

Dissemination of information to a specific audience and a limited amount of discussion.

INFORMAL DISTRIBUTION LISTS

features:

1. must be created by each participant
2. require neither an administrator nor ISB involvement
3. can include non-Ministry participants world-wide
4. participants can modify the version of the list that they create, selecting to whom their messages are sent:

primary function:

To disseminate information, pose questions, discuss topics with a specific group of people with a variety of affiliations.

LIST SERVERS (DISCUSSION FORUMS)

features:

1. must be established by purchasing "time" and access from a commercial Internet access provider
2. requires an administrator who can assist participants to subscribe/unsubscribe
3. participants can subscribe/unsubscribe independently, at any time (if you choose to set up the list server to allow this)
4. participation can be open to anyone who hears of the list (if you choose to set up the list server to allow this)

primary function:

To provide an easily-accessible open forum intended to facilitate discussion, dissemination of information, raising of questions, and seeking advice among a diverse group of participants with a variety of affiliations.

Whether your interest is in bark beetles, weevils, root diseases or all of these, methods of electronic communication are available through which you can communicate your questions, observations and concerns with your fellow forest health specialists and clients. For further information contact your local information systems support specialist or John McLaughlin at tel: (250) 387-8737, e-mail: jamclaug@mfor01.for.gov.bc.ca. For an example of a forest health discussion forum see the article "Armillaria@internet" in this issue.

- J. McLaughlin, Forest Practices Branch, Victoria.

Fournier Finishes M.P.M. Thesis on *Phellinus weirii*. Jeff Fournier, formerly at the Squamish Forest District and now Silviculture Officer in the Chilliwack Forest District, recently completed his Master of Pest Management thesis at Simon Fraser University. The thesis, *Spread of Phellinus weirii inoculated on the roots of standing and recently cut juvenile Douglas-fir trees*, determined the success of artificially inoculating trees, felling them at two intervals, and then tracking the subsequent spread of the fungus on host root systems. This work revealed significant results on the action of *Phellinus* in young, spaced stands and the potential usefulness of bridge-tree removal as a treatment. The thesis abstract follows.

The ectotrophic spread of *Phellinus weirii* inoculated on the roots of juvenile Douglas-fir was compared on trees that were left standing, cut down immediately after inoculation or cut down 6 months after inoculation. Measurements were taken at 6, 12 and 18 months post inoculation. A new "combined" inoculation technique provided significantly higher ($P > 0.005$) transfer success than the standard "block" inoculation method. Only data from the combined method was determined to be reliable enough to assess spread-related relationships. The use of linear spread distance to characterize pathogen spread was as effective as the more exacting measurement of area of spread. Differences in mean spread in proximal and distal directions were not significant. At 6 months, spread of *P. weirii* was significantly higher in both linear ($P < 0.01$) and area ($P < 0.02$) measurements in trees cut immediately after inoculation compared to those left standing. At 18 months, pathogen spread in these cut trees was lower than in trees left standing and was significantly lower ($P < 0.01$ for area and $P < 0.02$ for linear spread) than in trees cut 6 months after inoculation. Linear and area pathogen spread did not differ between 6, 12 and 18 months in cut trees, but were significantly less at 6 months ($P < 0.001$) than at 12 and 18 months in standing trees. The results show that felling a host tree just prior to or during infection may induce conditions that enhance pathogen spread for periods up to 12 months and discourage spread in the longer term. Cutting of hosts with well established infections may directly enhance pathogen spread for periods up to 12 months post treatment. Pathogen spread in pre-commercially thinned stands could be minimized by pre-treatment identification of areas of *P. weirii* infection and proper application of cutting and host retention treatments. Felling in the spring season may increase short term pathogen spread, with the opposite being true for cutting in the fall season.

Funding for this work was provided by the Vancouver Forest Region and the Squamish Forest District. Copies of the thesis may be obtained directly from Jeff (794-2100) or the undersigned. Congratulations Jeff!

- S. Zeglen, Vancouver Forest Region, Nanaimo.

Forest Health Inventory, Armillaria Root Disease Surveys, 1992 to 1996, Invermere Forest District. A draft report, available soon, summarizes the results of armillaria root disease pixel surveys in four biogeoclimatic zones and 19 timber type groups identified as containing armillaria. In 1992 pixel surveys were started and sampled about 5% of a silviculture opening or inventory polygon. A total of 18,420 ha was surveyed (9.2% of our current operable land base), with root disease identified on 13,581.5 ha, approximately 6.8% of our current operable land base. On 6,607 ha root disease incidence was over 8%.

Assuming there are no site-limiting factors, the cost to conduct a root removal treatment on the 6,607 ha is estimated at \$8,589,230.00. Using a volume reduction estimate of 30% below a healthy stand, the lost volume caused by root rot is estimated at 644,192 m³ or about one years logging for the Invermere Forest District.

This report was initiated to determine the location of armillaria. It is hoped that a sampling methodology for hazard rating the forest district and pilot project areas using forest maps can be developed over the next few years. The hazard rating would be more of a "red flag" to identify stands which may have a high probability of root rot. Work being completed in Coeur d'Alene, Idaho may provide the tools to set-up this rating. Actual impact from root disease and the various treatments are not yet available. It is hoped that calibration of the PROGNOSIS model will help with these calculations.

- E. Begin, Invermere Forest District, Invermere.

Determining Levels of Expenditure for Treatment of Armillaria Root Disease Based on Forest Level Objectives: Methods and Analysis. This project was initiated to deal with two issues. The first being the Chief Forester's expectation that "... studies on the effects of armillaria to be completed, and these effects to be quantified, prior to the next AAC (Allowable Annual Cut) determination." (AAC Rationale for Arrow TSA, October 1995). The second issue is the question of determining an acceptable level of treatment for armillaria infected stands, and to link this to forest-level, projected harvest schedule expectations. How much should be spent on treating armillaria infected stands, and what is the benefit in terms of projected harvest schedules?

The output from this project is a methodology that defines the relationship between the cost of treating infected stands, and the potential benefits derived in terms of projected harvest schedules over time. This methodology will demonstrate the kinds of data that are required to answer this question, and how it should be used in a forest estate analysis. So far, it is clear that existing information is lacking, with respect to both the measure of armillaria incidence across the forest, and its impact on the growth of existing and future stands. It is hoped that this analysis will help to direct energies to alleviating this lack of information. It is also hoped that the methods developed will be further refined and used for a wide variety of forest estate analyses involving explicit information on forest health questions.

A draft of this report will be available in the next month. Please contact Mark Messmer, telephone 250-356-9266, Forest Practices Branch, for information about this project.

- M. Messmer, Forest Practices Branch, Victoria.

Tomentosus Root Rot Impact Assessment in the Bulkley TSA.

The objective of this project was to assess the impact of tomentosus root rot caused by *Inonotus tomentosus*, in the Bulkley TSA, on stands with a component of interior spruce. The contract for this Forest Renewal B.C. Operational Inventory project was awarded to Cedrus Consulting, Smithers, B.C. The project involved estimating:

- a) overall incidence of disease in both interior spruce and lodgepole pine;
- b) volume of both species that was associated with those infected trees;
- c) percentage of volume infected;
- d) volume loss for the past 20 years;
- e) projected impact for the next 20 years;
- f) percent area infected within plots; and
- g) percent plots infected.

The timber losses caused by *Inonotus tomentosus* were estimated using growth and yield permanent sample plots containing an interior spruce component. Data were collected from both mature (>30 years old) and immature stands (< 30 years old).

Two loss estimates were reported. The first estimate - the most conservative - includes only those trees with infections that were positively identified based on the presence of pitted decay. Wood containing pitted decay and the associated red brown stain is the most positive means of identifying trees infected with *I. tomentosus*. The second estimate (in brackets) includes those trees that exhibited crown symptoms characteristic of tomentosus yet did not contain pitted decay based on the survey methods used.

The overall incidence of tomentosus root rot in interior spruce including both mature and immature trees was 2.10 (9.66) % based on a sample of 859 trees. The overall incidence of diseased lodgepole pine was 0.38 (1.13) % based on 532 trees. The volume of interior spruce and lodgepole pine trees infected was 2.70 (3.71) m³/ha for mature, and/or 0.32 (0.36) m³/ha for immature. This volume loss represents 2.11 (3.32) % of the mature interior spruce volume and 0.88 % of the mature lodgepole pine volume. The proportion of the immature interior spruce volume that was infected was 1.57 (1.79) %. The estimate of volume lost for the past 20 years was 0.18m³/ha for mature trees, dead 20 to 10 years, and 0.38 m³/ha for mature trees, dead 9 years to present. The projected volume losses for the next 20 years was 0.19 (0.24) m³/ha for mature plots and for immature plots 0.32 (0.12) m³/ha. The proportion of plot area infected with tomentosus was 5.69 (6.5) % for mature plots and 4.0 (5.5) % for immature plots based on an infected radius of 3 meters. The percentage of plots containing evidence of tomentosus was 40% for mature plots, and 25% for immature plots or a total of 36% overall.

The results of this study indicated that the losses due to tomentosus root rot in the Bulkley TSA are relatively small. The reason for these low values could be in part due to the methods used to sample individual trees. Since the trees were in permanent sample plots, the assessment for tomentosus had to be low impact. For that reason, a single increment core was taken at the root collar. A more accurate survey would involve drilling several

roots or possibly even excavating roots to look for the disease symptoms in roots. A second explanation, and probably the more important one, concerns the sampling strategy used in this study. Growth and yield permanent sample plots were chosen as a sample for this study as the sampling strategy was already established and it conformed to Resources Inventory Branch standards. However, growth and yield permanent sample plots were originally located in areas where there was no evidence of disease. According to staff at Resources Inventory Branch, if a plot landed in a diseased area, the plot would be relocated to an apparently disease free location. Assuming this was the case in the Bulkley TSA, the results of this study are still quite significant. Tomentosus root disease was present in over 2.0% of all spruce trees examined in plots that were designated as free of disease. If suspect trees are included, the incidence of disease is as high as 9.7%.

This study indicated that even with a biased sampling strategy, tomentosus root rot is responsible for a volume reduction of 2.12% in interior spruce stands.

The proportion of plots containing infected trees was perhaps more significant than the volume loss estimates. Of the 35 mature plots examined, 9 (25.7) % contained trees that showed evidence of being infected. In addition, five more plots were within a 3 meter radius of influence of infected trees outside of the plot perimeter. If these plots are included in the proportion of sampled area infected, the value is up to 40.0%. Considering that all of these plots were originally established in areas that were apparently disease free, these values are significant.

Tomentosus root rot, like other root diseases, is a disease of the site. The fungus has the ability to survive in a saprophytic state for decades, and slowly spreads from host to host. The areas of infected mature trees will remain infected as long as there are potential hosts on the site. If the presence of the disease is not detected during an assessment for a silviculture prescription, there is a good chance that the area will be reforested with interior spruce, since that was the species that was harvested from the site.

It is in second growth stands where root disease can cause the most damage. In the immature plots examined, 25.0% of the plots contained infected trees or were within a 3 metre radius of tomentosus infected trees outside the plot perimeter. The losses in these infected plots can be expected to increase and likely surpass the levels of infection that were associated with the original stand. As juvenile stands mature, root contacts increase and tomentosus can spread from tree to tree. The fungus spreads at a rate of 3-4 cm/year along susceptible host roots (Hunt and Unger 1994). New infections result from root contacts with infected inoculum and from spores. The extent to which spores are involved is not well known, however they have the potential to increase the rate of spread of the disease considerably.

The goal of this FRBC project was to produce an estimate of the unsalvageable losses due to tomentosus root rot in the Bulkley TSA and in the Prince Rupert Forest Region as a whole. This study is one step towards that goal. However, given the bias of the permanent sample plot sampling methodology, the results are clearly conservative. In order to determine a more representative estimate of losses due to tomentosus, another

sampling strategy is needed. Temporary sample plots were not moved for any reason according to Inventory Branch, but the difficulty with these plots is that they were temporary and therefore, are very difficult to relocate.

In a separate project, I selected a sample of 50 spruce-leading polygons for examination in the Bulkley TSA. This sample was randomly selected from the Inventory database and included only those polygons on the operable land base outside of any CORE ecosystems or similar reserves. Temporary sample plots will be established in the 50 selected polygons and all spruce and lodgepole pine trees in the plots will be measured for dbh and height and examined for evidence of tomentosus root rot.

A continuation of the FRBC Operational Inventory project will be conducted in the Kispiox TSA in the summer of 1997, and in the Morice and Lakes TSAs in 1998 and 1999, respectively.

Although FRBC funding for the second year of this project was cut by 60%, I will continue with a follow-up study in the Bulkley TSA.

- A. Woods, Prince Rupert Forest Region, Smithers.

A "New" Root Disease Survey Method Tackles an Old Problem. As first reported in the December 1995 issue of *Forest Health Progress*, we have been attempting to rationalize the many current root disease survey methods listed in the Forest Practices Code *Root Disease Management Guidebook*. Many of these methods are inadequate and few are statistically valid. Some current survey methods are more suited as tools to determine the occurrence of root disease over broad areas rather than to provide a specific, stand level incidence rating required for stand management and silviculture prescriptions required in the guidebook.

We set out from basic principles to construct a quantitative sampling method that would: (a) be efficient in both effort and cost; (b) produce a statistically reliable result that would assist the prescriber in selecting an appropriate treatment regime; (c) fit into current information systems; and, (d) provide a useful tool for further research. We decided to concentrate on juvenile stands first as we were unsure that a single sampling method would work well across all age classes, stand densities, and for all root diseases. We created a scheme which would "oversample" by collecting tree data along a strip transect 5 m wide and spaced at 25 m intervals. This provided 20% coverage of the target area--obviously too time-consuming and expensive for operational use.

Using this method over the last two years, we collected data from 16 coastal and interior stands containing varying levels (2 to 13%) of laminated, armillaria, tomentosus, and blackstain root diseases (thanks to Boundary, Bulkley, Duncan, Kispiox, Penticton, Revelstoke, and Vernon Forest Districts). The data were analyzed by selectively stripping away sampled trees until an optimal balance between sample

size and variance was reached (i.e., by manipulating transect width and interval). The analysis indicated that a strip transect of 3 m width spaced at 50 m intervals (6% coverage) would be the most effective and efficient. Indications are the sampling procedure was sound for all tested areas. Copies of the statistical evaluation are available from the undersigned.

This “new” method will fill the need for a quantitative tool to produce a reliable incidence estimate with known confidence limits. This tool may still not be the “best”, way to decide how to stratify a stand into treatment units, or decide on a treatment, as it does not provide a visual representation of disease distribution; only a number representing root disease incidence of the sampled area. It does, however, allow us a necessary tool for use when comparing other quantifiable physical stand characteristics for such purposes as designing hazard and risk rating systems.

In order to fulfill the complimentary requirement for a visual (or qualitative) root disease assessment method, several districts are turning to the use of 100% sketch map surveys. This method entails systematically covering the entire area and recording the occurrence of root disease by inspecting standing dead, down, and symptomatic trees. The product from this method is a map which illustrates root disease location by species. Prescription writers then have the flexibility of adding buffers and creating treatment units based on site conditions and constraints. The downside is that this method does not produce a reliable incidence number with which to designate a stand; only an estimate of area affected.

The line transect method will be operationally field tested over the next year or two in order to refine procedures and attempt to estimate a reasonable cost per hectare. A detailed description of the line transect survey procedures will be released following this testing period with advice on how and when best to use it. We have plans to “automate” the survey by writing a program which would run on hand-held data loggers, thereby increasing accuracy and productivity by ensuring fewer errors are entered into the survey data. The program would produce incidence results, by selected variable (e.g., host species, root disease, etc.), with confidence intervals. Plans for having the program also produce a computer-generated stratification map of the surveyed area have been scrapped as little enthusiasm for this option was shown at the recent provincial forest health meeting.

Another obvious next step is to develop a corresponding survey for mature stands to assist silviculture prescription writers. It is uncertain that the line transect method for juvenile stands would work equally well for larger, root disease-affected trees in less dense arrangements. This project had been scheduled to start this year, but fiscal difficulties have postponed this initiative.

- S. Zeglen, Vancouver Forest Region, Nanaimo, and
V. Fletcher, Forest Practices Branch, Victoria.

MAMMAL DAMAGE

New Information on Deer Browse Control Using Barriers. After release of the publication *Seedling Barrier Protection from Deer and Elk Browse* earlier in 1996, we received information on several techniques and products that are of interest to forestry staff:

- A barrier technique (overlooked in the publication) called "bud caps" appears to offer very inexpensive browse control for young trees such as Douglas-fir.
- A commercially produced wire cage product is available at a considerably lower cost than indicated in our publication.
- Some prices have changed for Vexar® and other products.

The bud cap barrier technique appears to have been used for many years in a variety of forms. The method involves covering the leader bud with a cap (usually a cylinder of paper or plastic) in the spring before the deer start browsing young trees. The technique appears to work for tree species, such as Douglas-fir and true firs, that have an erect leader. It is best to apply bud caps only to trees showing vigorous growth and with a dominant leader bud. We expect that protection is possible against low to heavy browsing intensity. Each year a new bud cap can be applied, or the previous year's bud cap could be pulled up to re-cover the new bud. Remove the lateral buds from the bud cluster to be protected, so that their growth does not interfere with the bud cap. Lateral stems and foliage will be browsed, but the leader should escape damage, and after it reaches 1.5 m height, it should escape browsing without protection.

Bud caps, shown to us by Huock Resource Consultants Ltd, in Qualicum Beach, B.C., were made from 10 cm x 12.5 cm cards of good quality bond or waterproof paper. Two cards could be made from one standard 8.5 x 11.5 inch page. The card is rolled along its width into a cylinder with a diameter of about 5 cm and stapled. The cylinder is placed over the tree leader, and the lower portion of the cylinder is pinched and stapled to create a gentle friction fit with the leader. When first installed or when readjusted, the bud inside the cylinder should be in the lower portion of the cylinder. Do not staple or attach the cylinder to the leader. If possible, the cylinder should be able to be easily pulled up the stem to cover the next bud.

Waterproof paper bud caps, maintained once per year, appear to endure for about 2 to 3 years. An excellent waterproof paper to make bud caps is out-of-date forestry field cards. In other than extreme weather or browsing conditions, bud caps may be all that is needed to assist trees to escape browsing.

Metal browse barrier cages, previously custom made devises, are now a standard product. Currently the only company known to us that produce the cages is Sweetwood Enterprises Ltd, P.O. Box 344, Sointula, B.C., Canada, V0N 3E0 (phone 250 973 6420, fax 250 973 2025). Product information provided for 1996 by Sweetwood Enterprises Ltd. lists a galvanised metal cage (132 cm x 122 cm) for a unit cost of \$1.75 to \$1.80, depending on the volume purchased.

Based on the comparison of products in our report, this would result in an approximate installed cost of \$3.67 per seeding including the wooden stake, seedling, planting and installation costs. Please consult the report for assumptions about this estimate. We expect the approximate net present cost to plant and protect 1 ha of seedlings for 6 years to be \$4003.00, and for 50 ha, \$200,136.00. Actual costs may vary from this estimate. This is a substantial reduction in our cost estimate for custom made metal cages.

For reasons of stand tending worker safety we recommended that metal cage barriers be removed once the trees have escaped browse suppression. Galvanised metal barriers could be re-used following their removal. We have not attempted to estimate the costs and savings associated with the cage removal or re-use.

Canadian Forestry Equipment Ltd., 17309 - 107 Avenue, Edmonton, Alberta, T5S 1E5, (phone 403 484 6687, fax 403 484 6763) advised that prices of some of their products, are less than those listed in our damage control publication. Compared to price estimates presented in our publication in Table 2 quantities over 2000 and up to 50 000 sell for an estimated price of \$1.91, rather than the stated price of \$2.14 (1995 dollars at an 8% discount rate). The supplier price for Tree-Pro® is currently \$1.49 to \$1.95 per unit, depending on quantities always over 4000. These prices include delivery to Vancouver or interior of British Columbia locations.

Suppliers current unit prices for specific products should be obtained to estimate the costs of individual browse control projects.

For more information contact the product suppliers, or the author at 250 387 8738.

- J. Henigman, Forest Practices Branch, Victoria.

New Publication on Predator Habitat Enhancement. A report *Predator Habitat Enhancement as a Strategy for Managing Small Mammal Damage in B.C. Forests: A Problem Analysis* Now Available. The report was written for us on contract by Frances Backhouse and Todd Manning, and copies are available from Forestry Division Services Branch, Victoria.

The purpose of this problem analysis was to compile and analyze existing information on enhancement of carnivore and raptor habitat as a means of controlling small mammal populations. This information will be of use to biologists and foresters, forestry and wildlife technicians and forest management researchers.

Forest management legislation in British Columbia requires that provincial forest lands be managed to include biological diversity and wildlife. The legislation also requires that forest resources be protected from damaging agents. Wildlife enhancement opportunities which contribute to the control of forest resource damage should be a win-win for everyone.

Mammal damage of commercial forest trees occurs sporadically across B.C. Generally the damage is an annoyance, but for specific sites it can be a serious problem to forest managers. Tree damage is commonly associated with increasing populations of species of voles, snowshoe hares, red squirrels, porcupines and black-tailed deer (this report does not discuss deer). In areas where mammal damage is a chronic problem, it is preferred, wherever possible, to encourage naturally occurring predators of the problem animals. Forest planning intended to locally enhance predator populations should ultimately help reduce tree damage as well as contribute to wildlife management objectives.

Given a regular supply of small mammal prey, it should be possible to increase carnivore or raptor predator populations through enhancement of their preferred habitat. Greater numbers of predators should result in fewer small mammals in areas where high populations cause extensive tree damage. We do not expect to eliminate a pest problem, rather it is hoped to maintain or restore a balance in animal populations, thereby reducing damage to trees and seedlings.

Since few other jurisdictions with forests similar to British Columbia tried predator habitat enhancement techniques, recommendations offered in this problem analysis need to be tested through field research in the province. Assessment of many of the methods proposed in the report will be best undertaken as part of larger forest research initiatives. Predator habitat enhancement strategies could also be attempted as part of operational forest programs by forest licensees in their five year development plan areas.

For more information on mammal damage control or on this new publication, please contact the author at 250 356 5886.

J. Henigman, Forest Practices Branch, Victoria.

PERSONNEL

FOREST PRACTICES BRANCH

John Muir	Forest Health Officer	Victoria	387-8740
Peter Hall	Forest Entomologist	Victoria	387-3842
Val Fletcher	Sampling/Surveys Specialist	Victoria	356-8763
Tim Ebata	Forest Health Project Specialist	Victoria	387-8739
John McLaughlin	Forest Pathologist	Victoria	387-8737
John Henigman	Damage Assessment Specialist	Victoria	387-8738
Shirley Turcotte	Forest Site Management Secretary	Victoria	953-3582
Dwaine Brooke	Noxious Weed Control Officer	Kamloops	319-4074 (Cell Ph.)
Marsha De Wolf	Biocontrol Technician	Kamloops	319-4250 (Cell Ph.)
Susan Turner	Biocontrol Specialist	Kamloops	319-4240 (Cell Ph.)
	Noxious Weed Office Phone	Kamloops	376-3973

TREE IMPROVEMENT PROGRAM

Robb Bennett	Seed Pest Management Officer	Victoria	652-6593
Michelle Hall	Seed Pest Management Biologist,	Victoria	652-7613
Ron Planden	Seed Planning Forester	Victoria	652-8303

NURSERY AND SEED OPERATIONS BRANCH

Don Summers	Manager, Nursery Extension Services	Surrey	930-3301
Dave Trotter	Nursery Pest Mgmt. Specialist	Surrey	930-3302
Diane Gertzen	Special Proj./Christmas Tree Specialist	Surrey	030-3309

CARIBOO FOREST REGION

Regional Staff

Leo Rankin	Forest Entomologist	Williams Lk.	398-4439
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District Staff

Bob Mitchell	Forest Health Officer	Chilcotin	394-4700
Brad Powell	A/Forest Health Officer	Quesnel	992-4400
Von Vickers	Forest Health Officer	Williams Lake	398-4341
Don Wright	Forest Health Officer	100 Mile House	395-7873

KAMLOOPS FOREST REGION

Region Staff

Lorraine Maclauchlan	Forest Health/Research	Kamloops	828-4177
Hadrian Merler	Research Associate	Kamloops	828-4176

District Staff

Rob Martin	Forest Health Spec./Woodlot For.	Clearwater	587-6700
Dave Piggin	Forest Health Forester	Kamloops	371-6534
Ed Senger	Forest Health Specialist	Lillooet	256-1277
Pat Byrne	Forest Health Specialist	Merritt	378-8449
Margot Hollinger	Forest Health Specialist	Penticton	490-2242
Savas Koutsantonis	Forest Health Technician	Penticton	490-2250
Jim Wright	Zone Forester, Silviculture	Salmon Arm	832-1424
Wayne Anshelm	Forest Health Specialist	Salmon Arm	832-1428
Kirk Hughes	Forest Health Specialist	Vernon	558-1784

NELSON FOREST REGION

Region Staff

Art Stock	Forest Entomologist	Nelson	354-6633
Don Norris	Forest Pathologist	Nelson	354-6143

District Staff

Dan Reibin	Forest Health Officer	Arrow	365-8613
Ross Elliott	Forest Health Officer	Boundary	442-5411
Liz Goyette	Forest Health Officer	Cranbrook	426-3391
Emile Begin	Forest Health Officer	Invermere	342-4200
Julie Castonguay	Forest Health Officer	Kootenay Lk	825-1142
Norm Tennant	Silviculture Specialist	Revelstoke	837-7611

PRINCE GEORGE FOREST REGION

Region Staff

Robert Hodgkinson	Forest Entomologist	Pr. George	565-6122
Richard Reich	Forest Pathologist	Pr. George	565-6143
Stuart Taylor	A/Forest Resources Team Leader	Pr. George	565-6207

District Staff

Bruce Doerksen	Forest Health Technician	Pr. George	565-7100
Sharron Schiefelbein	Forest Health Technician	McBride	569-3748
Nathan Voth	Forest Health Technician	Vanderhoof	567-6363
Barb Harrison	Forest Health Technician	Ft. St. James	997-5276
Steve Bower	Forest Health Technician	Mackenzie	997-2200
Kathy Walker	Silviculture Technician	Dawson Creek	784-1200
Brain Farwell	For.Res & Pract - Silviculture	Ft. St. John	787-5600
Steve Lindsay	Resource Officer - Silviculture	Ft. Nelson	774-3936

PRINCE RUPERT FOREST REGION

Region Staff

Neil Endacott	Silviculture Officer	Smithers	847-7513
Alex Woods	Forest Pathologist	Smithers	847-7478
Ken White	Forest Entomologist	Smithers	847-7479
Lou Tromp	Stand Tending/Veg Mgmt For.	Smithers	847-7514
Don Russell	Range Officer	Smithers	847-7443
Gerry Pinkerton	Reforestation Forester	Smithers	847-7512

District Staff

Gary Lloyd	Senior Zone Forester	Bulkley	847-6307
Bill Camenzind	Silviculture Specialist	Bulkley	847-6310
Glen Buhr	Silviculture Practices Forester	Cassiar	771-4211
Bob Wilson	Silviculture Officer	Kalum	638-5138
Doug Davies	Zone Forester	Kalum	638-3290
Paul Hanna	Silviculture Officer	Kispiox	842-7600
Todd Bresser	Forest Health Technician	Morice	845-6224
Todd Burgess	A/Silviculture Officer	Morice	845-6200
Ted Traer	Silviculture Officer	Lakes	692-7515
Fiore Milinazzo	Forest Health Technician	Lakes	692-7515
Mike Grainger	Silviculture Specialist	North Coast	624-7460
Mark Vieweg	Resource Officer-Silviculture	Lakes	692-7515

VANCOUVER FOREST REGION

Region Staff

Don Heppner	Forest Entomologist	Nanaimo	751-7107
Stefan Zeglen	Forest Pathologist	Nanaimo	751-7108

District Staff

John Ingram	Resource Officer - Silviculture	Campbell Rv.	286-9300
Buck Tanner	Timber Specialist	Campbell Rv.	286-9300
Jeff Fournier	Silviculture Officer	Chilliwack	794-2225
Kelly Schellenberg	Small Business Forester	Duncan	746-2768
Shawn Rice	District Silviculturist	Mid Coast	982-2000
Mark Palmer	District Silviculturist	Pt. Alberni	724-9205
Chuck van Hemmen	Resource Officer - Silviculture	Pt. McNeill	956-5034
Ron Diprose	Forest Health Technician	Sunshine C.	485-0730
Allan Sugg	District Silviculturist	Qn. Char. Is.	559-6212
Doug Bacala	Basic Silviculture Officer	Squamish	898-2134

MEETINGS

Forest Health Provincial Specialists. On April 8-9, 1997, a very successful meeting for provincial forest health specialists was held at Richmond, B.C. Brief introductions or presentations on April 8th were followed by workshop sessions and discussions the next day. Of 34 attendees, 19 were from districts and seven from regional offices.

The meeting provided valuable information for staff on recent issues and developments, and was particularly appreciated by newer members from some of the northern districts.

Janna Kumi, Assistant Deputy Minister, Operations Division attended the first day session, and provided encouraging news on funding of forest health activities and other initiatives.

Several follow-up items are being pursued, including a presentation to the Operations Division Management Team on ministry policy needs to ensure prompt milling of bark beetle-infested logs.

The value of having another meeting next year was re-affirmed, and it is scheduled for April 14-16, 1998. Richmond is still regarded as the most convenient and cost-effective location for most staff. The program committee for the 1998 meeting includes Robert Hodgkinson, Prince George Forest Region, John McLaughlin, Forest Practices Branch, and David Piggin, Kamloops Forest District.

- J. Muir, Forest Practices Branch, Victoria.

1997 Western Forest Disease Work Conference. The 1997 Western Forest Disease Work Conference will be held in Prince George, British Columbia, at the Inn of the North, during the week of September 15, 1997. The Program Chair is K. Lewis, the local arrangement committee is comprised of R. Reich, A. Woods, J. McLaughlin, and J. Beale. Rona Sturrock is the Secretary, and Walt Thies is the Chairperson for the conference.

The initial mailout with details of the conference and a draft program were sent out in February. A second announcement including registration information will be sent out in May. A final announcement and complete program will be sent out this August. This conference is an excellent opportunity to meet forest health practitioners from universities, government agencies and private industry from across North America to discuss current and proposed management practices.

- Richard Reich, Prince George Forest Region, Prince George.

Western Balsam Bark Beetle Management Issues. I moderated a session at the Western Forest Insect Work Conference in Prince George and produced the following summary.

Approximately 60 people attended this workshop and the biology, impact and management of the western balsam bark beetle (WBBB), *Dryocoetes confusus*.

Sandy Kegley, USFS Coeur d'Alene, Idaho, presented beetle flight data from three years of trapping performed by her and Ken Gibson, USFS, Coeur d'Alene, Idaho. Their results supported the two flight period emergence pattern described in the literature, but, there was wide variation in both timing of flights and numbers emerging between years.

Leroy Harder, an Masters of Pest Management student from Simon Fraser University, worked with Lorraine Maclauchlan in the Sicamous Creek Alternative Silviculture Systems trial in the Kamloops Forest Region. He examined beetle attack patterns on baited trees. He also collected mensurational data on live and recently killed trees and on snags in various conditions of deterioration. Within trees, exit holes were observed from about 2 m from the ground up to 11 m. Resin flow, presumably caused by the tree attempting to pitch out the beetle, occurred between 5 to 13 m on the tree. Exit holes were not found on boles less than 21 cm diameter; resin flow stopped at 19 cm. This could explain why beetles do not usually attack small diameter trees as they do not produce brood in stems <21 cm. His data indicated that in the stand examined, 25% of the basal area was snags with evidence of WBBB. Most (but not all) of the large diameter trees were attacked, although some small diameter trees had also been killed.

Roberta Parish (BCMoF, Research Branch) also undertook an intensive dendrochronology study in the same area. She found that red trees on average were dead for about 4 yrs, greys 17 yrs, and three snag classes were dead for 29, 44 and ? (too much variability) years, respectively. The longest time a snag had been dead was 60 yrs. Leroy attempted to determine if mortality in the stand he examined was due to an epidemic of WBBB. His conclusion was that he could not tell the difference between a long term outbreak or a chronic infestation. John Borden said "It is like an above-ground *Armillaria ostoyae*". Some problems he faced were determining what contribution downed trees made in the rate of loss calculation since these trees are too decayed to use for dendrochronology.

Another interesting result from Parish's work was the discovery of substantial release of trees that were over 100 yrs old that remained suppressed in the understorey. Release was determined to occur when ring widths increase by 200% and, since no evidence of fires was found to correspond with the release period in the 1860's, it is hypothesized that a spruce beetle or other bark beetle outbreak may have removed the overstorey.

What are the management options for this beetle? Because of the diffuse nature of the attacks, large landscape units should be managed. Ideally, partial cutting could be utilized to salvage damaged patches as well as mimic the beetle's attack behaviour. Baiting could be used to enhance the efficacy of tree removal if warranted. Low log quality and value discourages practising partial cutting in stands where extensive cutting requires a larger road network that is not paid by the value of the harvest as with conventional clear-cutting. There was some discussion that partial cutting subalpine fir may exacerbate problems with *Armillaria ostoyae*. Fortunately, in northern British Columbia, *Armillaria ostoyae* is not present. There was also a discussion of the hazard rating system that is being performed by Phero Tech Inc. and being ground tested at several British Columbia locations. The system is based on stand parameters described in Art Stock's Ph.D. thesis.

John Borden summarized the status of pheromone research for WBBB. Currently a racemic exo-brevicommin bait is available commercially from Phero Tech Inc. However, based on Stock's (1994) work, the true pheromone appears to be a 9:1 ratio of (+) exo: (+) endo-brevicommin. The commercial bait is a 9:2 ratio of (+) exo: racemic endo-brevicommin which "sort of works" but is sold in this formulation due to high costs of production. Borden suggested that if Phero Tech used the 9:1 bait, they could reduce the release rate six-fold and cost savings could be made. M.Sc. candidate Nicole Jeans will be working with Borden at Simon Fraser University to further field test the baits and various formulations. Repellancy has been found with 100% endo-brevicommin but no one has worked on this. It may be a suitable tool for protecting trees on ski hills.

Lorraine Maclauchlan, Kamloops Forest Region, described a large-scale inventory of subalpine fir leading (50% or more) stands in her region. Stands are stratified by biogeoclimatic zone and subzone. They are surveyed from helicopters, followed by a ground survey of 1-2 ha. First year results indicate difference in certain ecosystems related to age class and the different roles WBBB plays in stand succession.

Tim Ebata, Forest Practice Branch, observed in a 9 year permanent plot study that the average needle retention time for subalpine fir is 3 years with a maximum retention of 5 years, depending on the degree of crown exposure. This was judged subjectively from the ground as the maximum length of time the tree would be detected as a "red" during aerial surveys. In the first two years after attack, the crown is bright red; by the third year the tree has faded to brick red.

Natural enemies of WBBB have been listed in emergence studies from caged infested subalpine fir bolts by Art Stock during his M.Sc. thesis work. There are numerous species associated with the beetle but much remains unknown about them. *Pityokteines minutus* is one of the major bark beetle associates. Art Stock is presently the only person working on testing MSMA as a post-attack treatment. Blowdown trees are more attractive than baited trees.

Current management recommendation for stands under attack by the beetle depend on economics and management constraints. If the stand can be clearcut, probably the most economical choice is standard clearcut and planting. If constraints limit clearcutting, partial cutting in a way that mimics the beetle could theoretically manage the stand in a classical uneven age management regime. The key factor is that this beetle does not "explode" in population like mountain pine beetle or spruce bark beetle. The bait and cut strategy could be applied IF the strategy is to remove all of the beetles that one can through harvesting while beetle populations are low. Beetles apparently can be moved 50 to 70 m through baiting, however, in most stand conditions where the beetle is a management issue, infestations are found throughout the stand and baiting would not be that efficacious.

The proactive, hazard-based approach is the only one valid over the long-term. Stands of high hazard but showing little beetle history (few reds or greys) should be given highest ranking for harvest to maximize the potential sawlog volume. Stands with a long history of attack and mainly of pulp quality pose a management problem since they are of far lower value but it may be important to convert them into more productive seral stands. Obviously, a better inventory of these stands is required for long-term planning. The Bulkley Forest District has the most experience managing forests infested heavily with WBBB. It is suggested that they be contacted for more "hands on" information.

The question of value of the standing snags is being examined by Tim Ebata, Bill Camenzind, Ken White and Gerrard Olivotto. A recent timber supply review did not address to the question of value and salvage of pulp logs created by WBBB. Dendrochronology was used to date snags (similar results to Parish) and chip samples from each snag class were analyzed for pulp quality and paper strength. Surprisingly, trees that have been dead for up to 30 years produced good quality pulp. Thus, in good pulp markets, the potential fibre volume is far higher than would be indicated by cruising of green and recently dead trees. This same study is ongoing and has an extensive inventory component that will determine if the beetle caused mortality is caused by recent or old outbreak or is chronic. As in Harder's study, fallen trees cannot be included in the analysis since they tend to "melt" away as soon as they make contact with the forest floor.

There was interest in having a symposium on WBBB and subalpine fir/spruce ecosystems in British Columbia perhaps in the fall of 1997. Industry will probably be interested.

- T. Ebata, Forest Practices Branch, Victoria.

Forest Health Strategic Plan for British Columbia. Forest Renewal B.C. (FRBC) has requested that a strategy for forest health investments be prepared for the 1998/99 call for proposals. Unlike previous attempts by the Ministry of Forests to provide strategic direction to FRBC, the requested plan must involve all "Forest Health Stakeholders". As the only formal body that has representatives of nearly all stakeholders involved in forest health issues, the Provincial Forest Health Committee was identified as the forum for strategy development and approval. A proposal to the Forest Health Committee for the formation of a working sub-committee to develop, review and present this strategy will be made at the spring business meeting in Nelson.

Regional investment plans also require strategic investment direction and will require similar stakeholder input and review at the regional level. Following the approval of the provincial strategy that will serve as an umbrella strategy, regional strategies that reflect local forest health priorities will then be developed through stakeholder committees and meetings.

Input from all forest health specialists, researchers, operational staff from government and industry, and other stakeholders is vital for this process to work to provide FRBC with a framework for forest health investments. Similar requests have been made for other stakeholder groups in an effort to achieve independent investment recommendations.

- T. Ebata, Forest Practices Branch, Victoria.

Summary of Root Disease Survey Training Workshop. This session at the provincial forest health specialist meeting at Richmond, April 8-9, 1997, was divided into two topics: root disease survey methods and root disease identification and management training. The first topic consisted of admission that many current root disease survey methods were not adequate to the demands placed on them and few had been statistically validated. Many surveys, including pixels and IMPS, are more suited as tools to determine the occurrence of root disease over broad areas. However, they are ill-suited for use in quantifying disease incidence on a stand specific basis and produce dubious results when used in pre-SMP or SP assessments. With this in mind, it is realized that the varied number of surveys currently listed in the *Root Disease Management Guidebook* needs to be rationalized.

A quantitative survey method that shows promise for use in juvenile stands (pre-SMP) is being tested. This method should fill the requirement for a survey which quantifies the incidence of root disease based on above-ground symptoms and will be of most use to those who require statistically reliable output. Copies of the statistical analysis of the field data collected to date are available from the undersigned. A detailed description of the survey method will be released after field testing is completed this year. There is interest in seeing whether this method will also work in mature stands for pre-SP purposes.

In order to fulfill current root disease assessment requirements, several districts in the Vancouver Forest Region are using 100% sketch map surveys for SP and SMP stands. This method produces a map which illustrates root disease location by species. Prescription writers then have the flexibility of adding buffers and treatment units depending on local conditions and constraints. Survey costs, for experienced contractors, have recently ranged from \$42-100/ha. While this may seem high, once produced, a good map should last the life of the stand unless inoculum removal is conducted prior to final harvest.

The problem of finding experienced contractors to conduct root disease surveys (of any nature) and produce quality results was covered under the second topic. The recently piloted two-day root disease management workshop was discussed. Overall, the workshop was found to be useful for district and licensee field staff and contractors. The workshop covers basic biology and identification and the five-stage root disease management process outlined in the guidebook (hazard rating, surveys, future risk, evaluation, and management strategies) both indoors and in the field. Some changes to the workshop format and content need to be made based on experience gained during the pilot session.

To ensure the quality of information remains high, regional pathologists agree that they should take the lead in delivering the workshop in their respective regions. To assist in delivering workshops, it was agreed that neighbouring pathologists and resources from the Canadian Forest Service and universities be tapped to reinforce the message and provide individual expertise and assistance, particularly for the field portions, if travel funding is available. The workshops, for this year at least, will be advertised through the Forest Continuing Studies Network. Watch for a location near you.

- S. Zeglen, Vancouver Forest Region, Nanaimo.

TABULATIONS AND GRAPHICS

Table 1. Spruce beetle emergence for hibernation at Chunamon Bay in 1996¹

<u>Treatment</u>	<u>Number emergence traps</u>	<u>Number trees</u>	<u>Mean no. emerged immature adults per 2660 cm² phloem per tree</u>	<u>Mean no. live unemerged immature adults per 2660 cm² phloem per tree</u>	<u>Percent emergence of immature adults*</u>
Early felled	17	9	6.3 ± 7.0	35.3 ± 26.9	18.5 ^a
Late felled	10	5	3.5 ± 4.0	24.8 ± 11.3	9.5 ^a
Standing	11	6	34.8 ± 36.3	38.3 ± 20.4	39.8 ^b

*Percentages followed by the same letters are not significantly different, $p = 0.01$ (g-test of independence)

¹Please refer to article *Spruce Beetle Emergence for Hibernation Research* by R. Hodgkinson on p. 14.

Table 2. Spruce beetle emergence for hibernation at Petoy Creek in 1996¹

<u>Treatment</u>	<u>Number emergence traps</u>	<u>Number trees</u>	<u>Mean no. emerged immature adults per 2660 cm² phloem per tree</u>	<u>Mean no. live unemerged immature adults per 2660 cm² phloem per tree</u>	<u>Percent emergence of immature adults*</u>
Early felled	20	10	0.8 ± 1.0	10.4 ± 10.7	7.0 ^a
Late felled	15	9	1.1 ± 1.4	5.1 ± 3.0	13.0 ^a
Standing	20	10	19.3 ± 12.9	11.6 ± 5.9	60.2 ^b

*Percentages followed by the same letters are not significantly different, $p = 0.01$ (g-test of independence)

Table 3. Spruce beetle emergence for hibernation in the ESSF Biogeoclimatic Zone in 1996¹

<u>Percent emergence per 2660 cm² phloem per tree*</u>			
<u>Site</u>	<u>Early felled</u>	<u>Late felled</u>	<u>Standing</u>
Chunamon Bay	18.5 ^a	9.5 ^a	39.8 ^b
Petoy Creek	7.0 ^a	13.0 ^a	60.2 ^b

*Percentages followed by the same letters in rows are not significantly different, $p = 0.01$ (g-test of independence).

¹Please refer to article *Spruce Beetle Emergence for Hibernation Research* by R. Hodgkinson on p. 14.

PUBLICATIONS AND REPORTS

- Backhouse, F. and T. Manning. 1996. *Predator Habitat Enhancement as a Strategy for Managing Small Mammal Damage in B.C. Forests: A Problem Analysis.*
- Nemec, A.F.L. 1997. Evaluation of line-transect survey methodology for detection of root disease in young coastal and interior stands. Contractor file report. Ministry of Forests. Nanaimo.
- The Code and Forest Health. 14 Minute Video and Pamphlet. Available from S. Turcotte, Forest Practices Branch, Victoria.