



Province of
British Columbia
Ministry of Forests

FOREST HEALTH PROGRESS

A summary of forest health activities in the British
Columbia Ministry of Forests.

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Thoughts on the B.C. Forest Service Silviculture Program, Including Forest Health.

Over the next few years, I see a great deal more interest by the general public, politicians and all stakeholders in managing forest vegetation (i.e. practice of "multi-purpose" silviculture) across the landscape.

The public expects forests to produce a variety of tangible and intangible values; many of these will be overlapping; many will have to be managed over varying geographic areas and landscapes; and, undoubtedly funds will be in short supply. It will be a great challenge to creatively work with various resource users, to cost-effectively manage forest vegetation to achieve a wide variety of objectives.

In carrying out our role, we will have to keep an open mind and cooperate closely with many disciplines to get the job done. We have only practiced some form of silviculture for 30 to 40 years in British Columbia, and we all know that we live in an area that is blessed with a tremendous biological diversity, and that we have only just begun the process of understanding ecosystem function and response to human intervention.

Forest health must be an important component in all manipulations of forest vegetation. You and your forest health colleagues are making believers out of many people. You have shown people the consequences of not being aware of, or disregarding forest health issues. You have some numerical estimates of very impressive loss reductions and yield gains. People are now listening to what you have to say - more people than you may have imagined!

Now that you are working in the Silviculture Program, you have unlimited potential to educate, inform and integrate your thinking with your new colleagues. This is not easy but the outcome will be an agreement from other silvicultural disciplines whose cooperation you need to help deliver forest health prescriptions.

In conclusion, congratulations on your achievements; welcome to new responsibilities for designing integrated silvicultural treatments; and take advantage of the very promising opportunities that lie ahead.

- H. Benskin, Silviculture Branch, Victoria.

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FOREST HEALTH PROGRESS

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EDITOR'S NOTE

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

Contributions labeled with an appropriate subject heading should be submitted to the regional forest health forester, or advisor, who will edit and forward them to Silviculture Branch. Forest Health Progress is submitted to the spring (May) and winter (December) meetings of the Forest Health Committee.

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

EXECUTIVE SUMMARY

This issue of Forest Health Progress - a report on B.C. Forest Service Silviculture Forest Health Activities - includes 65 articles or short reports on insects, diseases, animal damage, pesticides and more general subjects or issues.

An overview of the challenges facing silviculture and how we need to develop integrated, networked solutions for forest health issues was provided by H. Benskin.

Updates for other general subjects were provided for an inter-ministry assessment of roadside tree injury attributed to de-icing salt (p. 15); development of damage models for root diseases, defoliating insects and others (p. 11); new regulations that exempt bark beetle trap trees from requirements for pre-harvest silviculture prescription (p. 31); forest health training initiatives (p. 12); forest-level forest health inventory sampling (p. 8); compilation of damaging agents for silviculture and forest health surveys (p. 10); free growing standards (p. 8); and use of prescribed fire (p. 17). A seed pest management report (p. 17); a damage assessment of lodgepole pine provenance trials (p. 9); an analysis of Douglas-fir beetle management and armillaria root disease (p. 10); and studies on partial-cut harvesting and tree wood decay (p. 16) were also reported.

Activities for insect management included an overview of bark beetles and defoliating insects in the Cariboo Forest Region (p. 22); bark beetle policy development (p. 30); silviculture manual revisions (p. 30); development of a debarker (p. 33); using hazard zones to predict bark beetle outbreaks (p. 26); a comparative assessment of single-tree removals and MSMA to reduce beetle outbreaks (p. 45); helicopter logging (p. 23); possible use of groups of dead trees to control Douglas-fir beetle (p. 27); and training for spruce beetle detection surveys (p. 34).

For leader weevils, reports on pheromone research (p. 19); use of weather data for hazard mapping (p. 25); and results of a shading trial (p. 27) were presented. Programs to control western spruce budworm (p. 33); Douglas-fir tussock moth (p. 34); and gypsy moths (p. 31) were summarized; and a pheromone project (p. 29) is planned. A study was undertaken to determine the risks of introducing damaging agents to the Queen Charlotte Islands (p. 24).

For armillaria root disease, an equipment trial for juvenile spacing (p. 36); an update on the research working group activities (p. 36); and surveys (p. 36) were reported. Regional guidelines were prepared for armillaria root disease and laminated root rot (p. 38).

Animal damage reports included porcupines (p. 39); and an encounter with a black bear (p. 39).

Work with pesticides included a literature review (p. 41); and a study of the effects on stream organisms of *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) (p. 40); a trial to support registration of *B.t.k.* for western hemlock looper (p. 42); assessments of boron rods and liquids to control mountain pine beetle (p. 44); and a trial of neem, a new insecticide (p. 46).

Brief reports also were presented for several recent meetings including the forest disease work conference (p. 52); Canadian Entomological Society (p. 53); and provincial forest health specialists (p. 54). Future meetings include leader weevils (p. 55); and forest health (p. 52).

- **J. Muir, Silviculture Branch, Victoria.**

FOREST HEALTH - GENERAL

Challenges and Teamwork in the Silviculture - Forest Health Subprogram.
(Presented by Mike Wyeth on behalf of Henry Benskin to the provincial forest health meeting, September 28, 1993, at Penticton, British Columbia.)

Here are some of my thoughts on the British Columbia Forest Service (BCFS) Silviculture Program, inclusive of forest health, as I see it over the next few years. In short, I see a great deal more interest by the general public, politicians and all stakeholders in managing forest vegetation across the landscape (i.e. the practice of "multi-purpose silviculture) to meet a wide variety of objectives. This will involve establishing and controlling the composition, quality and growth of trees, shrubs and minor vegetation for both narrow and broad resource use objectives.

It is clear that the public expects forests to produce a variety of tangible and intangible values. Many of these will be overlapping; many will have to be managed over varying geographic areas and landscapes; and, undoubtedly funds will be in short supply. The challenge will be to creatively work with various resource users to cost-effectively manage forest vegetation to achieve a wide variety of objectives.

We have taken a pro-active role in recent years to support a wide range of research and demonstration work, guideline development and so on, to develop the tools necessary for multiple purpose silviculture. The silvicultural systems program, wildlife trees, biodiversity guidelines for juvenile spacing, and many regional standard operating procedures are good examples of our continuing commitment.

In carrying out our role, it will be important to be humble, keep an open mind and cooperate closely with the many other disciplines that we need to get the job done. We have only practiced some form of silviculture for perhaps 30 to 40 years in British Columbia and we all know that we live in an area that is blessed with a tremendous biological diversity, and that we have only just begun the process of understanding ecosystems function and response to human intervention.

The silviculture program will not only attract interest in its forest vegetation manipulation role, but also in how this work is managed and delivered. My guess is that some form of community tenure is only a matter of time, because the local public demands a greater say in land use and forest practice. As regards program delivery, watch for more Forestry Worker Development Plan type of initiatives where the government tries to achieve both regional economic goals and social goals in a cost-effective way. Multi-purpose silviculture with more local community involvement, but subject to provincial stewardship standards is where I see things going.

In the immediate future we also face some urgent requests for information. Aside from Commission on Resources and Environment (CORE), forest practices code, protected areas strategy, and round table on the economy and the environment, we also have the timber supply review process. A consistent message is that short term harvest levels must be reduced in many management units. The government is asking the BCFS to suggest mitigation options, and silviculture has been asked to suggest solutions.

The forest sector advisory committee, which was established fairly recently to advise the cabinet planning committee, is in the process of developing an industrial strategy for the forest sector. This group, which includes industry executives, is undoubtedly also talking about silviculture opportunities - but probably in a hard business sense. If industry increases its investment in silviculture today, how much more timber can it harvest? Under what tenure arrangements would it make such investments? Specifically what amount of additional financial return does silviculture deliver in both the short and long term?

Stakeholders in the silviculture industry, with their investments and employees, are keenly interested in all of this as well - the nursery industry is concerned with the declining backlog to be planted; and the silviculture contracting industry, with planting and stand tending. Our business of silviculture is important to many people these days. The BCFS budget is about \$300 million, while the major license holders spend about \$150 million: a total of \$450 million a year! There are very high expectations and incredibly exciting opportunities to advance the program.

Forest health must be an important component in all manipulations of forest vegetation to achieve resource management goals. I must compliment you and your forest health colleagues outside the BCFS in coming a very long way in a relatively short period of time in making believers out of many people. You now have a captive audience. You have shown people the consequences of not being aware of, or disregarding forest health issues. You have numerical estimates of some very impressive loss reductions and yield gains. People are now listening to what you have to say - more people that you may have imagined!

Now that you have exposure, you must continue to work hard on the traditional underpinnings of a defensible program: strategic plan, cost-benefit studies, training program, and a systems plan which will link to silviculture information systems. In the area of bark beetle management you have already succeeded in establishing a world class detection and control program. Your next challenge will be to follow through in the other forest health areas as well.

There also comes the added responsibility of working within silviculture and within the broader forest management context that we face today. Now that you are working from the inside of the silviculture program, you have unlimited potential to educate, inform and integrate your thinking with your new colleagues. But whether you are a site preparation or stand tending specialist, or a seed operations or forest health specialist, you are all a part of the silviculture team, and I expect you to do your part in contributing to integrated silvicultural solutions. A forest health perspective, concern or suggestion needs to be discussed and negotiated with other disciplines so that we can come up with workable silvicultural solutions. This is not easy; it takes time, patience and requires cooperation and respect for other viewpoints. The outcome will be a more robust solution, because you will have a buy-in from other silvicultural disciplines - whose cooperation you need to help deliver forest health prescriptions!

You have the opportunity to make the practice of forest health an everyday occurrence by integrating your skills and knowledge into regional and provincial silvicultural guidelines and procedures.

In terms of future silviculture program budgets, we will make the case for a least maintaining our \$300 million allocation, and re-directing money towards investments in stand tending and forest health as the backlog is reforested. I look forward to a strengthening of working relationships between forest health and stand tending specialists because your respective interests are very interdependent.

The last point I want to make deals with forest health research. Your program presently lacks sufficient support in that area, and I share your frustrations about the apparent inaction. As part of the FIDS roles and responsibilities presentation to Wes Cheston, John Cuthbert and John Drew, which is planned for November, I will be raising the issue once again and seeking direction. It is clear to me that we cannot hope to achieve full potential in a forest health program without a dynamic and client-oriented supporting research effort. If the Canadian Forest Service cannot provide it, then we must necessarily look elsewhere. That is the message I will be delivering.

In conclusion, congratulations on what you have achieved to this point. Welcome to new responsibilities for designing integrated silvicultural treatments with your other colleagues in the program, and take advantage of the very promising opportunities that lie ahead.

- H. Benskin, Silviculture Branch, Victoria.

Forest Level Multi-Pest Survey, 1993. Twenty, nine-plot Forest Level Multi-Pest Survey (FLMPS) clusters were installed in the Arrow Forest District in 1993 as a follow-up to the 23 clusters established in 1992. Further testing the individual tree damage and severity measurements gathered from these surveys, combined with damage intensity calculations, should enable Forest Health to assess yield impacts and derive Operational Adjustment Factors.

To date, Multi-Pest sampling of the Interior Cedar Hemlock (ICHdw) biogeoclimatic subzone in the Arrow Timber Supply Area (TSA) has cost over \$40,000 (not including data analysis) which effectively prohibited coverage of the entire TSA. However, such work may be continued as part of a Vegetation Inventory Working Group (VIWG) project. The VIWG is a subgroup of the Resource Inventory Committee (RIC), which is undertaking a comprehensive resource inventory for the province.

Silviculture and Inventory Branches will analyze the data gathered and provide recommendations for future activities. For further information, contact Jeff Beale, or Rick Stewart.

- R. Stewart, Nelson Forest Region, Nelson.

Free Growing Standards. Free growing surveys are carried out in each regenerated stand to ensure that it is established and likely to achieve final stocking. Upon confirmation of free growing, the ministry becomes responsible for further management of the stand. Damaging agents such as insects, pathogens, mammals, and others often adversely affect individual trees and groups of trees to the extent that free growing is uncertain. In effect, the presence of significant damage to stands indicates that final stocking, as defined in the Pre-Harvest Silviculture Prescription, will not be met.

Standardized criteria for assessing the health and potential for free growing affected by damaging agents are necessary to ensure consistent evaluations between licensees and the Ministry of Forests. Similar types of stands in different areas of the province must be evaluated using the same criteria for damage type and severity. Standardized damage thresholds are being developed to allow assessment of the free growing status of trees during surveys. They are based on recognition of damage symptoms rather than on recognition of a wide variety of potentially damaging agents.

- P. Hall, Silviculture Branch, Victoria.

Survey Roles and Responsibilities Review. A review of forest health surveys by the Forest Service and Canadian Forest Service, Forest Insect and Disease Survey (FIDS) was conducted by a joint task force. The purpose of the review was to identify possible areas of duplication and recommend improved surveys. Several options were developed for consideration incorporating modifications to both organizations and formally redefining roles and responsibilities. These options are being examined by the executives of both agencies.

- P. Hall, Silviculture Branch, Victoria.

Damage Assessment of Lodgepole Pine Provenance Trials. Funded by the Forest Health Section of Silviculture Branch, a systematic assessment of damage at our lodgepole pine provenance plantations has been initiated. In 1993, we assessed 25 plantations, including the large family-structured plantation at Red Rock (a total of about 38,000 trees). The remaining 30 to 35 plantations will be assessed next year.

Our assessment focused on western gall rust, terminal weevil, small mammal (porcupine) damage, and foliage disease. These damage agents were not assessed with equal intensity. We did a complete assessment of the most severe ones, and a partial assessment of the others, the former for screening provenance-to-provenance differences (genetic resistance) and the latter for quantifying site differences.

Initial results indicated that some provenances showed a high level of tolerance (resistance) to damage, e.g. Swan Hills, Alberta, to western gall rust, and Mount Watt and Hawk Hills, Alberta, and Jackfish Creek, Fort Nelson, to porcupine attack. Provenances from low elevation wet-belt areas were generally more tolerant of needle cast. Provenance differences in stem rust and needle cast tolerance were very consistent from plantation to plantation. Terminal weevil was the only damage for which we did not detect a consistent pattern in provenance variation.

Equally important was the large difference in damage severity from plantation to plantation. One major goal of this project was to establish if there were predictable correlations between severity and ecological and site conditions of plantations.

British Columbia's network of provenance tests provides a unique set of material for studying problems of plantation lodgepole pine. These experimental plantations were planted at a wide variety of sites using stock of known genetic background and the same silviculture treatments thereby removing most of the factors that confound interpretation of results derived from natural forests or commercial plantations.

- C. Ying and X. Wu, Research Branch, Victoria.

Douglas-fir Beetle Management and Effects on Armillaria Root Disease. A project was initiated to determine the correlation between Douglas-fir beetle, *Dendroctonus pseudotsugae*, and armillaria root disease. Current management practices to control Douglas-fir beetle may exacerbate damage by armillaria root disease by providing new stumps and root systems of felled trap trees, and thus increasing inoculum for disease spread.

Sites repeatedly used for trapping Douglas-fir beetle in the Interior Douglas-fir (IDF) biogeoclimatic zone were surveyed. Trap tree stumps were inspected for signs of armillaria root disease such as basal resinosis, mycelial fans, and rhizomorphs. If armillaria was found in the area, a survey was done of a 100 metre by 100 metre block and the incidence of root rot was mapped. The map was then analyzed to determine if armillaria had spread due to the trap trees or to some other stress.

The Douglas-fir bark beetle problem is mainly isolated to the IDF biogeoclimatic zone which contains a large component of Douglas-fir suitable for the development of infestations. However, we concluded that a flare-up does not occur due to cutting. Active armillaria and Douglas-fir beetle are both increased by moisture stress, and therefore in the dry IDF zone both of the organisms are moving at full speed.

It appeared that the present treatment for bark beetle was not accelerating the spread of armillaria.

- D. Doidge, A. McLeod and J. Smith, Cariboo Forest Region, Williams Lake.

Damaging Agent Tables. In the near future standard provincial tables will be available which list economically significant damaging agents that affect commercial tree species. A proposal has been made to the forest regions to create tables to display impact information for all biogeoclimatic subzones in each of the six forest regions. Information for subzones which cross regions would be correlated. Discussions will soon occur with regional forest health staff to finalize and format these tables.

The damaging agent impact will be measured, using a combination of incidence and severity on the particular tree species of interest. A measure of incidence would be used to identify what percentage of trees in a species are affected within a specific subzone. The severity measure for a particular tree species in a subzone would convey the impact that the damaging agent has on the tree. Other important qualities, such as damaging agent persistence or cycling, or the affect of management treatments, will, if possible, be represented in the tables.

The tables are expected to be used by a diverse audience. People who do Pre-Harvest Silviculture Prescriptions (PHSP's) and silviculture surveys could use the tables to initially identify all potentially significant damaging agents on a site prior to the site visit. The relative importance of the damaging agents described in the tables should affect how the surveyors approach their site evaluations. Other groups who would use the tables include forest prescription auditors, forest health trainers, forest health administrative staff, and researchers. The tables should facilitate discussion and comparison of alternatives when making priority decisions. If you wish more information on the development of the damaging agent tables, please contact the author.

- J. Henigman, Silviculture Branch, Victoria.

Damage Agent Impact Model Developments. The forest productivity and decision support section of Research Branch is working in cooperation with the Canadian Forest Service to incorporate their root rot simulator (ROTSIM) and spruce weevil attack trials model (SWAT) into the ministry's yield projection systems for managed forests. Specifically, these systems are the tree and stand simulator (TASS) and a model which evaluates the impact of silviculture on yield, lumber value and economic return (SYLVER).

ROTSIM was developed by the late Dr. Bill Bloomberg to simulate the impact of laminated root rot on coastal Douglas-fir. Major restructuring of the code reduced the size of the program and execution time by a factor of ten. Validation of ROTSIM is in progress under the direction of Jeff Beale. Test runs show that both stump and bridge tree removal options are working. ROTSIM has also been linked into SYLVER which opens up the possibility of performing financial analyses.

SWAT, developed by Dr. Rene Alfaro, is currently being tested and calibrated in concert with TASS. An option that introduces a level of immunity to trees via the EZJECT pesticide bullet has been added to the system along with an option for sanitation thinning.

- J. Beale, Silviculture Branch, and K. Mitchell, Research Branch, Victoria.

Forest Health Training Update. Several initiatives were undertaken in the first year of the forest health training strategic action plan, including:

Planning and Implementing a District Forest Health Program. Before and during the creation of the forest health training plan, a course was developed to address the needs of forest health staff at districts in the Vancouver Forest Region. Forest health training for the districts had been identified as a high priority in a training needs analysis conducted by that region. It was felt that such a course would have a provincial scope and could be used as a prototype for similar modules tailored for delivery in other areas of the province.

A one-week course with the objective of providing knowledge and skills necessary to deliver a district forest health program was developed and delivered in March, 1993, in Chilliwack, to district forest health specialists. The materials produced for this coastal pilot were reviewed and another version is being developed by specialists in the Prince George, Prince Rupert and Cariboo Forest Regions. This course will be piloted in April, 1994.

Root Disease Training. A root disease management course has been developed by Silviculture Branch and the Nelson Forest Region through Industrial Forestry Service Ltd. The course is directed at people who prescribe, implement and audit silviculture programs and treatments. Because of the prevalence of armillaria root disease in the Nelson Forest Region, the pilot session focused on recognition and management of this disease. Overall objectives of the course are to gain the skills necessary to recognize the disease, its ecological role, and interaction with other components of the ecosystem, particularly with respect to rates of spread and severity. Other objectives include to assess the need for, plan and perform a root disease survey, to be able to evaluate the costs and benefits of root disease management at the stand and landscape levels, and to be able to implement management options. Training objectives were developed in a June focus session and the first session of the course was held October 6-7, 1993, in Revelstoke. The course will be upgraded to include other root diseases, so that people who are presenting it can select the diseases of importance in their area and tailor it for local concerns.

Forest Health Forest Worker Training. The Cariboo Forest Region used their Regional Forest Worker Training Specialist to modify a Forest Health for Stand Tenders course that was developed last year through Industrial Forestry Service. The course pilot was delivered on November 15, 1993, in Williams Lake. The regional training specialist will deliver the final training package to Forest Worker Development Program (FWDP) crews in the Cariboo and Prince George Forest Regions.

The course will also be revised and adapted for the southern interior and coastal British Columbia.

Bark Beetle Training. At branch, as a basis for bark beetle training, we developed two sets of bark beetle field identification sheets. One set uses sketches and a minimum of text and is designed to assist field personal to conduct operational ground surveys/probes. The other set is a supplement to the *Field Guide to Pests of Managed Stands*, and contains more detailed descriptions of the life-cycle, signs and symptoms, and damage caused by each species, plus color photographs.

Forest Health Training Modules for Silviculture Surveys (Including Stand Tending Prescriptions) and Pre-Harvest Silviculture Prescriptions (PHSP). These courses were identified as the highest priority in the review of the Strategic Plan for Forest Health Training. After much deliberation and consultation with the surveys and PHSP specialists at Branch and others in the regions, we determined that the content of forest health courses for silviculture surveys, stand tending prescriptions and PHSP's should be complimentary. Therefore, to avoid unnecessary duplication of effort, and because a higher level of knowledge and skills is required by people who develop prescriptions, these modules are being developed under one contract, and will be designed so that the skills are additive. The contract for the development of these modules was awarded to Laing and McCulloch. A focus session was held October 21-22, 1993, in Vancouver to define training objectives and to designate an advisory group. Both courses will be piloted by March, 1994.

- K. Hopkins and P. Humphreys, Silviculture Branch, Victoria.

Forest Health Information Systems. An Information Management Plan has been completed under contract by LGS Group Inc. and has been circulated for review. The necessary planning work has now been completed to the point where Forest Health application systems that are aligned with Silviculture and Ministry initiatives can be developed. A careful analysis of Forest Health's information needs and its business functions has identified a requirement for a core set of interrelated application systems as follows:

Damage Agent Occurrence. Captures information about areas affected by damage agents. The system will capture specific damage agent occurrence information, including what the damage agent is, when it occurred, how bad the infestation is and who identified it. The system will provide for mapping of affected areas as well as reporting of character data.

Forest Health Survey. Captures and reports detailed data collected in the field as a result of any number of different Forest Health surveys.

Decision Support. Provides each district with access to a registry of available data sources, a number of standard decision support tools and a set of standard interfaces to key sources of forest health data.

Treatments and Results. Tracks information about the treatments applied to target infestations. The system will allow users to determine what was done to an affected area, by whom and when. The system will also provide facilities to allow forest health staff to determine the effectiveness of the treatments they have used.

Project Management. Assists forest health staff in the districts plan and budget for projects, schedule and deploy resources and manage the progress of forest health project activities on an on-going basis.

These applications will work hand in hand with the Integrated Silviculture Information System (ISIS). A detailed analysis of forest health and ISIS data models indicated shared data and required interfaces. These are summarized in the diagrams on pages 56-59 of the Tabulation and Graphics Section.

The Damage Agent Occurrence Tracking and Project Management application systems clearly share data with ISIS and its users and these systems will be developed as modules within the overall Integrated Silviculture Information System if timing and budget factors permit. If not, both Damage Agent Occurrence Tracking and Project Management should be developed so that they may interface directly with ISIS when this does become feasible.

All of the data captured by the forest health systems have spatial components and it would be valuable to update and display these on a map. It is recommended that forest health participate fully in all Silviculture GIS initiatives. In the short run it is recommended that forest health concentrate on mapping affected areas as part of the Damage Agent Occurrence Tracking application system. This mapping should be done in concert with the "tactical GIS" initiative already underway in the Silviculture Branch using the Mapview product.

In the longer term, forest health data should form an integral part of a province wide Distributed Silviculture Database. This data will then be available for fully integrated geographic information processing along with that of ISIS and other silviculture and ministry systems.

The Information Systems Management Plan has been developed to meet the long term business objectives of forest health and specifically support district, region and branch operations. Support of silviculture information systems initiatives such as ISIS and GIS has been of prime consideration.

An overview of the information systems development plan is presented on page 56 in the Tabulations and Graphics Section. For more information, please contact the undersigned.

- P. Humphreys, Silviculture Branch, Victoria.

Roadside Tree Injury Committee (RSTIC). The RSTIC was established on the instruction of the Minister of Environment in July, 1989, to investigate the causes of roadside tree damage. RSTIC is chaired by Ministry of Environment, Lands and Parks (J. van Barneveld) with membership from Ministry of Forests, Silviculture Branch (J. Muir) and the Ministry of Transportation and Highways, Roadside Development (A. Planiden).

The investigation of roadside tree damage involved two phases. First, RSTIC studied the issue at Boitanio Park in Williams Lake, and recommended the reconstruction of the run-off drainage.

Second, RSTIC managed a contract with Soilcon Ltd. to investigate the causes of roadside tree injury at 17 locations throughout southern and central interior British Columbia. Funding was supplied by Ministry of Transportation and Highways.

The second phase has been completed and reports on Phase 1 and Phase 2 are being conveyed to the Ministry of Forests and the Ministry of Transportation and Highways.

Upon completion of the site assessments, Soilcon Ltd conducted a workshop to provide the terms of reference for a study to determine the fate of salt in the environment. Reports on the Boitanio Park issue, salt impacts on 17 sites, the workshop and a literature review have been distributed.

Road de-icing salt was involved in damage to the trees in Boitanio Park and in 16 of the 17 sites studied in the interior of the province. The damaged trees, however, did not represent a hazard for general forest health. The fate of de-icing salt in relation to ground and surface water was not determined but no damage to aquatic habitat was observed. The Ministry of Transportation announced that it will continue its research into the effects of salt on the environment.

- J. van Barneveld, Ministry of Environment, Lands and Parks, and
J. Muir, Silviculture Branch, Victoria.

Partial Cut Harvesting, Tree Injury and Decay. Because of increased use of partial cut harvesting systems in the Prince Rupert Forest Region, several issues not usually associated with clearcut logging have arisen. One is how much damage can a tree endure before it is unsuited for stand management objectives. Another is how to determine acceptability standards for residual trees when using these systems. In order to address these issues, several projects were initiated.

The first project was a post-harvest damage survey of nine stands located in the Bulkley Forest District and harvested using a variety of methods, including horse and small machinery. This recently completed survey, along with data gathered during the partial cutting trial at Date Creek in the Kispiox Forest District, will provide a picture of damage to residual crop and understory regenerating trees. Other information expected includes the level of damage for each type of harvesting method and information on current and potential site stocking. On the basis of this field experience, a post-harvest damage survey will be developed to include free growing and residue surveys in one package.

In order to reap more information from these stands, permanent sample plots will be installed next field season to track damaged trees over time. Selective examination of these trees will yield information on how various species, particularly spruce and true firs, respond to varying levels of bark removal, scarring, broken tops, etc., in the Sub-Boreal Spruce Biogeoclimatic (BEC) Zone.

A retrospective project is also proposed which will examine trees damaged by selective logging during the 1950's and 1960's. Reconstructive work will allow the tracing of injury and link it to host response, as well as the entry and development of decay fungi.

Other related, ongoing work by Eric Allen, Pacific Forestry Centre, Victoria, details the type and amount of various decay fungi inhabiting tree species common to the Interior Cedar-Hemlock BEC zone. Over 60 trees have been sliced, diced, and wrung dry of slime in order to determine how fungi contribute to the structure of these stands. This complements previous work by Kathy Lewis on advanced cedar and hemlock regeneration in the same zone.

A recent contract awarded to Ralph Neville for a comprehensive literature review of tree injury and partial cut harvesting research will provide a solid reference for further work in this area. By mid-March, Ralph will complete the review and answer ten specific questions posed by regional and district forest service staff.

- S. Zeglen, Prince Rupert Forest Region, Smithers.

Ecosystem Maintenance Burning Evaluation and Research (EMBER) Report. Because of poor weather during the spring and early summer of 1993, only one of the burns planned was conducted. Even though unusually high precipitation occurred throughout the Kootenays, the Invermere Forest District did manage to treat about 40 ha with an understory burn in May. Ignition and control presented no problems although extensive mop-up, due to rising indices, pushed costs to well over \$100/ha. (It should be noted that treatment of larger areas will significantly reduce per hectare costs).

In 1994, three burns on a total of 850 ha are planned in the Cranbrook and Arrow Forest Districts. The impact of burning on vegetation, forest health, range values, fuel reduction and smoke emissions will be monitored. In addition, the districts will share responsibilities for public meetings, media work, and resources. For further information contact Rick Stewart, 354-6144.

- R. Stewart, Nelson Forest Region, Nelson.

Seed Pest Management Report, Fall 1993. Spruce Cone Rust, *Chrysomyxa pirolata*. Currently, ferbam is being used to control this rust in interior spruce seed orchards. We are examining less toxic, more "user-friendly" alternatives to ferbam. In 1993, at Skimikin Seed Orchard, a trial using triforine, metiram, and myclobutanil against spruce cone rust was conducted in the Central Plateau interior spruce high elevation orchard. Efficacy data will be analyzed over the winter and another trial is planned for 1994. Germination tests on treated seed are in progress.

Fir coneworm, *Dioryctria abietivorella*. In the first year of this study we tested pheromone attractants in conjunction with Simon Fraser University, surveyed wild stand and seed orchard populations, and collected and reared larvae from various interior and coastal locations. Pheromone tests have all been negative to date. Wild and laboratory colony adults are currently being tested at Simon Fraser University to better characterize the sex pheromone(s) of this moth. Populations were generally low across the province this year which made collection of substantial numbers of specimens difficult. In the coming year we plan to expand and modify the pheromone testing, rear adults from large duff samples collected in the interior, and continue collecting and rearing larvae from Douglas-fir cones. Primary aims of this project are to pinpoint when adults emerge and fly during the year and to identify a pheromone attractant that can be used as an effective monitoring tool.

Hemlock Woolly Aphid, *Adelges tsugae*. A trial of Enstar® (kinoprene), dimethoate, and Safer's Soap® on hemlock woolly aphid was conducted this summer. Results for Safer's and dimethoate were inconclusive. Effects of kinoprene (an insect growth regulator) are not expected to be apparent until next year.

Larch Cone Woolly Aphid, *Adelges lariciatus*. Larch cones from Kalamalka Seed Orchard were monitored on a biweekly basis from early April until late July. Data have yet to be analyzed. The population appears to be above 1992 levels. Monitoring will continue in 1994, and trials are planned to test control options and examine effects of this adelgid on cone and seed production.

Seed Orchard Monitoring. In 1993, cone and seed insects and diseases were not damaging in British Columbia seed orchards. However, *Adelges tsugae* populations were sprayed at two orchards this summer with mixed results. The cool, damp weather provided ideal developmental conditions for this cold adapted insect and populations increased over the summer. Normally hemlock woolly aphid enters diapause early in the summer and remains quiescent until the return of cool weather.

Natural Stand Monitoring. In our first year of active cone and seed monitoring in natural stands, we dealt primarily with cone samples collected in the Prince George, Kamloops, and Nelson Forest Regions. As with seed orchards, this year we noted few problems in natural stands. Larch cone woolly aphid was common in larch collections from Nelson and Kamloops Forest Regions. One sample of cones of *Abies lasiocarpa* from the Salmon Arm area showed nearly total infestation of seed by an unidentified seed midge (Cecidomyiidae).

- R. Bennett and B. McEntire, Silviculture Branch, Victoria.

FOREST INSECTS

Pheromone Communication in the Genus *Pissodes*. In North America one ecological class of bark beetle — *Pissodes strobi*, white pine weevil, and *P. terminalis*, lodgepole terminal weevil — breeds in vigorous leading shoots of healthy conifers. Another ecological class, including *P. nemorensis* and *P. schwarzi*, breeds in the branches, bole or root collar region of recently dead, weakened, or moribund trees.

Given that these four species are very similar morphologically, have overlapping host ranges, and could potentially breed in the same host conifer, how does each species maintain reproductive isolation, and also protect a host resource from conspecifics? Pheromones in beetles serve to bring the sexes together, indicate the location of host plants, and discriminate between occupied and unoccupied hosts.

Aggregation pheromones were reported for *P. nemorensis*, but later workers showed that male *P. strobi* produce an unknown allelochemical that interrupts the response of *P. nemorensis* to its natural or synthetic aggregation pheromone.

In British Columbia, *P. schwarzi* is commonly found in lodgepole pine infested with comandra blister rust, *Cronartium comandrae*. In many areas of lodgepole pine regeneration, there is a minor component of spruce regeneration. This is frequently infested with *P. strobi*, and *P. terminalis* is present in the pine terminals.

In 1989, an initial experiment investigated whether *P. schwarzi* produces an aggregation pheromone. Pitfall traps were set up using PVC drainpipe inserted into the soil. All traps had a 4-5 cm long section of fresh lodgepole pine wrapped in a fine mesh fabric, suspended at ground level inside the trap. Four treatments were combinations of weevil and pine sections:

1. One male *P. schwarzi* + pine section
2. One female *P. schwarzi* + pine section
3. pine alone
4. Empty trap (unbaited control)

Weevils that entered the holes were caught in the bottom of traps in a plastic dish containing antifreeze to kill the insects. The insides of the traps were coated with liquid teflon to prevent weevils from walking the side walls. At approximately weekly intervals from June to September, captured weevils were collected and the pine was replaced. Throughout the summer, 48 *P. schwarzi* were captured in traps baited with males; no weevils were caught in unbaited traps, or in traps baited with females on pine or pine sections alone. Forty-six of the *P. schwarzi* captured were females, indicating a male produced sex pheromone.

The seasonal response of female *P. schwarzi* to the male-baited pitfall traps indicated two peak periods of activity: early June and mid- to late-July. Trap catches were generally highest in warm, dry weather. The first seasonal peak probably represented overwintered mature adults, and the second peak of response probably represents newly emerged adults. In a normal summer, new adults emerge from infested boles and root collars from mid-July through August and oviposition by these new adults begins approximately 25 days after emergence.

Having shown that *P. schwarzi* produces and responds to a pheromone in a similar fashion as *P. nemorensis*, I then wanted to explore the relationship of *P. schwarzi* and *P. strobi*.

In 1993, another pitfall trapping experiment was established using the same protocol as in 1989. The treatments assigned in a totally randomized block design were:

1. Male *P. schwarzi* + pine section
2. Male *P. schwarzi* + male *P. strobi* + pine section
3. Male *P. strobi* + spruce section
4. pine + spruce section

The male *P. schwarzi* baited traps were included as a comparison.

The traps were situated in the montane spruce zone, in a naturally regenerated stand of lodgepole pine which had scattered spruce regeneration. Trees were about 16 years old. Approximately 37% of the pine was infected with *C. comandrae* and there was evidence of both past and current *P. schwarzi* infestation, *P. terminalis* attack on the pine leaders, and *P. strobi* attack on the spruce.

It is commonly believed the *P. strobi* mates on spruce terminals. However, there are no data supporting this as the only site of mating. Since most *Pissodes* spend much of their life in the duff or somewhere in the ground, I wanted to test the hypotheses that *P. strobi* produced a pheromone and mated when active in the duff.

Secondly, I wanted to test the hypothesis that *P. schwarzi* and *P. schwarzi* males together with host volatiles would inhibit the response of *P. schwarzi* females.

In 1993, only 17 *Pissodes* and 3 *Hylobius* were captured in traps. The *P. schwarzi* baited traps caught the same number of weevils - four female and one male - as the *P. schwarzi/strobi* baited traps.

Weather greatly influenced the 1993 results and there was high mortality of the bait weevils in traps coupled with a shortage of replacement insects for the traps, therefore the total number in each treatment in any given week varied.

There was a significant difference among treatments in the proportion of weevils caught, with the highest number in the *P. schwarzi/strobi* combination and *P. schwarzi* males. Both male and females responded, with a slightly higher response by females to all treatments except the controls.

Choice Bioassays:

Some insects select hosts based on vision, chemical cues, presence of a conspecific, or occupation of the host by eggs of another female.

P. terminalis discriminates among potential host trees on the basis of visual cues, choosing taller trees with longer terminals, so I wanted to test if there was a short-range discrimination as well, based on chemical cues. It would be advantageous to a female to lay her eggs in a host that was not already occupied by another females' offspring.

A fecund female weevil was presented with a choice of two hosts:

- 1) one section of pine containing eggs of another female,
- 2) one section of pine containing no eggs.

The treatments were called "used" and "clean", respectively.

The weevils were allowed to feed and oviposit for 24 hours in 1989, and 48 hours in 1991, and then the test pieces were assessed. Tests in which there was no oviposition on either "clean" or "used" hosts were deleted from the analysis.

In 1989, 53% of the used and 21% of the clean hosts had no oviposition, indicating significant initial preference for "clean" hosts (Chi-square test, $P < 0.001$).

The mean number of oviposition niches in the "clean" hosts in both 1989 and 1991 were significantly higher than the mean number of oviposition niches in the "used" hosts. In 1991, for example, when female weevils were presented with a "used" host containing on average 3.9 oviposition niches and a "clean" host containing none; on average 2.4 oviposition niches were created in the "clean" host compared to less than one created in the "used" host.

A strategy of avoiding "used" hosts would be of adaptive advantage for *P. terminalis*, in that repeated oviposition by the same or other females would be deterred. The solitary larva usually hatching from the single egg per puncture would then have a maximal chance of survival in the limited resource of a new leader.

Should the suggestion of a deterrent compound be upheld in future experiments, there may be practical utility of such a compound as a "biorational" pesticide.

In conclusion, there were strong indications that the weevils do communicate with pheromones. *P. terminalis* employs a deterrent oviposition pheromone, or "marker" pheromone, and *P. schwarzi* males produce an aggregation pheromone. However, it is still uncertain whether *P. strobi* employs either intra- or inter-specific communication.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Cariboo Forest Region Aerial Survey. The annual aerial pest survey in the Cariboo Forest Region was completed on November 8, 1993. Wet weather caused significant delays in the aerial survey this year. University of Victoria Biology Cooperative Education student Carolyn Puckett coordinated the survey, which was carried out by regional and district Forest Service staff with help from a contractor in areas of anticipated low damage (low-priority areas).

The region was mapped on a 1:40 000 forest cover base. Fixed-wing aircraft flew on a north-south grid at 2 kilometre (high-priority areas) and 4 kilometre (low-priority areas) spacing.

Mountain pine beetle inside the control area at Chilko Lake in the Chilcotin Forest District remains at a manageable level. Infestations that were detected in 1992 at nearby Taseko Lakes are apparently unrelated. These infestations, and others in the Cariboo Forest Region, doubled in number from 600 in 1992 to over 1200 this summer. Most of the increase occurred in the Quesnel and Williams Lake Forest Districts.

No action (beyond pheromone baiting in the spring of 1993) has been taken to control mountain pine beetle on the military reserve west of Williams Lake. Administrative responsibility for the area remains under discussion by federal and provincial governments and the Toosey Indian Band.

Douglas-fir beetle damage remains at the same level as reported for 1992 - about 3000 infestations exist in the region. Half of this damage is located in the military reserve, where no action has been taken since the outbreak began in 1988.

No significant spruce beetle damage was found.

Western balsam bark beetle damage increased significantly over the region this year, including previous severe outbreaks in Franklyn Arm and Edmonds Creek, in the Chilcotin Forest District.

Populations of western hemlock looper in the Quesnel Lake area of Horsefly Forest District appear to have collapsed due to disease. Some mortality of hemlock and western redcedar is expected as a result of the outbreak, which began in 1990.

Minor amounts of defoliation by two-year cycle spruce budworm were observed.

Forest tent caterpillar defoliation in the eastern part of the region increased significantly from 1992, both in area and in severity.

No significant defoliation by western spruce budworm or Douglas-fir tussock moth was detected from the air.

A pine needle cast, *Lophodermella concolor*, infected lodgepole pine foliage over much of the Williams Lake, Horsefly and 100 Mile House Forest Districts.

Survey results (area and volume damage figures) are not yet compiled. A report will be available by Christmas.

- M. Hamm, Cariboo Forest Region, Williams Lake.

Helicopter Removal of Beetle Infested Trees in the Cariboo Forest Region. A number of helicopter beetle removal contracts have been established in the Cariboo Forest Region to deal with Douglas-fir beetle and mountain pine beetle infestations on remote sites.

Helicopter removal of beetle infested trees has a number of benefits. It is a suitable alternative control method for steep, inaccessible sites or areas that are sensitive to soil disturbance or that have wildlife concerns. The cost of helicopter logging compares favourably with fall and burn treatments, especially because of the high value of wood at this time. The cost of falling and burning Douglas-fir beetle infested trees varies from \$80 to \$200 per tree, depending on tree size and location. Generally, costs are high because trees are on sites with difficult terrain and poor access and the large size of the trees makes the disposal extremely laborious. Falling and burning pine frequently costs \$60 to \$80 per tree for the same reasons. The cost of helicopter removal is ameliorated by the sale of the wood. Due to the high cost of this method, however, only infested trees are removed and the old attack trees are left as wildlife trees.

In 100 Mile House Forest District, helicopter removal of mountain pine beetle infested trees cost \$40/tree, while removal of Douglas-fir beetle infested trees from 40 trap tree sites cost \$124 per tree. In the Williams Lake and Quesnel Forest Districts, a regional helicopter contract is also underway to harvest Douglas-fir beetle infested trees. A total of 1,950 trees containing a volume of 3 800 m³ will be extracted during November and December, 1993.

The proactive approach to manage bark beetle in locations that have difficult access is to build helipads and harvest trap trees and any adjacent infested "overflow" trees. Using helicopters during the autumn beetle probe survey, overflow trees can be marked to make the areas ready for tender. This approach was used by 100 Mile House Forest District this year with good success. However, funding must be in place so that these trees can be removed.

Success of and maximum benefits from helicopter removal operations depend on the following factors:

1. Establishing a cost sharing agreement with the Small Business Forest Enterprise Program (SBFEP), which is responsible for selling the wood. To date, Forest Health has been paying the costs and SBFEP has been receiving the returns on the wood.
 2. Ensuring that the beetle probe survey is done to exacting specifications and that tree marking and mapping are accurate. The Global Positioning System in fixed wing and rotary aircraft works very well to pinpoint infestations, landings, helipads and other crucial locations.
 3. Ensuring that the helicopter contractors are experienced and qualified for the job.
 4. Establishing the project early enough to avoid the onset of bad weather and snowfall.
- L. Rankin, Cariboo Forest Region, Williams Lake.

Assessment of Risks Associated with the Accidental Introduction of Forest Pests to the Queen Charlotte Islands. The forests of the Queen Charlotte Islands, due to their insularity from the mainland, are potentially at risk to accidentally introduced damaging agents. The span of ocean that separates the islands from the mainland has resulted in the development of unique forest ecosystems and biological equilibriums. Many species of plants and animals found on the mainland do not exist there. As a result, the Queen Charlotte Islands are free of a number of common damaging agent species that could cause serious problems if they were introduced.

Successful damaging agent introductions, usually the result of human activities, are very often irrevocable. The invading agent can often 'explode' to extreme densities in its new environment. Most invading species that achieve calamitous populations perform their 'outbreak' in a habitat that is less rich and less diverse than the one they came from.

A number of damaging species have already been introduced to the Queen Charlottes. These include Sitka deer, Cooley spruce gall adelgid, spruce aphid and, most recently, white pine blister rust. Sitka deer were introduced by early pioneers. They are currently a major problem for cedar seedlings, although they also exert a positive benefit by controlling brush competition in young forest plantations. Cooley spruce gall adelgid was brought to the island with a few Douglas-fir trees and is now causing galls on native Sitka spruce. The spread may be limited by the lack of Douglas-fir on the islands. The spruce aphid has been established on the islands for many years. Spruce aphid damage is most evident along the eastern shore of Graham Island. White

pine blister rust was brought to the islands in white pine planting stock that was established as a trial (see Forest Health Progress, Vol. 12(1):29).

The white pine weevil is currently thought to be the most serious damaging agent. It has been suggested that the white pine weevil cannot exist on the Queen Charlotte Islands because the climate is too cool. However, weather data for these initial assessments came from exposed, and therefore, cooler locations (Sandspit Airport and Tasu Inlet). Recent information suggests that at least some locations are probably warm enough to support weevil broods.

There are three main conifer tree species available for reforestation on the Queen Charlottes, Sitka spruce, western hemlock, and western redcedar. The establishment of the white pine weevil could severely restrict the utilization of Sitka spruce. This, together with the fact that the use of western redcedar is already severely limited due to heavy browsing by deer, could result in western hemlock becoming the only tree species available for widespread reforestation. Since hemlock is affected by native hemlock dwarf mistletoe, and western blackheaded budworm, there is concern about possible introductions. Some foresters are interested in introducing new tree species to the islands, but many of these also have associated insects or diseases that could be introduced with them.

The Vancouver Forest Region has contracted von Schilling Forest Management to conduct a risk assessment associated with the accidental introduction of forest insects or diseases to the Queen Charlotte Islands. A final report is due by the end of the year.

- D. Heppner, Vancouver Forest Region, Vancouver.

White Pine Weevil Hazard Rating Using Fire Weather Data. Data to derive degree-day hazard ratings for white pine weevil in various biogeoclimatic subzones in British Columbia were obtained from relatively few Atmospheric Environment Service weather stations. In many cases, extrapolated data were used from stations located in different subzones at far different latitudes. Local, hourly weather data collected by the British Columbia Forest Service Fire Weather System from May to September are ideal for calculating degree-days for white pine weevil hazard ratings, although there are a few limitations. For example, not all stations record data on an hourly basis and not all years are complete due to equipment breakdowns. Because of these factors, only a few data sets from the dozens of stations are suitable for this analysis. It is also recommended that degree-days used for the hazard rating be based on an average of at least five years of data to account for yearly climatic variation.

To process the data, a contract was written for the development of a degree-day calculator using Microsoft Excel. The raw data for a particular remote fire weather station is requested from Protection Branch and is downloaded as a text file. This program, which should be completed by January 1, 1994, will be made available to

anyone requiring it, and can be obtained by calling or writing the undersigned. The threshold temperature is a user-defined parameter so the program can be used for studies other than white pine weevil hazard rating. If you anticipate collecting 1994 fire weather data, notify the regional fire weather technician or the district protection resource officer to ensure that the hourly data is collected and stored for you. Hourly data, in most cases, is not archived, because only the 1:00 P.M. temperature is required to calculate the fire weather index.

- T. Ebata, Prince Rupert Forest Region, Smithers.

Can the Shore-Safranyik Susceptibility Rating System be Used to Predict Where Mountain Pine Beetle Infestations Will Begin? Most forest districts in British Columbia that have significant mountain pine beetle infestations have determined stand susceptibility using the Shore and Safranyik rating system. However, in most forest districts where bark beetle populations are maintained at endemic levels, the rating is used to prioritize future harvesting. In an effort to determine the rating's usefulness as a predictive tool to forecast where new infestations will begin, a review of the Morice Forest District's archived probing data was done. Spot infestations, mapped on 1:20 000 forest cover maps were tallied along with the polygon in which they were found. The polygon was cross-referenced with the hazard rating made in 1989 by Phero Tech Inc. and the frequency of attacks within different hazard classes was plotted.

The results were very interesting and confirmed observations by district and regional staff. New infestations are most commonly found in stands that are age class 5 or older. Unexpectedly, age class 7 and 8 pine leading stands, although uncommon, did not have the highest frequency of attack. Instead, over 20% of the infested trees were located in stands that were not rated because they contained minor lodgepole pine components or were in polygons less than 4 ha in size. It appears that many infestations in the Morice Forest District begin in stands that have a low component of seral pine and a high component of climax subalpine fir and spruce. The beetle appears to be hastening the process of converting these stands to their climax state. These infestations will, if left unchecked, spread to adjacent pine leading stands.

This study reveals that the hazard rating is limited as a tool to prioritize intensive probing and reinforces the need for continued reliance on aerial detection.

The report is not complete at this time, but will be available in the new year.

- T. Ebata, Prince Rupert Forest Region, Smithers.

White Pine Weevil Shading Trial Update. In 1993, the second annual assessment of the Kalum Forest District overstory removal operational trial (Sx 91404) was completed, with some positive results. Two replicates of this trial are located in the Kitimat Valley and a third is located near Greenville in the lower Nass Valley. Negligible weevil attack was recorded in the Nass plots, so the following discussion pertains only to the Kitimat Valley replicates. The trial compares weevil damage and leader growth of Sitka spruce in replicates containing three 1 ha blocks. Each block was either brushed and weeded as per normal district procedures, brushed in 15 m wide east-west oriented strips separated by 5 m wide untreated strips, or left untreated. All blocks were located within the same stand type and were separated by at least 25 m of untreated stand.

As hypothesized, Sitka spruce recently released from deciduous overstory competition were attacked at a significantly higher rate than those located within an adjacent control stand. However, attack rates varied considerably between strip plot replicates. Leader growth did not show a consistent response to either brushing treatment (i.e. in one brushed replicate, leader growth was greater than in the control but in the other replicate it was not).

These results confirm observations of the response of white pine weevil to recently released spruce. Recommendations for vegetation management prescriptions and amendments to regional free-growing standards are forthcoming.

- T. Ebata, Prince Rupert Forest Region, Smithers.

"Dead Zone" Trapping for Douglas-fir Beetle in Interior British Columbia. Douglas-fir beetle attacks large mature and overmature Douglas-fir trees. It is a particular problem in mule deer winter ranges where the large overmature veteran Douglas-fir provide critical cover, shelter and forage.

There has been a continuous search to find new methods to control the beetle, particularly in areas where access is difficult and harvesting is not feasible. Lindgren funnel traps, baited with aggregation pheromones have been used for monitoring bark beetle flights for many years. Some attempts have been made to use the traps to absorb and eradicate populations of Douglas-fir beetles. However, funnel traps baited with Douglas-fir beetle pheromones often result in extensive overflow attack of adjacent standing trees.

We thought that placing these traps in a centre of dead trees would prevent overflow into residual adjacent live trees and coined the term "dead zone" trapping. If successful, this method would protect timber and wildlife values, as well as reducing the need to develop access roads in sensitive areas. The objective of the "dead zone" trapping project was to determine if high intensity placement of Lindgren funnel traps in centres containing only dead trees can absorb the emerging beetle populations and prevent overflow attack into adjacent green trees.

The two year project involved Leo Rankin, Cariboo forest health entomologist, Dan Miller, Phero Tech Inc. and Don Wright, forest health officer, 100 Mile House Forest District. In late winter, 1992/93, a 156 ha study area at Upper Loon Lake in the 100 Mile Forest District was surveyed for bark beetles. Funnel traps were placed in the centre of groups of infested trees prior to the beetle flight in the spring. Ninety multiple unit Lindgren funnel traps were placed. They were baited with Douglas-fir beetle pheromone lures consisting of frontalin, ethanol and methylcyclohexanol.

All beetle infestation centres with three or more current attack trees were "dead zone" trapped. The number of traps placed at each site varied according to the number of brood trees. Collection and maintenance of the traps commenced in May and ended in August when the traps were removed. The beetles were collected in zip-lock lunch bags which were labeled with a date and location. Broken and damaged traps were repaired and erected during the bi-monthly collections. To avoid bear damage, which caused significant problems in 1992, pulley systems were used to place the traps higher. After the insects were collected they were dried and counted.

In both years over 250,000 beetles were captured in Lindgren funnel traps. After trapping in 1992, 201 current attacked trees were discovered. In 1993, 195 current attack trees were found. Although some trap locations appeared to absorb all the beetles and prevent adjacent trees from being attacked, other centres had conspicuous and abundant overflow.

The results were encouraging during the first year. Although there was considerable overflow, a number of infestation centres had been overlooked during the initial beetle probe, which may have had a negative impact on the trapping effectiveness. During the second year, a very intensive probe ensured that no infested trees were overlooked. Nevertheless, the number of overflow trees was roughly the same as the previous year.

Besides not reducing beetle attack significantly, the "dead zone" trapping was not cost effective. The cost of this project in 1993 was \$14,000, which included \$6,600 for labour, \$4,600 for equipment and \$2,000 for insect counting. If this was a proven effective control method, insect counting would not be necessary, and the equipment, once purchased, would only require approximately 20% annual replacement. Therefore, a realistic cost for this control method would be \$7,520 per year and average of \$83.55 per trap with labour composing 88% of the cost.

There was 450 m³ of 1993 beetle infested wood present on the study area. At a conservative average price for wood of \$60/m³, the gross revenue from harvesting is \$27,000. Because this area has poor access, it would be helicopter logged at a contract price of \$145/tree. At an average of 2.1 m³ per tree, it would cost \$31,070 to remove the trees, resulting in a net cost of \$4,070. This is less than the \$7,520 for the funnel traps project, and the wood will be utilized. Helicopter disposal would eliminate all

infested trees, whereas the funnel trap method would still leave 195 trees to be disposed.

The 1993, "dead zone" trapping reduced the number of beetle attack trees by only 2.5% and the goal of eliminating overflow into adjacent trees was not attained. At this time it appears that "dead zone" trapping is not a feasible method for Douglas-fir beetle control.

- L. Rankin, Cariboo Forest Region, Williams Lake.

Lymantriid Pheromone Research. A proposal has been made by a working group at Simon Fraser University to identify and develop semiochemicals for a variety of Lymantriid species including Douglas-fir tussock moth, European and Asian strains of gypsy moth, and Nun moth. An enhanced pheromone for the tussock moth would provide greater control through mating disruption, and add an additional option to the current use of the nucleopolyhedrosis virus. Pheromones developed for the other species would provide better tools for detection and discrimination of introduced insects of concern. The B.C. Forest Service is supporting this initiative.

- P. Hall, Silviculture Branch, Victoria.

Mountain Pine Beetle Status in Penticton Forest District. Aggressive management actions to address priority mountain pine beetle related harvesting have resulted in less 1993 red attack in many areas of Penticton Forest District. Additionally, the summer of 1993 was cool and wet, causing slower than normal development of pine beetle broods. The emergence of adult beetles and attack of new host trees appears to have been late and prolonged into the late fall.

This has resulted in less green attack, lower attack densities, and poorer brood development than is normally found. The situation varies between sites depending on slope, aspect, stand type, and proximity to stand edges. It is expected that overwinter beetle mortality should be higher than normal in 1993 attacked trees, and that the 1994 emergence and attack will be reduced and prolonged, possibly resulting in a continued reduction of losses.

Weather patterns for the coming winter and for next spring and summer will be major factors that determine the course of the outbreak within the next two years. A cold winter with low snowfall, a cool spring, and a cool wet summer would be the most favourable for the reduction of losses. If conditions favourable to the beetle occur, populations are still expected to be reduced, although they could recover within a year. It is important to take advantage of current conditions.

- P. Hall, Silviculture Branch, Victoria,
and L. MacLauchlan, Kamloops Forest Region, Kamloops.

Bark Beetle Responsibility Matrix. A draft policy is being developed which specifies roles and funding responsibilities for bark beetle management activities by Forest Service and licensees under a variety of tenures. This policy, if adopted, will provide a provincial standard ensuring consistency across all forest regions and districts. The draft policy will be available for review and comment in the near future.

- P. Hall, Silviculture Branch, Victoria.

"SWAT" Used to Assist Spruce Beetle Count. To get a rapid estimate of spruce beetle population levels and trends in susceptible areas of the timber supply area, the Golden Forest District utilized an "O"-team emergency crew of experienced spruce beetle surveyors, drawn from the Kootenay Lake Forest District and regional offices. Doug McMullin and Jim Schafthuizen, Kootenay Lake Forest District, Rick Stewart, Nelson Forest Region, and Liz Williams, Golden Forest District surveyed the area in five days using a helicopter to survey remote drainages.

The team produced an assessment with recommendations which was used to formulate an action plan for the district. The "SWAT" team approach was a success, and should be useful in other situations where the Forest Service needs forest health information quickly but there is a shortage of available staff or local contract expertise. For further information contact Kevin Edquist, Golden Forest District or Rick Stewart, Nelson Forest Region.

- A. Stock, Nelson Forest Region, Nelson.

Bark Beetle Manual. The bark beetle management chapter in the Silviculture Manual, (Volume 4, Forest Health), is expected to be rewritten this year. The chapter will concentrate on procedures and planning approaches and will minimize discussion of background material. The chapter will conform to standard formats and will be written by a working group composed of a number of branch and regional entomologists. The chapter will include discussion of mountain pine beetle, spruce beetle, and Douglas-fir beetle. Other chapters to be developed in the next few years include those for defoliators and terminal weevils.

- P. Hall, Silviculture Branch, Victoria.

Amendments to the *Forest Act* Include Exemptions for Trap Trees. As a result of Bill 56, greater efficiency in the PHSP process will result. Interim implementation guidelines are available which contain a section on the cutting or removal of single trees or small groups of trees for purposes such as controlling insects to maintain forest health, or to limit the spread of tree diseases to adjacent stands. Justification for all basic silviculture exemptions must be recorded and may be subject to audit, and district managers will be fully accountable. Any questions concerning these interim guidelines should be directed to Don Mullett, or Brian Murphy, Silviculture Branch.

- J. Muir, Silviculture Branch, Victoria.

European Gypsy Moth - 1993. Agriculture Canada conducted eradication treatments using *B.t.k.* in several locations of British Columbia in 1993 including Richmond, Burnaby, Hope, Salt Spring Island, and Victoria. Subsequent trapping results indicated successful eradication on most sites; however, a few moths were trapped and egg masses were found in the Victoria area, and several male and female moths and egg masses were found in Hope, indicating that these treatments were not entirely successful. The Victoria and Hope areas will probably be treated again in 1994.

Trapping in other areas picked up a few moths in several traps. Several males and egg masses were found in South Vancouver (outside the 1992 spray zone) where a few moths had been detected in 1992, Whiskey Creek (near Coombs), and Nanaimo. Treatments may be recommended for these sites in 1994.

- P. Hall, Silviculture Branch, Victoria.

Asian Gypsy Moth Treatment Results. Approximately 18 000 ha, covering most of Vancouver, British Columbia, were treated with three aerial applications of *B.t.k.* in the spring of 1992 to eradicate an introduction of the Asian strain of gypsy moth. Two successive years of intensive pheromone trapping in the area have yielded only negative results for Asian gypsy moth, which indicates that the treatments were effective. Trapping will continue to be intensified in high risk areas around the harbour and port facilities.

- P. Hall, Silviculture Branch, Victoria.

Gypsy Moth Risk Assessment. A contract to conduct a risk assessment of the impacts of gypsy moth on British Columbia resources has been signed by the Forest Service. The risk assessment is intended to be a comprehensive study on the potential impacts of gypsy moth should it become established in the province. The study will include information on the following:

- probability of establishment;
- probable areas of British Columbia where climate would be suitable for gypsy moth survival and expansion;
- potential host range of the gypsy moth in British Columbia;
- likely impacts of the gypsy moth on forest resources, agricultural crops, watersheds, biodiversity, recreation, urban areas, pesticide use by various levels of government and private individuals, import/export limitations, and others;
- classes of stakeholders and estimates of the impact on their interest;
- expected progression of impacts over time given an initial introduction into the lower mainland; and,
- impacts on society and communities of the gypsy moth and control efforts.

The study is to be completed by March, 1994. A report will be made available to those interested. The results of the study are intended to provide a basis for developing policies and approaches to gypsy moth management and will be used by a number of agencies including the Ministry of Forests, Ministry of Agriculture, Fisheries, and Food, and the Ministry of Environment, Lands, and Parks.

- P. Hall, Silviculture Branch, Victoria.

Gypsy Moth Treatment Option Review. Agriculture Canada has proposed a study to review and assess the options available for the eradication of European gypsy moth in British Columbia. An assessment will be made of the effectiveness of treatment options in inhibiting the establishment of permanent populations versus the potential impact on the environment and on human health. This study will complement the risk assessment being conducted by the Forest Service and, together, will form a basic information base upon which policy and operating decisions can be made by involved agencies.

- P. Hall, Silviculture Branch, Victoria.

Brush Saw Mounted Debarker Tested in the Invermere Forest District. The Invermere Forest District, in cooperation with Seymour Engineering of Coquitlam, has been testing a hand-held brush saw mounted debarking head for use in single tree treatment of mountain pine beetle infestations. The debarker has excellent potential for use when or where other single tree treatments cannot be used. For example, the debarker can replace falling and burning during fire season (April 15 through October 15), and replace MSMA in watersheds and 10 m pesticide-free zones.

Production is approximately equivalent to falling and burning (50-70 minutes for an entire tree to a 10 cm top), except where trees can be satisfactorily debarked without falling. In this case a debarker can treat a lodgepole pine tree in 5-8 minutes. Although the machines have undergone extensive modification and field testing, further modifications are required to meet Workers Compensation Board recommendations for levels of handle vibration. A report on the operational testing is being prepared and should be available in 1994. For further information contact Art Stock, Nelson Forest Region or Emile Begin, Invermere Forest District.

- A. Stock, Nelson Forest Region, Nelson.

1993 Western Spruce Budworm Program. In May, 1993, a training session was held at the Air Operations Base in Kamloops on the operational aspects of an aerial spray program. Over 30 people participated from the B.C. Forest Service and industry. Instructors were: Amy Onken, USDA, West Virginia; Lowell Ritchey, private consultant; Craig Howard, Ministry of Natural Resources, Ontario; Stephen Nicholson, Novo Nordisk; Jim Cooper, Western Aerial Applications, Delta; Ken Westfall, Kamloops Air Operations, and myself. Topics included calibration techniques, spray swath analysis, use of the swath kit, and all aspects of coordinating and running an aerial spray program using *B.t.k.* The course was very useful and more are planned for the future.

The budworm population is declining throughout the Kamloops Forest Region, but populations were still moderate to high in the Kamloops, Vernon, Lillooet and Merritt Forest Districts during 1993. Treatments in the Salmon Arm and Penticton areas were canceled due to low numbers of larvae sampled in May. All other areas planned for treatment had moderate to high insect populations.

Treatments in 1993 were done using four Hiller 12E turbine helicopters, each equipped with four beecomist nozzles. Staging sites were located on or near spray blocks. The *B.t.k.* was trucked out to the staging sites each morning for loading. A Bell 206 was used to monitor the spray operations and assist the Hillers in marking swaths. The weather throughout the spray program was cool and wet. However, the relatively high humidity facilitated very long spray windows and ensured that the project was completed in a timely manner.

The 1993 treatment commenced on May 30th, and was completed on June 16th. Just over 34 000 ha were treated in 18 days, or approximately 161 spray hours. The area includes some research sites which were treated with Foray 48B® and 76B® at 60 BIU/ha, 136 ha at Ellison Provincial Park, and 780 ha on Tree Farm License 49 (Riverside Forest Products).

Overall the treatment was very successful. Due to the quantity of data generated from the sampling, a summary of only the Kamloops Forest District results are presented (please refer to the Tabulation and Graphics Section of this issue). For a complete summary of data and the 1993 program, please contact the Kamloops Forest Region.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

The Douglas-fir tussock moth in the Kamloops Forest Region - 1993. This marks the third consecutive year of nuclear polyhedrosis virus (NPV) treatment for Douglas-fir tussock moth, in the Kamloops Forest Region. As indicated by fall egg mass survey results, current outbreak will collapse in 1994 although some small isolated patches of defoliation are expected.

A total of seven sites were treated with NPV. Numerous other sites where defoliation was predicted were either left as control areas or as low priority areas for treatment. Much of the area treated in 1993 was on private land, but directly adjacent to Crown forested land. All landowners were notified in writing about the problem and written consent was requested. The application was done using one Hiller 12E turbine equipped with four Beecomist nozzles. Approximately 610 ha were successfully treated on May 28th, 1993, between 5:30 and 11:00 a.m. Both the Canadian and USA formulation, Virtuss® and TM Biocontrol-1® were used. The virus was applied at full dosage rates, as well as at a reduced dosage rate (2/3 potency) to compare efficacy.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Spruce Beetle Ground Detection Training in Prince George Region. B.C. Forest Service staff, consultants and Canadian Forest Service specialists, met in July, 1993 to discuss changes in current spruce beetle survey methodology for the Prince George Forest Region. This meeting was timely since ground detection of spruce beetle has greatly increased in the region.

Major changes in the methodology agreed upon at this meeting include the adoption of the following:

- new bark beetle codes;
- bark surface area factors;
- walkthroughs prior to grid probing;
- standardization of probe line parameters; and
- more formal training requirements.

The above consensus led to production of a new Spruce Beetle Probe Card (FS 1111) and four beetle probe training sessions were held between August and November, 1993. The sessions were designed specifically for ground probing personnel who classify spruce beetle attacked trees and for those that field check such work. Course content included 3.5 hours of classroom instruction, 2.5 hours of field training, and a 1 hour written examination. Altogether 81 contractors, 13 licensee staff, and 6 Forest Service Resource Assistants successfully completed the course and were registered in the Region. A list of registrants and their companies is available from the undersigned.

The existing regional Standard Operating Procedure on spruce beetle ground detection is being revised to include the above changes and new requirements. It is eventually hoped that spruce beetle and other bark beetle probing methodologies can be provincially standardized.

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

FOREST DISEASES

The Tree Max Trial in Southeastern British Columbia. Recognition of armillaria root disease as a serious problem in Nelson Forest Region led to examination of techniques to reduce both the incidence and spread of the disease. The removal of roots from the soil and exposure of the organism to air-drying, has been the primary mechanism investigated. In thinning operations, this technique also breaks root contact between crop and removed trees, which prevents transfer of disease.

In October 1992, the British Columbia Ministry of Forests rented the Tree Max, a Swedish manufactured implement capable of pulling trees complete with roots from the ground. The implement was tested under a variety of stand conditions throughout Nelson Forest Region. The Forest Engineering Research Institute of Canada (FERIC) participated in one portion of this trial in November, monitoring the Tree Max in a study block in Golden. Further information regarding the results of this trial can be obtained from Ross Tozer, Regional Manager, Nelson Forest Region.

- D. Norris, Nelson Forest Region, Nelson.

Armillaria Research Working Group. A working group was formed in December, 1992, to encourage communication and cooperation between researchers and field practitioners who are involved in armillaria-related issues. Main objectives of the working group are:

- a) undertake an integrated multi-disciplinary research program to address resource management objectives in armillaria infected stands; and
- b) inform regional and district staff and other clients of historical and current research initiatives and future research needs and directions.

Members of the working group currently include people from the Ministry of Forests, (Regional Silviculture, Forest Health, and Forest Sciences, and Silviculture Branch Forest Health and Training Sections), Canadian Forest Service, and Ministry of Environment, Lands and Parks.

- J. Beale, Silviculture Branch, Victoria.

Surveys for Armillaria Root Disease in Blocks Scheduled for Spacing. During the summer of 1993, cooperative education students Jason Smith and Alex McLeod surveyed 30 blocks for armillaria root disease that were scheduled for juvenile spacing.

Five of the blocks had armillaria root disease infections. As a result, either modifications of the spacing regime or no spacing will occur on these blocks.

- D. Doidge, Cariboo Forest Region, Williams Lake.

Aerial Survey for Armillaria Root Disease. During the third week of October, 1993, Richard Reich and Don Doidge attempted to map armillaria root disease in plantations between Horsefly and Quesnel Lakes from a Bell 206 helicopter. Coloured 1:40 000 scale forest cover maps were used. These were drawn on 1:250 000 scale maps for the navigation convenience of the helicopter pilot and aerial surveyor.

Armillaria root disease in plantations can be easily detected from the air. Usually a red tree will be seen first and then surrounding grey and faded trees. During the fall, however, leafless deciduous trees can sometimes be mistaken for grey conifers.

The 1:40 000 map scale was too small for optimum mapping accuracy, and because these particular maps were used for bark beetle aerial surveys, only the current cutblocks were coloured.

The solution may be to use 1:20 000 scale maps to include cutblocks with older (10-30 years) trees. These cutblocks should also be located and coloured on the maps. The use of 1:20 000 maps should allow a higher flight and a slower passage over the ground, which would increase mapping accuracy. Mid-summer is probably the best time for the aerial survey, as the maximum contrast between red and green trees is visible at that time. Unfortunately, deciduous trees in full leaf may block the visibility of some diseased conifers.

- D. Doidge, Cariboo Forest Region, Williams Lake.

Browne Lake: A study in Death and Decay. A study area was established this summer in the Browne Lake area east of Kelowna to measure and monitor the effects of armillaria root disease in both spaced and unspaced pine stands in the Interior Cedar-Hemlock (ICH) biogeoclimatic zone.

In the early 1970's, the area was harvested to control an outbreak of mountain pine beetle, and lodgepole pine at approximately 5000 stems per hectare was naturally regenerated. In the early 1980's, an opportunity to space the stand became apparent and pre-stand tending surveys were done. In 1985, two blocks with a total area of 54 ha were spaced under the Section 88 program. The following year, another project was started but was discontinued after one hour of work. The district resource assistant and the crew chief had discovered a strange white fungus underneath the bark of some mysteriously dead pine trees. The regional pathologist was summoned, and promptly diagnosed the causal organism as armillaria root disease. The crew was moved to another location and a large note put on the project area's file saying "DO NOT SPACE!".

In the summer of 1993, the area was revisited. Tree mortality caused by armillaria was now much more evident, and that same resource assistant and crew chief (both now wiser and older) were very depressed. However, they decided to take another approach - they called it a trial.

The area was resurveyed in order to compare the original pre-stand tending data (by original stratum), the final post-stand tending data (on the spaced areas), and the currently existing stand. A series of permanent sample plots will be established to monitor further changes over time. For further information, contact Dave Calder (the former crew chief) or Mike Jobke (the former resource assistant).

- D. Calder, Kamloops Forest Region, Kamloops.

Root Disease Guidelines for Kamloops Forest Region. Guidelines for Pre-Harvest Silviculture Prescriptions in the Kamloops Forest Region for armillaria root disease and laminated root rot were formally signed by the regional manager in August, 1993. The guidelines apply to all PHSP's submitted after September 13, 1993 and they have been positively received by both industry and Ministry staff. The documents contain detailed detection criteria, management strategies, and free-growing assessment and liability criteria. The intent is to avoid a "cookbook" strategy of management, and to provide an operational framework that is pragmatic, fair, and workable. This approach has been met with enthusiasm thus far, and should ensure a cooperative and professional approach to the management of these diseases.

- D. Calder, Kamloops Forest Region, Kamloops.

MAMMAL DAMAGE

Porcupines Continue to Dine Out in North Coast. Porcupines continue to gnaw their way through the forests of the North Coast Forest District. The annual resurvey of permanent damage transects in the Khutzeymateen Inlet and Ford's Cove areas revealed new attack levels of 2.0 to 12.7% and 0.9 to 3.4% respectively on each transect. Approximately 5.4% of trees in the Khutzeymateen Inlet, and 2.1% in the Ford's Cove survey areas were attacked this year. Western hemlock remained the preferred species. The annual mortality rate for porcupine-attacked trees continues at 1% in these stands.

In order to examine porcupine damage in younger (20-30 year old) stands, four areas harvested in the 1960's and early 1970's were surveyed by cooperative education students Naomi DeLury, Brenda Drummond, and Daniela Imhof. Thirty percent of surveyed trees in Kromann Creek area had suffered damage; 18% of trees in Tuck Inlet and 6% of trees at Hayward Creek were also damaged. No damage was observed at Little Windsor Creek. All damaged trees were western hemlock and no tree mortality was attributed to porcupine.

- S. Zeglen, Prince Rupert Forest Region, Smithers.

Glen Sparrow Versus Big Black Bear Versus Root Disease. Glen Sparrow, a local forest health contractor, confronted a big black bear. Apparently, Glen surprised the bear. And yes, he was in a root disease center some distance from a suitable climbing tree.

The bear charged. Glen and his dog ran. The dog ran faster than Glen. The bear got within a mere three steps of Glen. As he ran, Glen began dropping various pieces of apparel. Fortunately, Glen got into a tree at the edge of the root disease center. Apparently, the bear was sidetracked by Glen's cruising vest!

The incident occurred near Sabiston Lake, in an area called the Steam Shovel. If you wish to get a sense of the excitement, the fear and the sweat of the chase, just get Glen to tell the story.

Keep your head up and eyes peeled, take the Bear Hazard course, or go in the bush with someone that runs slower than you.

- D. Piggin, Kamloops Forest District, Kamloops.

PESTICIDES

Using Mesocosms to Determine Effects of the Bacterial Insecticide *B.t.k.* on a Stream Invertebrate Community. A research project on the effects of *Bacillus thuringiensis* Berliner var. *kurstaki* (*B.t.k.*) on a stream invertebrate community was conducted by Limnotek Research and Development Inc. and a report on the study will soon be published by the Ministry of Forests.

Commercial formulations of the insecticidal bacterium, *B.t.k.* are widely used to control outbreaks of Lepidoptera, and are frequently sprayed over bodies of water. To examine the effect of *B.t.k.* exposure on the abundance and composition of stream benthic invertebrate communities, an experiment was conducted using replicated, streamside flowthrough mesocosms (see diagram on page 61 of the Tabulations and Graphics Section). The mesocosms received water and invertebrate colonists from a second-order coastal stream on southwestern Vancouver Island. Invertebrate fauna were allowed to colonize the mesocosms for six weeks. Two treatments, low (50 BIU • ha⁻¹) and high (≥ 100 times the low rate) were then applied for 2.5 hours. Sampling of several variables before, during, and after treatment supported analyses of variance to contrast both treatments with controls (i.e. no *B.t.k.* application).

Bacteriological sampling showed that concentrations of *B.t.k.* reached target levels. Elevated concentrations of spores were detected in the treated mesocosms even four days after the dose was applied. There were no significant differences in the density or composition of benthos sampled both before the *B.t.k.* application and seven days after. Benthos densities were highest in the high dose mesocosms. There were no significant differences in emergence rate of adults from the troughs due to treatment.

Behavioural responses to *B.t.k.* exposure were assessed by monitoring invertebrate drift. During the 2.5 hour treatment period marginally elevated mayfly drift rates were observed, but these differences were negated during the remainder of the observation period. The minor behavioural response may have been due to increased turbidity that occurred in the high dose mesocosms.

Leaf packs of red alder were placed in each mesocosm at the beginning of the experiment to test the hypothesis that adsorption of *B.t.k.* spores on organic surfaces would lead to reduced densities of detritivores. There were no significant differences in detritivore densities on leaf packs between treatments. However, there were differences in the ash-free dry mass of leaf remaining, with the lowest mass in the controls.

There was no evidence *B.t.k.* created adverse effects for the benthic community in the mesocosms. There were no toxic responses by any of the organisms examined in this study. The reduction in the decomposition rate of leaf packs when *B.t.k.* was added might be the result of the spores or the carbohydrate matrix in the commercial formulation of *B.t.k.* providing an additional food source.

Copies of this report will soon be available from the Technical and Administrative Services Branch, publication number FS 203 HSI 93/7.

- J. Henigman, Silviculture Branch, Victoria.

Environmental Report on *B.t.k.* A report has recently been published by the Canadian Forest Service and the B.C. Forest Service, entitled *Environmental Report and Current Status of Bacillus thuringiensis var. kurstaki Use for Control of Forest and Agricultural Insect Pests*.

There has been a dramatic increase in the use of *B.t.k.* in recent years. In 1980, for example, about 2% of the total area treated for spruce budworm in Canada was sprayed with *B.t.k.*, and this proportion increased to about 63% by 1990. The dramatic rise in *B.t.k.* usage is based on an extensive, worldwide accumulation of data pertaining to research, development, operational experience, and detailed investigations on potential side effects.

This review of the environmental impact of *B.t.k.* summarizes all the published information which could be found through an electronic literature search (Commonwealth Agriculture Bureaux Abstracts, Agricola, and Biosis). Additional information included in this review is based on all authoritative, published references available to us in various libraries. Although the formal literature search was halted at the end of 1991, in a few instances reports published in 1992 were also added because they filled information gaps (e.g., the effect of *B.t.k.* on aquatic insects) or because they provided new or additional information (e.g., the effect of *B.t.k.* on immunocompromised people and other health concerns).

This report was assembled primarily for the members of the Forest Health Committee, forest health, pesticide, and public health officers, and forest managers, in order to assist them in managing and explaining the use of *B.t.k.*. The data, presented without critical comments or interpretation, is synthesized under various subject headings that reflect frequently raised concerns. Authors are paraphrased and, whenever possible, direct quotations and page numbers are provided to assist interested people in locating the original information.

If you wish a copy of this report, please contact me or Dr. Otvos, Canadian Forest Service, Pacific Forestry Centre.

- J. Henigman, Silviculture Branch, Victoria.

Efficacy Assessment of Foray *B.t.k.* on the Western Hemlock Looper. The western hemlock looper, *Lambdina fiscellaria lugubrosa*, (Hulst) (Lepidoptera: Geometridae), is a destructive defoliator of conifers in British Columbia. Although the preferred host of the looper is western hemlock, during epidemics, many other coniferous species are also defoliated.

Historic records of the Forest Insect and Disease Survey, Forestry Canada, show that the western hemlock looper reached outbreak proportions in the Kamloops Forest Region in 1963-64, 1973-76, and 1983-84. The current outbreak beginning in 1990, appears to be the most severe. In 1992, over 88 000 ha of visible defoliation were mapped in the Kamloops Forest Region, more than double the area defoliated in 1991. Defoliation was severe on 43% of the area, moderate on 41% and light on the remainder. Survival of severely defoliated stands most of which were adjacent to high use traffic corridors and recreational areas was uncertain.

Natural controls of the western hemlock looper include parasites, predators and a polyhedral virus disease. Heavy rains during the flight period can reduce egg laying and adverse weather conditions during the hatching period may eliminate or substantially reduce population numbers. Starvation is a factor in terminating outbreaks where severe defoliation has occurred.

In eastern Canada, *Bacillus thuringiensis* Berliner var *kurstaki* (*B.t.k.*) has been sprayed on outbreaks of the eastern hemlock looper to control outbreaks. It is presumed that *B.t.k.* would also be effective against the western hemlock looper, to date there are no other products available. Another problem associated with control of the western hemlock looper is early detection. Much of the damage is done in the first year of an outbreak and by the time the outbreak has been detected it is too late for control measures to be implemented. Graduate students with Forestry Canada and Simon Fraser University, are presently working on aspects of looper biology to develop a forecasting system using egg, larval and pupal sampling, and also are studying the pheromone biology of the looper.

In 1993, because there was increasing pressure to manage vast outbreaks of forest defoliators both from the standpoint of forestry and visual quality, the Kamloops Forest Region, in cooperation with Novo Nordisk Bioindustrials and Abbott Laboratories, conducted a trial to treat ± 100 ha of hemlock looper infested semi-mature to mature western hemlock with *B.t.k.* This trial should enable *B.t.k.* products (Foray 48B® and Dipel 48AF®) to be registered for western hemlock looper.

The trial was established in the Perry River drainage in the Salmon Arm Forest District. This area suffered light to moderate defoliation by the looper in 1992, and the prediction from egg mass samples was for a slight increase in population. The trial consisted of three treatment blocks for both Foray 48B and Dipel 48AF, ranging from 10 to 20 ha each, with three control areas. A Hiller 12E turbine equipped with 4 Beecomist nozzles was used to treat the blocks the application rate was 40 billion international units per ha. The application was made in early July, when the insect population is in second to third instar. Art Stock, Bob Hodgkinson, John Henigman, their summer students, and Marnie Duthie, assisted the ground layout of blocks.

Two 45 cm branch tips were clipped from mid-crown (or as high as possible with the pole pruners) from the north and south aspect of each sample tree. The length and average diameter was measured to the nearest cm. A defoliation estimate was done on each branch sample using the Fettes (Fettes 1950) estimate. The number of larvae in each sample was recorded along with the state (live/moribund) and instar of each insect. All other associated insects were recorded. Abbott's Corrected Mortality estimate was calculated (Abbott 1925). In addition to the larval sampling, fall egg mass samples will be collected from the center portion of each block (treatment and control) to estimate 1994 defoliation. The looper is not a strong flier and by sampling well within block boundaries the influence of migration should be minimal.

The weather was very cool and wet at the time of treatment, but, there was no heavy rain for at least eight hours after the spray. Generally, good efficacy was seen in each of the treatment blocks. Most likely the cool weather reduced feeding and this would have influenced the mortality. By the second post-spray sampling time, the late hatch was apparent in the number of early instar larvae that were present in the samples.

Other larvae species were tallied but the majority were western spruce budworm, sawflies and other looper species. There was no significant fluctuation in distribution of other species among sites (except for the Foray-1 site) or among sampling times.

A full report of this trial may be obtained from the Kamloops Forest Region.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Boron was a Bust. As described in previous issues of Forest Health Progress, crystalline boron rods were tested for their effect on development of mountain pine beetle. Boron, as a spray treatment, has been used to protect structural timbers from wood borers, and furniture from powder-post beetles. It is chiefly used, as wood preservative because of its fungicidal properties. It was hypothesized that boron, in either a liquid or solid form, could affect beetle survival directly through its insecticidal properties, or indirectly through altering the beetle's micro-environment by suppressing the growth of the symbiotic blue-stain fungi.

In the summer of 1992, Simon Fraser University cooperative education students Brenda Drummond and Larry Davis, inserted boron rods into 30 trees two weeks before the main beetle flight. At a nearby site, another 40 trees were treated, one and two weeks after the trees were determined to be mass attacked. In addition, ten trees were treated with liquid Boracol 30® using the same hack and squirt method that is used to apply MSMA. During the summer of 1993, Brenda returned for a second work term and assessed beetle survival and fungal development.

Larval survival estimates, followed later by adult emergence assessments, were not significantly different between controls and any of the boron treatments. Boron appeared to have no effect on bark beetle survival. One problem noted was the limited distance that the chemical translocated during the year. The rods dissolved very slowly; and in most cases, 75% of the rod remained after one year. Sapwood analysis for boron conducted by the Glyn Road Forest Research Laboratory, showed that very little boron was detected at heights greater than 1 m above the rod. However, the boron did suppress growth of the blue-staining fungus within a thin line 30 cm above and below the rod.

A full report is available upon request from Brenda Drummond or Tim Ebata.

- T. Ebata, Prince Rupert Forest Region, Smithers.

Boron Trials in Prince George Forest Region. In 1992, in cooperation with the Prince Rupert Forest Region, liquid and solid formulations of boron were tested against mountain pine beetle. In July, ten semiochemically-baited lodgepole pine trees in each of two locations were injected with 100 mm solid rods of anhydrous disodium octaborate (Timbor®) using 8, 10, or 12 rods per tree. A rechargeable drill was used to bore lateral holes around each tree's circumference so that most of the inserted rods bisected phloem tissue without leaving more than a 10 cm gap between rods. Holes were then plugged with silicon caulking. A comparable number of lodgepole pine were baited with semiochemicals and left otherwise untreated to serve as checks. There were no significant differences between total attacks on boron-treated and untreated lodgepole pine. Unfortunately, the rods failed to diffuse adequately and were, therefore, not efficacious.

In a second, larger trial, we tested a liquid formulation of disodium octaborate tetrahydrate (Boracol 30®) as a "post-attack" treatment on semiochemically-treated lodgepole pine. A total of 22 mountain pine beetle infested lodgepole pine trees located at two sites were treated with Boracol 30 between July 29 and August 5, 1992. An additional 22 semiochemically-treated and infested lodgepole pine at each site were left otherwise untreated to serve as checks. Boracol 30 was applied by cutting axe-frills around the lower boles of trees and inserting the liquid into the frills as one would use MSMA in an operational treatment. Efficacy sampling conducted in early June, 1993, revealed that although there was no repellency of attacking adults, the Boracol 30 was not efficacious as a post-attack treatment.

A final test of the liquid borons (Boracol 20® and 30) was made in mid-June, 1993, to assess their efficacy against mountain pine beetle in a "pre-attack injection" strategy. Preliminary data indicates that the injected liquids were not repellent towards attacking mountain pine beetle adults. An assessment of liquid boron's efficacy against the new broods will be undertaken in the spring of 1994.

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

Report on Single Tree Treatment Efficacy. Little efficacy information is currently available for either fall and burn or MSMA treatments. The Morice Forest District has archived mountain pine beetle probing data from 1985 to the present to analyze the success of these two forms of single tree treatment. Five mapsheets were selected that had a history of continuous fall and burn treatment in a portion of the mapsheet from 1985 to 1992. Three mapsheets that contained areas where MSMA treatments were carried out from 1988 to 1992 were similarly assessed.

Within a subsection of each mapsheet, numbers of green and red attacked trees were tallied for each year. Subsections selected had been treated only by fall and burn or MSMA. In addition, a tally of attacked trees for a further 15 mapsheets was done to produce a District average green/red ratio. Through a simple calculation, a projection was made of the potential number of trees that would have been killed if the trees located during the probes had not been treated. The cumulative numbers of trees killed and a change in volume in the affected polygons were calculated to compare the economic impact of the treated and untreated beetle infestations.

As expected, untreated infestations increased in size logarithmically. However, simulated impacts on the total volume of pine within the study areas over the seven year period were relatively minor since many of the stands within the subsections had low pine components. With larger green/red ratios, this impact would be far greater.

The report will be available upon request from Brenda Drummond or Tim Ebata.

- T. Ebata, Prince Rupert Forest Region, Smithers.

Experimental Use of Neem Seed Extract for Mountain Pine Beetle Control. A cooperative study between the Cariboo Forest Region and Ken Naumann, University of British Columbia, generated some promising results for mountain pine beetle control. Extracts of the seeds of the neem tree, *Azadirachta indica*, have a number of properties useful for the management of insect pests. Neem seed extract (NSE) causes mortality, improper moulting, impaired reproductive capacity, and deters feeding in various beetle species. NSE appears to be safer for natural enemies than most conventional insecticides. The objectives of the study were to determine if NSE translocates within conifers; and if hack and squirt injection of NSE will control mountain pine beetle.

Preliminary results indicated that NSE does translocate when injected into young Douglas-fir trees. Furthermore, field trials of hack and squirt injection of NSE in baited, mass-attacked trees resulted in fewer surviving larvae per unit area of bark and adult gallery length. Beetle mortality increased with increased NSE dosage. However, the highest NSE dose (1.2 % active ingredient) was not as effective as an application of MSMA at the recommended dose (32% active ingredient).

Sampling is currently underway to determine the efficacy of NSE on pupae in treated trees and its effectiveness in the upper bole of treated trees. Future work will focus on testing the efficacy of stronger concentrations of NSE. It is also necessary to prepare a thicker formulation to make it easier to apply.

- L. Rankin, Cariboo Forest Region, Williams Lake.

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Val Fletcher	Forest Health Research Forester	Victoria	356-8763
Jeff Beale	Forest Pathologist	Victoria	387-8739
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Michelle Schmidt	Pest Management Biologist, Seed Production	Victoria	652-5413
Dave Trotter	A/Nursery Pest Management Specialist	Surrey	582-6910
Robb Bennett	Seed Orchard Pest Manager	Victoria	387-3931

CARIBOO FOREST REGION**Regional Staff**

Al Randall	Silviculture Officer	Williams Lk.	398-4399
Mark Hamm	Forest Health Forester	Williams Lk.	398-4441
Leo Rankin	Forest Entomologist	Williams Lk.	398-4439
Don Doidge	Forest Pathologist	Williams Lk.	398-4442
Guy Newsome	Stand Tending Forester	Williams Lk.	398-4400
Chris Easthope	Range Agrologist	Williams Lk.	398-4396

District Staff

Doug Harris	Resource Officer, Silviculture	Chilcotin	394-4700
Troy Hromadnik	District Silviculturist	Chilcotin	394-4700
Glen Burgess	Resource Assistant Protection	Chilcotin	394-4700
Bob Mitchell	Forest Health Officer	Alexis Creek	394-4700
Derek Poole	Forest Health Officer	Horsefly	620-3239
Brad Powell	Forest Health Officer	Quesnel	992-4400
Wayne Hendy	Resource Officer Protection	Williams Lk.	398-4341
Von Vickers	Forest Health Officer	Williams Lk.	398-4324
Mel Dodge	Resource Officer Protection	100 MI. House	398-3812
Don Wright	Forest Health Officer	100 MI. House	395-7873
Charles von Hahn	Resource Officer Silviculture	Quesnel	992-4457

KAMLOOPS FOREST REGION**Region Staff**

Lorraine MacLauchlan	Forest Entomologist	Kamloops	828-4177
David Calder	Forest Health Forester	Kamloops	371-3707
Ron Gray	Stand Tending Forester	Kamloops	828-4163
Phil Youwe	Range Resource Agrologist	Kamloops	828-4097
Hadrian Merler	Research Associate	Kamloops	828-4176

District Staff

Dan McDonald	Resource Officer, Silviculture	Clearwater	587-6713
Rob Martin	Forest Health Officer	Clearwater	587-6781
Brent Olsen	Resource Officer-Silviculture	Kamloops	371-6577
Joan Demale	Resource Clerk-Silviculture	Kamloops	371-6529
Dave Piggin	Forest Health Officer	Kamloops	371-6518
Dave Horne	Resource Officer, Silviculture	Lillooet	256-1229
Simon Warhurst	Forest Health Technician	Lillooet	256-1227
Ed Nedokas	Resource Officer, Silviculture	Merritt	378-8400
Pat Byrne	Forest Health Officer	Merritt	378-8449
Margot Hollinger	Forest Health Officer	Penticton	490-2242
Savas Koutsantonis	Forest Health Technician	Penticton	490-2250
Bob Johnson	Resource Officer, Silviculture	Salmon Arm	832-1426
Jim Wright	District Silviculturist, Silviculture	Salmon Arm	832-1424
Jerry Wearing	Resource Officer, Silviculture	Vernon	558-1776
Eric Haupt	Forest Health Officer	Vernon	558-1784

NELSON FOREST REGION**Region Staff**

Art Stock	Forest Entomologist	Nelson	354-6633
Rick Stewart	Forest Health Forester	Nelson	354-6144
Don Norris	Forest Pathologist	Nelson	354-6143
Gerald Reichenback	Stand Tending Forester	Nelson	354-6280
Grant Griffin	Range Officer	Nelson	354-6211

District Staff

Tom Johnston	Resource Officer - Silviculture	Arrow	365-8615
Ross Elliott	Forest Health Officer	Boundary	442-5411
Andrea Inwards	Forest Health Technician	Boundary	442-5497
Liz Goyette	Forest Health Officer	Cranbrook	426-3391
Kevin Edquist	District Silviculturist	Golden	344-7500
Emile Begin	Forest Health Officer	Invermere	342-4200
Richard Mazzochi	District Silviculturist	Kootenay Lk	825-1142
Bill Beard	Resource Officer - Silviculture	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	Forest Health Forester	Pr. George	565-6123
Heather Dawson	Vegetation Mgmt Forester	Pr. George	565-4113
Les Herring	Stand Tending Forester	Pr. George	565-6191
Ken Long	Range Officer	Pr. George	565-6138
Bruce Johnson	Range Development Coord.	Pr. George	565-6139

District Staff

Bob Richards	Resource Officer - Silviculture	Pr. George	565-7100
Bruce Doerksen	Forest Health Technician	Pr. George	565-7100
Barbara Koch	Forest Health Technician	Pr. George	565-7156
Norma Stromberg	Resource Officer - Silviculture	McBride	569-3714
Dave Kraby	Resource Assistant - Silviculture	McBride	569-3748
Greg Rawling	Resource Officer - Silviculture	Vanderhoof	567-6363
Dave Banham	Forest Health Technician	Vanderhoof	567-6363
Lance Mitchell	Resource Officer - Protection	Ft. St. James	996-7131
Carl Hovey	Resource Assistant - Silviculture	Ft. St. James	996-7131
Andy Pakrastins	Resource Officer - Silviculture	Mackenzie	997-2200
Chris Broster	Forest Health Technician	Mackenzie	997-2200
Steve Bower	Assistant Forest Health Tech.	Mackenzie	997-2200
Cal Wilson	Resource Officer - Silviculture	Dawson Creek	784-2350
Sherilyn Smith	Resource Assistant - Silv.	Dawson Creek	784-2350
Brian Wesleyson	Resource Officer - Silviculture	Ft. St. John	787-5628
Lance Ollenberger	District Silviculturist	Ft. St. John	787-5628
Steve Lindsay	Resource Officer - Silviculture	Ft. Nelson	774-3936
Neil Edward	District Silviculturist	Ft. Nelson	774-3936

PRINCE RUPERT FOREST REGION**Region Staff**

Gerry Pinkerton	A/Silviculture Officer	Smithers	847-7512
Tim Ebata	Forest Entomologist	Smithers	847-7479
Stefan Zeglen	Forest Pathologist	Smithers	847-7478
Vacant	Forest Health Forester	Smithers	847-7477
Lou Tromp	Stand Tending Forester	Smithers	847-7514
Don Russell	Range Officer	Smithers	847-7443
Doug Kelly	Vegetation Mgmt. Forester	Smithers	847-7757

District Staff

Gary Lloyd	Resource Officer-Silviculture	Bulkley	847-6307
Bill Camenzind	Audit Forester	Bulkley	847-6310
Larry Michaelsen	Resource Officer-Silviculture	Cassiar	771-4211
Glen Buhr	District Silviculturalist	Cassiar	771-4211
Bob Wilson	Resource Officer-Silviculture	Kalum	638-3290
Rocky Chan	Incremental Forester	Kalum	638-3290
Rod Meredith	District Silviculturalist	Kalum	638-3290
Janice Bianco	Resource Officer-Silviculture	Kispiox	842-6581
Paul Hanna	District Silviculturalist	Kispiox	842-6581

Bruce Ward	Forest Health Technician	Morice	845-6224
Vacant	Resource Officer-Silviculture	Morice	845-6200
Mike Grainger	Resource Officer-Silviculture	North Coast	627-0462
Alex Gauld	Incremental Forester	North Coast	627-0475
Terry Chow	District Silviculturist	North Coast	627-0475
Wayne Martin	Resource Officer-Silviculture	Lakes	692-7515
Terry Thrower	Resource Assistant-Silviculture/Protection	Lakes	692-7515

VANCOUVER FOREST REGION

Region Staff

Don Heppner	Forest Entomologist	Burnaby	660-7653
Vacant	Forest Pathologist	Burnaby	660-7654
Mel Scott	Stand Tending Forester	Burnaby	660-7579

District Staff

John Ingram	Resource Officer - Silviculture	Campbell Rv.	286-9300
Lucy Stad	District Silviculturist	Chilliwack	794-2100
Brenda Koro	Forest Health Technician	Chilliwack	794-2100
Rob Furness	District Silviculturist	Duncan	746-2700
Nancy Colpits	Silviculture Planner	Mid Coast	982-2000
Mark Palmer	District Silviculturist	Pt. Alberni	724-9205
Chuck van Hemmen	Resource Officer - Silviculture	Pt. McNeill	956-5034
Carol Reagon	District Silviculture Planner	Pt. McNeill	956-5033
Ron Diprose	Forest Health Technician	Sunshine C.	485-0730
Mark Salzl	District Silviculturist	Qn. Char. Is.	559-8447
Earl Spielman	District Silviculturist	Squamish	898-2100

MEETINGS

Western International Forest Disease Work Conference Highlights Forest Health Issues. At a recent (September 12-16, 1992) forest disease conference at Boise, Idaho, I was very impressed to learn that forest health was the forest management issue and central strategic concern at the Boise National Forest. (A copy of their brochure and a background report are available from me for your information.)

The National forest supervisor has championed a forest health strategy because of recent alarming forest losses to insects and wildfire. The current strategy administered by a full-time silviculturist derived from a section on forest health in the national forest management plan prepared in 1986.

Although I had some reservations about the strategy - such as the emphasis on salvage operations - I was very impressed that forest health was so prominent and important.

Although our forest losses are not increasing, we have very similar forest conditions and concerns in the southern interior of British Columbia, and similar approaches, particularly prescribed fire and thinning, are being tried in the Nelson and Kamloops Forest Regions to develop healthier forest ecosystems.

- J. Muir, Silviculture Branch, Victoria.

1994 Western Forest Insect Work Conference. The 1994 conference is a joint conference with the Western International Forest Disease Work Conference and will be held in Albuquerque, New Mexico, March 7-10, 1994.

- P. Hall, Silviculture Branch, Victoria.

Integrating Social and Ecological Perspectives to Sustain Forest Health. The USDA Forest Service, Society of American Foresters, International Union of Forestry Research Organizations, and the Western Forestry and Conservation Association are sponsoring this conference, to be held in Coeur d'Alene, Idaho, October 11-13, 1994. This international conference is designed to explore ways to integrate the variety of perspectives and disciplines seeking an understanding of forest health and to develop the means of sustaining the health of our forests.

Registration materials are available from Christy Dorsey, Western Forestry and Conservation Association, 4033 South West Canyon Road, Portland, Oregon, 97221. Telephone/FAX (503) 226-4562.

- J. Muir, Silviculture Branch, Victoria.

1993 Canadian Entomological Conference. This conference was held in Sault Ste. Marie, Ontario, September 26 - 29, 1993. A workshop held on Sunday on *Improved Pesticide Applications* proved very pertinent to the Kamloops Forest Region, giving insight into spray technology and efficacy.

Some interesting points on aerial application are as follows:

- Atomizer position is not critical because you still get most of the smaller droplets at the two vortex positions. The motion of droplets behind wing into vortices was studied, and primary vortex comes down and secondary vortex (downwind) actually rises above level of aircraft. Two things happen to composition of droplet cloud: first they can evaporate, thus changing droplet size, or they can change density by diffusing out from core of spray cloud.
- Other parameters studied included insect feeding over time (number of bites/time; location; size of bites) and this was worked into a model relating *Bacillus thuringiensis* Berliner var. *Kurstaki* (*B.t.k.*) droplet size, targets and efficacy. Spread factors, spatial distribution and droplet size distribution are all important parameters and various questions were discussed:
 - what proportion reaches target surface?
 - how much is really encountered by target insect
 - bioavailability efficiency.

Gypchek may be used in highly sensitive areas, but is not at this stage intended to replace *B.t.k.* Gypsy moth virus is not high virulent and is rapidly inactivated on foliage, but is species specific. Many different doses, carriers, UV protectants and application methodologies have been tried, but much variability is still encountered. Since approximately 1987, Orzan has been used as a sunscreen (this is what we use to mix NPV for DFTM) and molasses as a feeding stimulant and partial sunscreen. This mix is fairly good and has given fairly consistent results. Gypchek against low density population of Gypsy Moth was tried, and it worked quite well, and they would like to test it more on low densities. In 1990 and 1991, lower doses of Gypchek were tried and it was found that the midway dose was equal to the standard, but the lowest dose did not give good efficacy.

Entotech (Novo Nordisk) is working on developing an "optical brightener" - which is another virus which may influence the efficacy of Gypchek. The Novo *B.t.k.* formulation mixed with Gypchek was used and found that these flowable formulations were much easier for application purposes. Different application methodologies (varying nozzles and aircraft) all have resulted in equivalent efficacy.

On Monday, September 27, 1993, student presentations were given. The President's prize for best talk was awarded to Lisa Poirier, working under Dr. Borden as well as Troy Danyk, working under Dr. Mackauer of Simon Fraser University. A very controversial talk was given by Neville Winchester, University of Victoria on his research in the Carmana Valley. He is looking at the biodiversity of arthropod fauna in old growth Sitka spruce canopies by way of "tree houses" situated in the canopies, and comparing this to the fauna found in cutblocks. He has recorded several new species in this habitat, and they exhibit strict habitat specificity. Although he stated that these species form a discrete epiphytic community and that removal of this habitat (Sitka spruce) will alter biological diversity and initiate extinctions at the population level, he did not present data which showed the diversity of species in cutblocks was greater than that in the arboreal old-growth.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

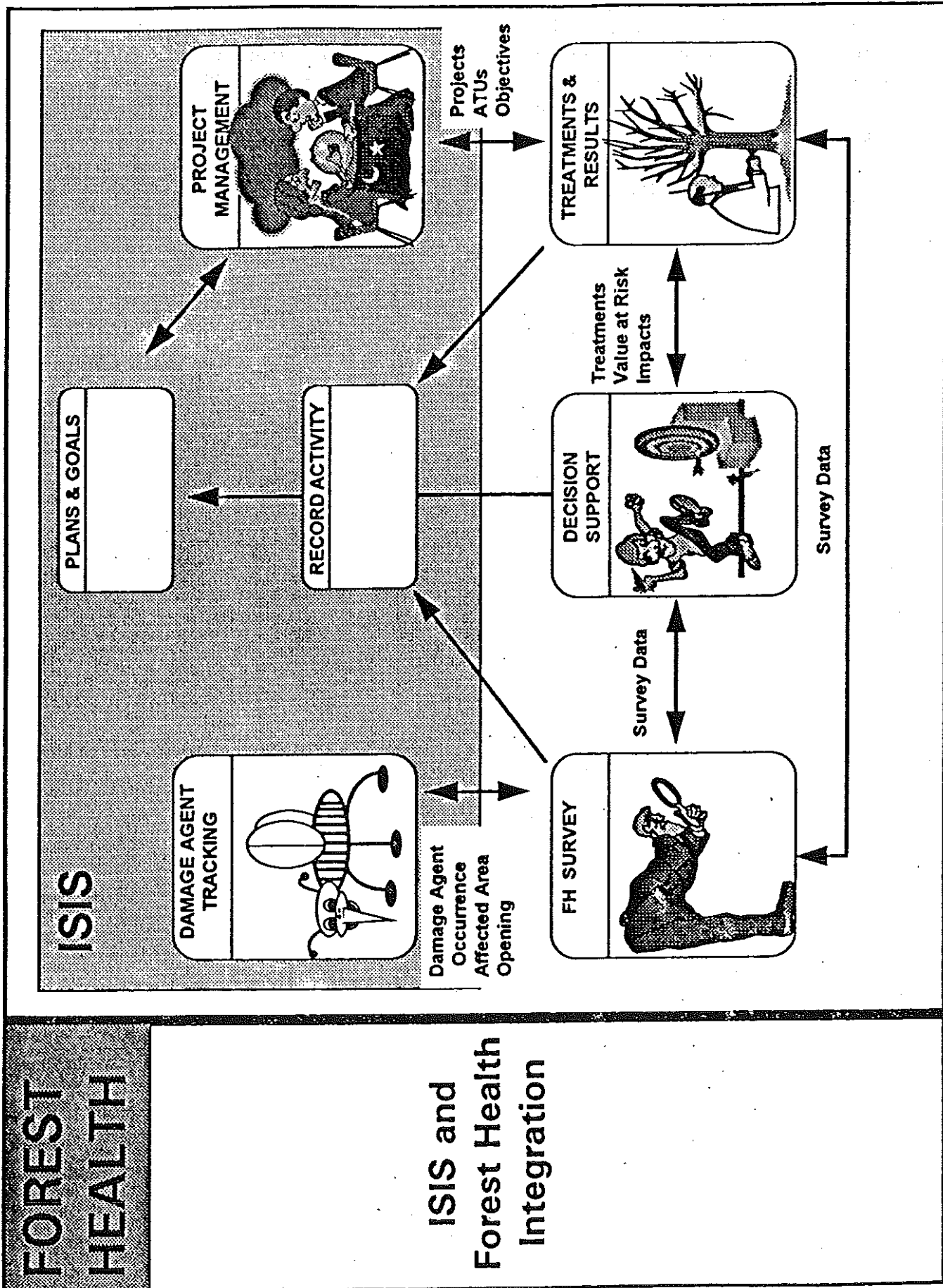
Provincial Forest Health Meeting. A very successful meeting of the provincial forest health specialists was held September 28-30, 1993, in Penticton, British Columbia. Some of the key action items resulting from this meeting include:

- support a forest health information systems plan developed by Val Fletcher and LGS Group Inc.;
 - initiation of regional-branch working groups to revise silviculture manual chapters on bark beetles and root diseases;
 - circulation of a policy proposal on management responsibilities for bark beetles by Peter Hall;
 - establishment of a working group, chaired by Dave Calder, Kamloops Forest Region, to draft a work plan and review forest health and incremental silviculture issues;
 - initiation of a regional-branch working group, chaired by John Henigman, to compile and review the forest health component of all silviculture surveys and existing forest health surveys;
 - circulation of draft Free Growing Standards and PHSP guidelines for assessing insects and diseases by Peter Hall. Notes and background reports for the provincial meeting were circulated, and copies can be obtained from Silviculture Branch.
- J. Muir, Silviculture Branch, Victoria.

White Pine Weevil Symposium. A symposium to discuss research and management topics relating to leader or terminal weevils, particularly white pine weevil, *Pissodes strobi*, is being jointly organized by Canadian Forest Service and the B. C. Forest Service. The symposium will be attended by personnel from across Canada and the western United States. The meeting will be held in Vancouver, British Columbia, January 19-21, 1994. For further information contact Dr. Rene Alfaro, Pacific Forestry Centre, (604) 363-3600.

- P. Hall, Silviculture Branch, Victoria.

TABULATIONS AND GRAPHICS



FOREST HEALTH

Core Forest Health Information Systems

System Functions

DAMAGE AGENT TRACKING

Captures Occurrence
Captures Affected Area
Captures Spatial Attrs.
Captures Text Attrs.
Reports Occurrence
Thematic Occurrence
Mapping

PROJECT MANAGEMENT

Yearly Project Plans
Annual and Project
Budgets
Setup FH Projects
Setup Project Objectives
Allocate & Schedule
resources
Track & Report Projects

FH SURVEY

Define FH Survey Type
Plan the FH Survey
Capture Plot Level Data
Summarize & Roll Up
to Affected Area, etc.
Report/Query/Map

DECISION SUPPORT

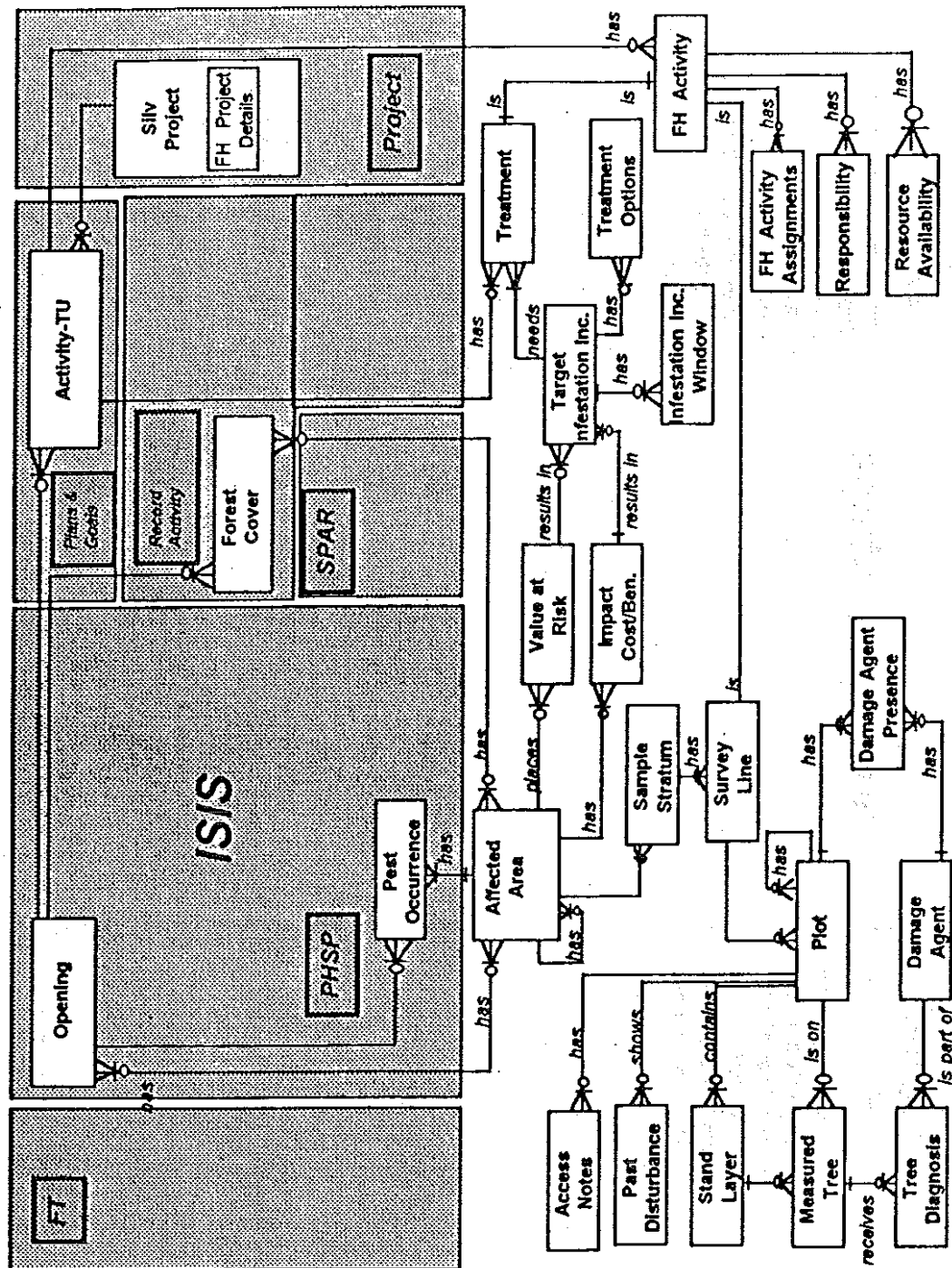
Various modelling and
analysis tools to:
Interface to data
sources
Risk Assessment
Impact Analysis
Analyse Treatment
options.

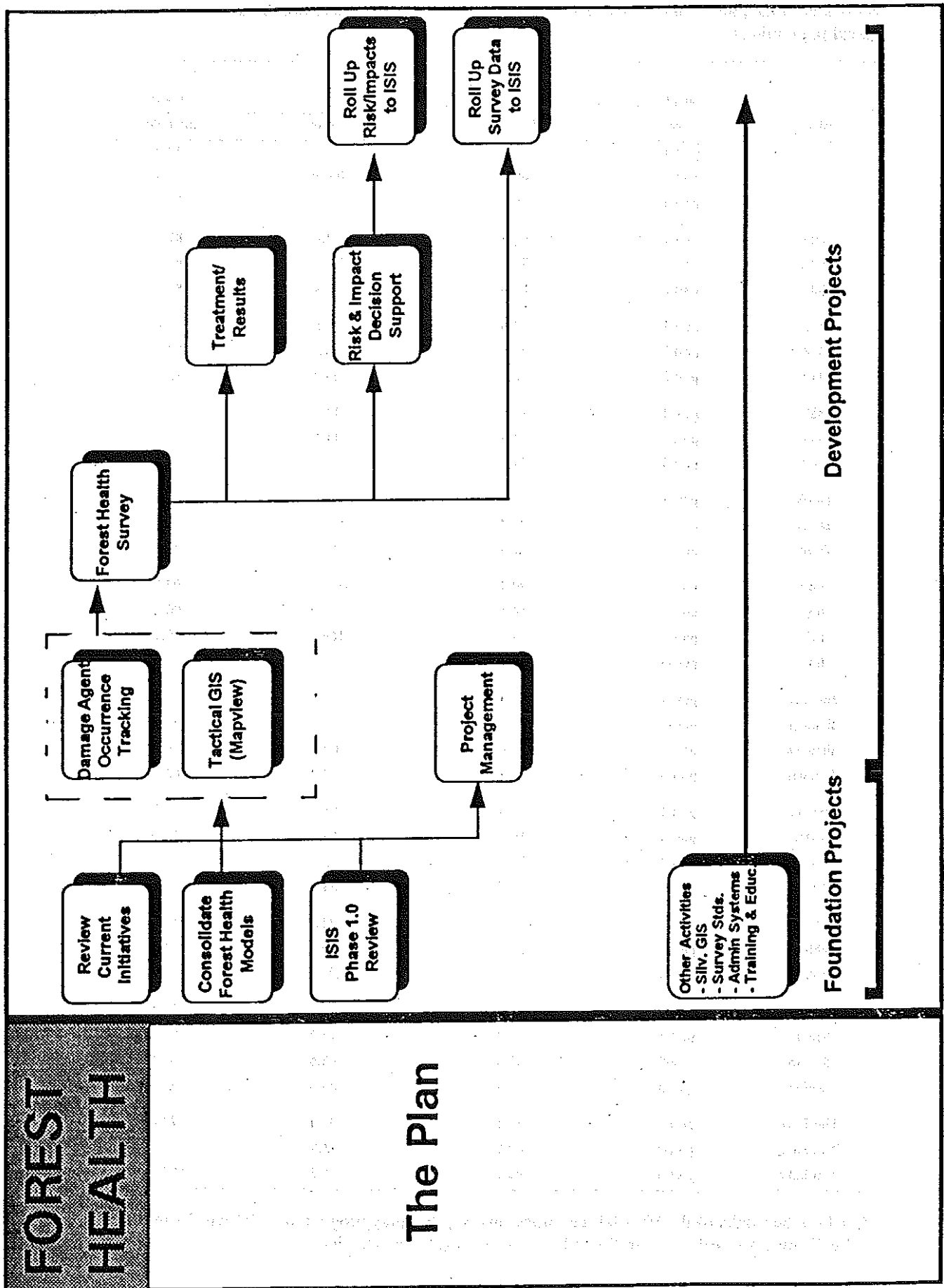
TREATMENTS & AUDIT S

Gather data about
specific treatments
Audit the results of
treatments

FOREST HEALTH

ISIS and Forest Health Integration





Efficacy results from the Kamloops Forest District, by block and sampling time, the percent mortality control or *B.t.k.*, and Abbott's corrected mortality estimate. Negative numbers indicate an increase in larval populations.

Block	Sample time	% mortality pre- to post-spray sample		Abbott's corrected mortality
		<i>B.t.k.</i>	control	
4	post-1	58.7	22.6	46.7
4	post-2	68.6	-200.0	89.5
4	post-3	85.1	22.9	80.7
Inks	post-1	90.4	22.6	87.7
Inks	post-2	74.1	-200.0	91.4
Inks	post-3	89.4	22.9	86.2
318	post-1	72.8	6.3	71.0
318	post-2	54.4	-261.7	87.4
318	post-3	93.9	65.3	82.5
387	post-1	-14.6	-11.8	
387	post-2	-38.5	-11.8	
387	post-3	29.6	-62.0	56.5
Duffy	post-1	55.4	1.9	54.6
Duffy	post-2	87.4	58.6	69.5
Duffy	post-3	84.5	46.5	71.0
Inks	post-1	90.4	-249.9	97.3
Inks	post-2	74.1	-169.7	90.4
Inks	post-2	45.8	-169.7	79.9
Inks	post-3	89.4	-170.9	96.1
Jimmies	post-1	46.1	-3.5	47.9
Jimmies	post-2	78.0	8.1	76.1
Jimmies	post-3	72.6	60.9	29.9
Jimmies	post-3	85.6	60.9	63.1
Paxton	post-1	83.3	65.3	51.7
Paxton	post-1	69.1	65.3	10.9
Paxton	post-2	71.9	72.5	-2.2
Paxton	post-3	91.7	84.3	47.3
Robbin's	post-1	-1430.5	-281.5	0.0
Robbin's	post-2	20.1	-376.3	83.2
Robbin's	post-3	-23.0	-496.6	79.4
Scuitto	post-1	47.3	16.2	37.1
Scuitto	post-1	72.7	16.2	67.4
Scuitto	post-2	88.8	46.6	79.1
Scuitto	post-3	91.5	36.4	86.6
Tim Lake	post-1	88.1	41.1	79.8
Tim Lake	post-2	89.0	-13.8	90.3
Tim Lake	post-3	94.2	1.6	94.1

Based on the results of the 1993 fall egg mass surveys, the spray program in 1994 will be much smaller and will cover primarily areas in the Lillooet and Merritt Forest Districts.

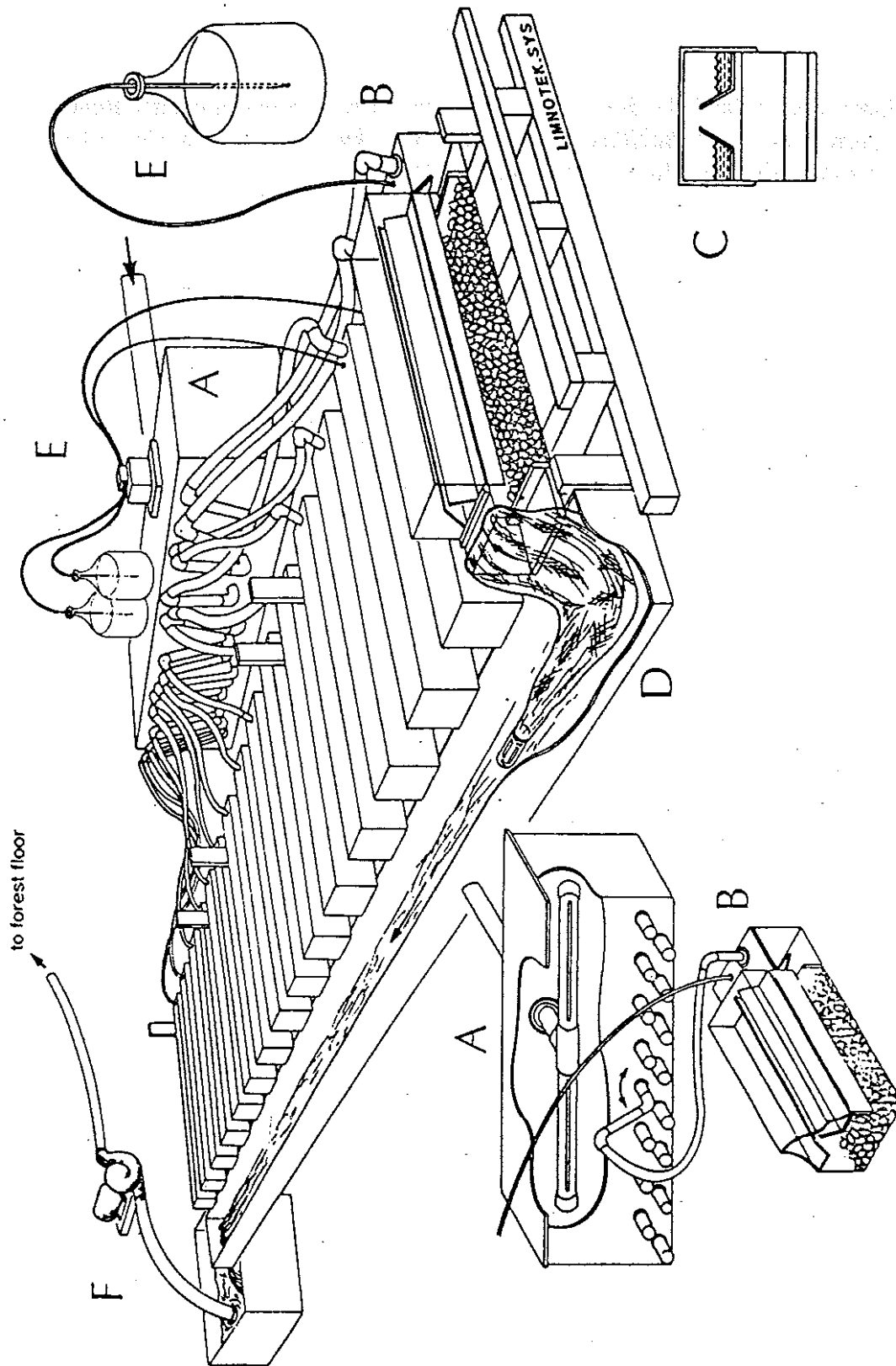


Figure 2.

Schematic layout of the mesocosm apparatus: A, head tank assembly showing the inflow pipe, water distribution inside the tank, and outflow regulated by standpipes; B, mixing chamber of each trough showing water inflow and Foray® injection line; C, cross section of emergence trap installed on top of a trough; D, drift net installed at the outflow of a trough; E, Mariotte bottle and pump systems for metering of the Foray® to treated troughs; and F, wastewater collection in a drainage trough that emptied into a collection basin and a 3" pump which dispersed the wastewater over the forest floor via several branched outlets to avoid ponding and formation of a surface stream

PUBLICATIONS AND REPORTS

Canadian Forest Service and the B.C. Forest Service, 1993. Environmental Report and Current Status of *Bacillus thuringiensis* var. *kurstaki* Use for Control of Forest and Agricultural Insect Pests. FS 203 HSI 93/7.