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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WHY A FOREST HEALTH COMMITTEE?

The Forest Health Committee, originally the Forest Pest Review Committee, was organized by Mike Finnis and Bob DeBoo to review large-scale, treatment programs proposed by the British Columbia Forest Service, and provide advice to the Chief Forester. Member agencies included federal and provincial departments of environment, fisheries, and health, and representatives of colleges, universities, forest industry associations, and labor unions. More recent activities of the committee include education of agencies' members, and promotion of training, research and other aspects of forest health.

Forest Health, a component of the Silviculture Program, is now developing a strategy to protect mature forests by suppressing or reducing damage from bark beetles and defoliating insects, and enhancing young forests by preventative treatments integrated into forest management practices. To be successful, the new Forest Health Program must address current forest resource and land-use issues, and facilitate or support several inter-related or inter-dependant programs of the ministry.

Therefore, a review of the purpose and function of the forest health committee is important. We should compare the role of the committee with other ministry advisory committees, and re-define or re-organize if needed.

Options for the Forest Health Committee will be presented and discussed at the committee meeting.

- J. Muir, Silviculture Branch, Victoria

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FOREST HEALTH PROGRESS

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EDITOR'S NOTE

Forest Health Progress is intended to report to the Forest Health Committee of British Columbia on issues, projects and proposals by Ministry staff.

Contributions labelled 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.

FOREST HEALTH - GENERAL

Five-Year Strategic Plan for Forest Health Program Will Soon be Completed. The document which describes the forest health program, and its role within Silviculture Branch, will soon be completed and ready for all to read. The need for a formalized strategic plan was identified at a meeting of silviculture managers and forest health staff in the fall of 1991. Since that time a basic understanding of the role of forest health in silviculture has been reached, and the components of a deliverable program have been determined.

The Forest Health strategic plan is compatible with the existing Silviculture five-year strategic plan. The document contains a description of the program, its mandate, history, organisation, staffing and delivery. A vision and objectives for forest health are also stated. Measurable goals are listed given alternative levels of funding and district staffing. A package of goals is recommended which would maximize economic returns, along with creating a large number of direct and indirect jobs.

We are confident that this strategic plan will give the forest health program clarity both for the program staff and for those who might be affected by it. It should be of considerable assistance in gaining funding support over the next few years.

When complete, copies of the strategic plan may be obtained from the Silviculture Branch in Victoria.

- J. Henigman, Silviculture Branch, Victoria.

Nursery Pest Management Update. The Nursery Extension Services Section has now settled into our new facility at the Green Timbers Reforestation Centre. We have our own building which we share with the Coast Nursery Administration Centre. The facility includes offices, a conference room, a lab and three test greenhouses.

This summer British Columbia hosted the annual meeting of the Canadian Forest Nursery Weed Management Association in Victoria. This association coordinates the preparation of data necessary to register and use weed control agents across Canada. It is an effective medium to exchange ideas, information and new technology. A meeting is held in a different province each year.

Dr. Paige Axelrood of B.C. Research was contracted to conduct a nursery study to evaluate possible sources of ***Cylindrocarpon*** and ***Fusarium*** inoculum, assess the influence of cultural practices on root infection, identify pathogen isolates to species, assess pathogenicity of the fungal strains found, and assess the seedling morphology at the end of the growing season. Seedlings with high and low ***Cylindrocarpon*** root infection will be selected for further evaluation on reforestation sites. The project will be finished in March, 1993.

Studies with naturally occurring pesticides are continuing. The insecticide neem which is derived from the Asian neem tree proved to be effective at controlling larvae of the variegated cutworm and was not phytotoxic to conifer seedlings. Citricide, a fungicide produced from the seed of grapefruits, appeared to reduce ***Botrytis*** infection and was also nonphytotoxic.

A large trial was conducted with the growth regulator paclybutrazol. It is hoped that this product will improve survival of seedlings by increasing resistance to drought. It also has application for nursery use because it induces bud-set and can help growers by ensuring stock has become dormant and ready to lift. Initial results have been promising but more work is needed to refine the timing and method of application.

Keithia foliar blight of western red cedar continues to be a significant problem for coastal nurseries. Surveys of infested stock in reforestation sites have shown that survival is poor. This year an extensive program to study the biology of the disease was conducted. Initial results show that keeping the foliage dry reduces Keithia survival, that the disease can be found on one-year and two-year old seedlings, and that applications of the fungicide Dithane® are effective at preventing infection, but only when applied at regular intervals throughout the growing season.

- G. Shrimpton, Surrey Nursery, Surrey.

Coastal Forest Health Training. Advanced Forest Health training for Ministry of Forests district forest health specialists is under development, and will soon be available within Vancouver Forest Region.

This pilot project was spearheaded by Vancouver Regional staff to provide specialists with the information they need to implement the district forest health program. Silviculture Branch will provide technical assistance and funding support, as well as ensuring that the project has provincial significance and can be easily modified for other regions.

The course will cover such items as planning, budgeting, impacts on harvesting levels, administration of forest health surveys and contracts, and damage prediction.

For further information, please contact Jeff Fournier at 660-7654.

- K. Hopkins, Silviculture Branch, Victoria.

Information Systems Initiatives.

Forest-Level Multipest Survey Trial in Arrow Timber Supply Area

During the months of October/November, 1992, a multipest survey trial was conducted in the Arrow Timber Supply Area with cooperation, contract management and funding provided by Nelson Forest Region (contact: Rick Stewart). Sampling methodology was based on an "inventory" type of sample which included height, dbh and forest health data for individual trees on both point (prism) and fixed-area plots. For this trial, a "cluster" of 16 plots, 20m apart, arranged in a square configuration was randomly located in a forest cover polygon. The sample polygons were chosen using the Forest Inventory Reporting (FIR) software which allows systematic sampling from a sorted list weighted by polygon area. Data from the Arrow trial must still be compiled and analyzed to develop a final, operational methodology which will address such questions as how many plots to use per cluster, whether to use point or fixed plots or a combination of both , etc. In addition, the field procedures will be reviewed with the contractor to determine whether or not greater data capture efficiencies can be obtained.

Currently the data collected in the forest-level survey is part of the Logical Data Model being developed as part of the Forest Health Business Area Analysis recommendations.

This trial resulted from the cooperative efforts of Stefan Zeglen, Rick Stewart, Patricia Humphreys, Jeff Beale, David Caverly (Ernst & Young) and Kim Iles (Kim Iles and Assoc.). For further information please contact Val Fletcher or Patricia Humphreys.

Forest Health Project Tracking Prototype

During the fall/winter of 1991/92, as part of the Forest Health Business Area Analysis Strategy, we undertook a project to determine a project management mechanism for the forest health program that would most effectively manage and track project activities against their objectives and budget.

Silviculture Branch requested Victoria Compucon Consultants to study the project management requirements of the forest health program. Two of the objectives of this study were to:

- make recommendations on the suitability for forest health of the project management components of existing Ministry systems (e.g. Integrated Silviculture Information Systems (ISIS));

- review the applicability of "off the shelf" project managment packages;

Functional and information requirements of Forest Health were determined through interviews with selected Forest Health staff at branch, regions and districts.

Some of the recommendations made by Compucon Consultants were, "Forest Health should take advantage of ISIS for their annual and 5-year planning, project definition and plan tracking. This would require both enhancement and a new development in ISIS."

Also recommended, "A project management package...should be optionally provided to districts/regions who require a tool for managing delivery of their projects..." and, "A download from ISIS should also be provided to 'populate' the chosen package."

In view of these recommendations Silviculture Branch has now initiated Phase II of this project - i.e. the development of a project management prototype.

This project will involve the determination of specific fields of data and the mock-up of corresponding screens for 5-6 of the most important, key, or most common Forest Health projects.

So far, we have gathered information from a cross-section of regional and district staff on the types of forest health land-based projects that are being managed on a daily basis. Particular thanks are extended to Dave Piggin, forest health officer in the Kamloops Forest District, who has provided us with valuable input on forest health project managment requirements at the district level and systems already being used in the Kamloops Forest District.

Forest Health project templates have now been developed on Microsoft Project. These will be further refined during a "hands-on" session to be held in the Kamloops Forest District office in December.

From this groundwork a very flexible and versatile project tracking tool will be produced that can be easily used by forest health staff to help improve the operational efficiency of the provincial program.

GIS Prototype

Some initial "proof of concept" work was initiated by Stuart Taylor of the Prince George Forest Region on the representation and analysis of spatial forest health data in the Robson Valley Forest District. Several mapsheets showing weevil, root rot and bark beetle polygons and associated attributes have been entered into a Geographic Information System (GIS), merged with the associated forest cover polygons and analyzed. Contact S. Taylor or V. Fletcher for further information.

- V. Fletcher and P. Humphreys, Silviculture Branch, Victoria.

ENTOMOLOGY

Assessing the Benefits of the Mountain Pine Beetle Control Program. A contract is underway with Phero Tech and Deloitte and Touche to assess economic benefits of the mountain pine beetle control program. This assessment will consider economic utility to the province and the local employment created. Both timber and non-timber resources will be considered. Issues addressed in the consultants final report will include:

- the short and long term benefits of a control program as these relate to the costs of maintaining the program;
- the costs and benefits associated with the proposed control program;
- a forecast of the average level of resources needed to maintain the proposed program; and
- a proposal for a rational control program utilising all or some combination of current treatment options.

The report will provide a template for analyzing other forest health programs. This project will be completed by April, 1993.

- J. Henigman, Silviculture Branch, Victoria.

Western Balsam Bark Beetle - Tree Killer or Natural Recycler? On October 19th and 20th, Dr. Art Stock, forest entomologist in the Nelson Forest Region, presented his Ph.D. thesis results to staff of the Bulkley and Morice Forest Districts and to the forestry staff of Northwood Pulp and Paper's Houston operation. Balsam bark beetle is a serious problem in Bulkley and Morice Timber Supply Areas (TSA's) because subalpine fir comprises 61% of the timber in the Bulkley TSA and 33% in the Morice TSA. In both areas, western balsam bark beetle, ***Dryocetes confusus,*** is killing significant volumes of overmature subalpine fir. Recently, the Forest Insect and Disease Survey Unit of Forestry Canada estimated that in the Bulkley Forest District an average of 30% of the mature volume in age class 8 and 9 subalpine fir stands is dead.

Art's research results have indicated that exo-brevicomin is an effective aggregation pheromone that can be used to concentrate balsam beetles. Baiting strategies need to be developed to utilize this new tool. He also demonstrated that endo-brevicomin successfully prevented trap logs from being attacked and may have a good future as an anti-aggregant. Endo-brevicomin may be useful for protecting high value stands. Ski hills and parks located in the Engelmann Spruce Subalpine Fir Biogeoclimatic Zone (ESSF) are probably the most likely places for the use of this technology.

An interesting discussion on the management of heavily damaged ESSF stands followed Art's presentation. These stands contain very low volumes of sawlogs due to the high proportion of dry snags and heartrot. Regeneration of high elevation stands has proven to be difficult. However, subalpine fir regenerates naturally in small openings in the climax forest. The western balsam bark beetle kills large diameter fir in discrete patches thus favouring fir regeneration.

Perhaps the most ecologically sound method of managing ESSF stands is to mimic the beetle and use group selection to favour natural regeneration. Unfortunately, economics do not favour this approach unless the low value wood can be inexpensively removed in the first logging pass. In stands that have very low volumes of live merchantable wood, it was suggested that the timber be left alone for 60 years to permit the natural regeneration to become merchantable. Such stands would have to be identified through a re-inventory to permit long range TSA planning.

The Western balsam bark beetle will continue to be a major killer of climax subalpine fir forests. However, these stands have probably sustained themselves for centuries. Rather than fighting nature, the most sound approach to managing these stands may be to mimic the beetle and use uneven-aged group selection logging over entire drainages in the ESSF.

We thank the Nelson Forest Region for permitting Dr. Stock to speak to staff in our Region.

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

White Pine Weevil Symposium Proceedings Still Available. Proceedings from the March 12, 1992 Spruce Weevil Symposium in Terrace are available from Tim Ebata (847-7479). The proceedings summarize the presentations and the following discussions of the following speakers:

- Dr. John McLean, University of British Columbia Forestry - Weevil Biology and Overstory Shading Trials
- Dr. Cheng Ying, Ministry of Forests, Research Branch - Genetic resistance to weevils in Sitka spruce.
- Dr. Rene Alfaro, Forestry Canada - Damage appraisal
- Dr. Michael Hulme, Forestry Canada - Biocontrol
- Stuart Taylor, Ministry of Forests, Prince George Forest Region - Hazard Rating
- Gerry Fraser, Canadian Pacific Forest Products - Stem Injected Pesticide Efficacy and the Vancouver Forest Region's Hazard Rating System
- Kevin Derow, Skeena Cellulose Inc. - Industry's Perspectives of the Weevil problem
- Kim Hayworth, Pacific Regeneration Technologies, - Cost/Benefits of Rehabilitating Weevilled Plantations.

The purpose of the symposium was to encourage industry and Forest Service staff to generate some ideas about managing the Kalum Forest District's vast area of weevilled Sitka spruce plantations.

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

Can Insecticide Treatments for White Pine Weevil Be Economic? As a result of the March 12, 1992 Spruce Weevil Symposium, a simple computer program was created that calculates the net future revenue of various silvicultural treatments, including periodic stem injections, for white pine weevil control.

Volume estimates from a Prince Rupert-calibrated version of Dr. Rene Alfaro's SWAT (Spruce Weevil Attack Trial) model were used to estimate the merchantable volume of stands attacked at rates that approximate those observed in the Kitimat Valley. From the economic analysis presentation by Kim Hayworth, stand establishment and tending costs and timber value estimates were obtained and were used to estimate the net future revenue of the infested stands using a program written on Excel software. The program was developed by Brad Pollard, Summer Youth Employment student, who called it WISTIP (Weevil Infested Stand Profitability Program). To simulate the effect stem injection treatments would have on weevil populations and volume losses, several treatment scenarios were developed and were run through the SWAT Prince Rupert model. The resulting volumes and costs for treatment were put into the WISTIP program and the net future revenue was calculated.

The result was that, in this particular set of circumstances (i.e. Kitimat Valley attack rates, 4% discount rate, $\$50/m^3$ wood value, etc.), net future revenue was maximized if a single stem injection treatment was done on each stem at age 16. This single treatment nearly tripled revenue over stands that were not treated ($3,626 vs. $1,289/ha) but was only one third ($8,708/ha) of the potential revenue from unattacked and untreated stands. Earlier treatments had less effect on weevil damage and the costs were compounded for a few more years. Increasing the number of treatments increased volumes but compounded treatment costs impacted on revenues.

This analysis shows that insecticide stem injections presently being tested by Gerry Fraser of Canadian Pacific Forest Products, and Don Heppner of the Vancouver Forest Region, are theoretically profitable under the simulated conditions. A sensitivity analysis of the calculations should be performed in the future and the process repeated when SWAT/TASS volume estimates are available. The assistance of Dr. Rene Alfaro and George Brown of the Pacific Forestry Centre in supplying the SWAT data is greatly appreciated.

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

Boron Rods Are In... But the Jury is Still Out. A test of Impel boron rods, which are crystalline 10 x 100 mm rods made of anhydrous sodium octaborate, was performed this summer in the Bulkley Forest District by Simon Fraser University co-operative education students, Larry Davis and Brenda Drummond. This trial was also replicated in the Prince George Forest Region. The objective was to determine the rate, timing and efficacy of the rods against the development of newly established mountain pine beetle brood. The rods were developed for protecting timbers and power poles from wood rotting fungi but they also have insecticidal effects on wood boring insects. It was hypothesized that the rods would hamper brood survival and development by either preventing the establishment of the symbiotic blue-stain fungi or directly killing the brood.

Pre- and post-attack treatments were established in two leave strips that were heavily attacked by mountain pine beetle. Pre-attacked trees were treated two weeks before pheromones were placed, and post-attacked trees were treated exactly one week after the tree was mass attacked. In each area there were ten control trees, ten trees inserted with four rods and ten with eight rods. The rods were inserted into holes made by a rechargable electric drill with a 9/16" spade bit. The holes were then sealed with silicone bathtub caulking. In the post-attack treatment only, a further ten trees were treated with 12 boron rods and ten trees with eight rods but they were treated two weeks after mass attack. As well, another ten trees were treated with the liquid boron formulation called Boracal 30®.

Increment cores were taken from 16 post-attacked treatment trees. Cores were taken radially to determine if staining had developed in the sapwood. Some staining was present in all samples but in varying intensity. These results do not allow us to reach any preliminary conclusions about the efficacy of these treatments. Next summer, beetle brood and fungal development will be assessed in greater detail and results will be published in the fall 1993 edition of Forest Health Progress.

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

Boron for Mountain Pine Beetle Control in the Prince George Forest Region. Under a Special Use Permit from the Pesticide Management Branch, solid and liquid formulations of boron were tested against mountain pine beetle in lodgepole pine in the Vanderhoof Forest District. Similar cooperative trials were also undertaken in the Prince Rupert Forest Region. Boron is a relatively safe fungicide and wood preservative which may restrict or prevent the growth of the blue stain fungi, ***Ceratocystis montia*** and ***Europhium clavigerum***. The latter are vital to the maturation of young mountain pine beetle adults.

In July, 1992, 10 semiochemically-baited lodgepole pine trees in each of two locations were injected with 100 mm solid rods of ***anhydrous disodium octaborate*** (Timbor) in densities of 8, 10, or 12 rods per tree. A rechargeable drill was used to bore lateral holes around each tree's circumference so that the inserted rods bisected cambium 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 untreated to serve as checks. There were no significant differences between total attacks on boron-treated and untreated lodgepole pine.

The second and main trial 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 each of two sites were treated with Boracol 30 between July 29 and August 5. An additional 22 semiochemically-treated and infested lodgepole pine 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 as an operational treatment.

Efficacy sampling will be conducted in late spring on the two experiments to assess boron toxicity to mountain pine beetle parent adults, larvae, pupae, and immature adults. Cambium and foliar samples will be taken from various portions of treated trees to assess boron residues and mobility. A pre-attack injection trial using Boracol 20 and Boracol 30 is planned for 1993. For further information, contact the undersigned.

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

White Pine Weevil Hazard Ratings for the Prince Rupert Forest Region. Following the methodology for Prince George Forest Region's hazard rating developed by Brian Sieben, Dave Spittlehouse and Stuart Taylor, a degree-day based hazard rating was performed for the Bulkley, Kispiox and Kalum Forest Districts by Simon Fraser University co-operative education student, Larry Davis. At this time, the analysis has only been completed for the Bulkley Forest District and has been hampered by the lack of suitable weather data.

As suspected, weevil damage is unlikely in the Bulkley Forest District, except in low valley bottoms, mainly along the Highway 16 corridor. Hazard ratings will be completed for the other districts by the end of November. However, to improve the resolution of the hazard ratings, requests for the necessary daily maximum and minimum temperature from fire-weather remote weather stations have been made for the 1993 fire season. These data will be used to update the hazard rating maps over the next three growing seasons.

Hazard ratings, once verified with ground survey data, will become an essential tool at the pre-harvest silviculture prescription stage for assessing the risk of white pine weevil infestations on spruce plantations.

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

Cariboo White Pine Weevil Clipping Project Completed. A five-year white pine weevil control project, begun in 1988 at Antoine Lake in Horsefly Forest District was completed in August, 1992. The 38.5 ha plantation is surrounded by mature forest so it is a relatively isolated trial site.

Infested spruce leaders were clipped every year in late July and placed in barrels covered with plastic screens. The barrels were hung in the plantation until the following spring to permit emergence of beneficial parasites and predators, while inhibiting the escape of weevils. The plantation was completely clipped twice each year. The average cost for clipping in 1992 was $365/ha. The plantation in 1988 had a current attack level of 7.2%.

From 1988 until 1991 the number of infested leaders was reduced overall by 25%. However in 1992, infested leaders increased by 62%, due partially to the very mild winter and some damaged barrels, which permitted weevil escape. Overall, the number of infested leaders increased 7.5% from 1988 to 1992. Clipping did not reduce the infestation level significantly over the five-year period. However, it did reduce the infestation level compared to unclipped plantations.

Clipping to control weevils does not appear to be feasible because of a number of factors. The cost of clipping is prohibitive, especially because it should continue until the trees reach a height where weevil attack is negligible, which could take fifteen to twenty years. The difficulties involved in mounting large scale clipping projects are daunting. The clipping window in the Cariboo Forest Region is roughly three to four weeks which does not permit much management flexibility. All adjacent plantations containing significant spruce components would have to be completely clipped to inhibit weevil spread. This would mean clipping whole valleys or watersheds.

Any delay in clipping infested leaders may be critical and endanger years of effort and investment. Supervision must be intense and clipping personnel must be of high quality, well motivated and trained in identification of white pine weevil damage. Damage to barrels in the field may release hundreds of weevils back into the plantation, again jeopardizing years of effort.

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

Foliage Colour Change Plots in the Cariboo Forest Region. Foliage colour change plots were established in the Cariboo Forest Region to calibrate observations made during the aerial pest survey with actual attack on the ground. A large percentage of current beetle-attacked trees go undetected because the foliage remains green during the aerial survey. The aerial survey is conducted from late July until September. In plots containing Douglas-fir beetle infestations, only 18% of currently attacked trees were red by completion of the aerial survey. These results allow us to make more accurate projections of actual infestation levels for these problematic bark beetles.

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

Spruce Beetle Helicopter Logging - Nikwikwaia Creek, Kamloops Forest District. Nikwikwaia Creek is a major tributary of the Adams River system and is vital to the world famous Adams River Salmon Run. Terrain instability, hydrologic factors, harvesting, and a 45-hectare spruce beetle outbreak have combined to create some interesting challenges for silviculture and forest health.

The spruce beetle infestation is located on steep unstable slopes (60-85%), in inaccessible areas, and along critical streams where conventional harvesting techniques are not permitted and single tree disposal methods such as fall and burn ($175/tree) or MSMA lethal trap trees ($30/tree) were the only available options. Although single tree disposal using a helicopter was considered an acceptable option, the cost of using this method is more than $200/tree.

In the spring of 1992, MSMA lethal trap trees were felled in the Nikwikwaia Creek area. A timber sale by forest health staff, issued under Section 16 of the Forest Act, took place in the fall of 1992.

Tundra Helicopters Ltd. was the successful bidder. They plan to use a Bell 204.5 helicopter to yard the logs. Spruce was sold for $0.45/$m^3$ bonus bid plus $0.25/$m^3$ upset. The volume tendered was 925 m^3.

By developing and utilizing helicopter logging techniques in Nikwikwaia Creek the Kamloops Forest District hopes to:

- incur "revenue" rather than program "costs" through helicopter logging;
- reduce the use of MSMA;
- reduce unsalvaged losses from single tree disposal methods; and
- develop helicopter logging as cost effective option for bark beetle control projects.

Although helicopter logging is an operational reality in many forest districts, the Nikwikwaia Creek project marks the first time helicopter logging through bonus bid has been attempted in the Kamloops Forest District. In 1993 and 1994 the District plans to expand the helicopter logging program to include other critical areas.

- D. Piggin, Kamloops Forest District, Kamloops.

Seed Orchard Pest Management Report -- 1992. In April 1992, Robb Bennett replaced Don Summers as Seed Orchard Pest Manager (auxiliary appointment). He is continuing and expanding Don's work with the able assistance of Bev McEntire and Michelle (Schmidt) Hall. Seed Orchard Pest Management can be reached at 387-3931 (office) or 652-7613 (lab).

Coast Orchards:

Green Spruce Aphid, ***Elatobium abietinum*** -- Because of the warm winter, green spruce aphid got off to an early start this year and consequently all coastal spruce orchards had problems. Phytotoxicity with Safer's soap **appears** to occur after the **second** spray and shows up within 48 hours. Coccinellid beetles or Ladybird beetles, have been released on spruce on a trial basis against green spruce aphid at Canadian Pacific Forest Products Nootka orchard.

Douglas-fir Cone Midge, ***Contarinia oregonensis*** -- Three coastal orchards (Koksilah, Quinsam, and Sechelt) had significant levels of this insect this year. No foliar sprays were used; instead trees were injected with MSR. Efficacy has yet to be evaluated. In conjunction with a student at Simon Fraser University we are looking at nematodes to aid in controlling this insect.

Hemlock Woolly Aphid, ***Adelges tsugae*** -- Hemlock orchards at Western Forest Products Lost Lake, MacMillan Bloedel Ainscough (containers), Canadian Pacific Forest Products Saanichton (containers) and Canfor Sechelt had significant to heavy populations of this aphid. Preliminary results of trials conducted at Lost Lake with Safer's, Trounce®, Cymbush®, Ambush®, diazinon, dimethoate, and MSR suggest that all are effective against ***A. tsugae***. Evaluation of this trial is ongoing. Timing of application, particularly with contact insecticides, is critical. Aphids must be in the active crawler, unwoolled, stage. It is important to use **fresh** stock, especially with Safer's products, because of chemical instability.

Balsam Woolly Aphid, ***Adelges piceae***, and Balsam Twig Aphid, ***Mindarus abietinus*** -- Diazinon was effective against both these insects in the ***Abies*** spp. orchards at Saanich and Canadian Pacific Forest Products Nootka. Coccinellids have been released on ***Abies*** spp. in cage trials against both aphids at Nootka.

Yellow Cedar Eriophyid Mite, ***Trisetacus chamaecypari*** -- This mite continues to be a problem in pollen cones and foliage of the young yellow cedar orchard at Canadian Pacific Forest Products Saanichton. A trial using a formulation of Sevin XLR +® with a very fine particle size and two species of predaceous mites has been initiated. Preliminary results with the Sevin trial show a variable amount of success in reducing the population.

Spruce Budworm, ***Choristoneura* spp.** -- Spruce budworm showed up on hemlock cones at FC Mt. Newton and Canadian Pacific Forest Products Saanichton in low numbers this year and caused insignificant damage.

Seed Bug, ***Leptoglossus occidentalis,*** and Fir Coneworm ***Dioryctria abietivorella*** -- Fir coneworm was universally present in Douglas-fir at low levels but no orchards appeared to suffer significant losses to this insect. At Canfor Sechelt coneworm was present in hemlock cones at very low levels (< 1%). This was a novel occurrence. Seed bug was common in Douglas-fir and hemlock orchards at all sampling locations. Life history data and methodology for evaluating impact for both these insects are poorly understood and make monitoring/management a difficult issue.

Interior Orchards:

Larch Woolly Aphid, ***Adelges lariciatus*** -- This aphid, new this year to the interior, was observed on larch cones at Kalamalka. The aphids were found mostly under scales on the margins of seeds but did not appear to cause much damage. This insect was monitored bi-weekly during the maturation of the cones. Evaluation of the effects of larch woolly aphid on this year's seed production is pending. This aphid may become a continuing problem at Kalamalka due to the proximity of the larch orchards to spruce, its primary host.

Gall Aphids ***Adelges cooleyi, Pineus similis,*** and others -- At Skimikin, sprays of thiodan and dormant oil successfully reduced populations of gall aphids in the interior spruce orchards. No phytotoxic effects were noticed.

Spruce Budworm, ***Choristoneura occidentalis*** -- The Kamloops Forest Region staff sprayed ***B.t.k.*** aerially over Skimikin as part of their spray program for the forests of the area. Seed orchard staff also applied ground sprays of ***B.t.k.*** to the spruce orchards and container trees. Subsequent monitoring indicated that the applications were successful.

Spiral Spruce Cone Borer, ***Strobilomyia anthracina*** -- Laboratory trials using nematodes against maggots collected from Skimikin spruce cones were done at Saanich this year. Results of these trials indicate that spiral spruce cone borer is a suitable host for the nematode. There are, however, some concerns about the performance of the nematodes under field conditions (i.e. inability to survive, infection of non-target organisms, etc.)

Spruce Cone Rust, ***Chrysomyxa pirolata*** -- Spruce orchards were sprayed with ferbam this spring at Skimikin. A trial with a less toxic fungicide, Polyram®, is in the planned for next year.

White Pine Weevil, ***Pissodes strobi,*** in Spruce -- White pine weevil was monitored in spruce progeny trials at Prince George again this year. The parasite enhancement program has had some operational difficulties and has been dropped for the time being. Leaders are still being clipped but instead of being stored in screened barrels they are simply burned. Levels of infestation are similar to last year. Leaders were collected and have been placed in rearing facilities at Pacific Forestry Centre to check parasite levels.

Pine Needle Sheath Miner, ***Zelleria haimbachi*** -- This caterpillar caused extensive damage to lodgepole pine at Fletcher Challenge Eagle Rock this year. The orchard is inactive at present and no control measures are planned. Sprays of ***B.t.k.*** effectively controlled this insect at Kalamalka.

Seed bug, ***Leptoglossus occidentalis*** -- Significant populations of adults were noted early in the summer in spruce orchards at Fletcher Challenge Eagle Rock and Kalamalka.

- R. Bennett, Silviculture Branch, Victoria.

Cariboo Forest Health Aerial Survey. The annual aerial pest survey in the Cariboo Forest Region was completed on October 15, 1992. The survey was coordinated by University of Victoria co-operative education student, Kerri Howse. Mapping was done by regional and district Forest Service staff.

The entire Region was sketch-mapped on 1:40 000 forest cover maps from fixed-wing aircraft flying a north-south grid. Flight lines were two kilometres apart for high priority areas, and four kilometres apart for low-priority areas.

A mountain pine beetle outbreak at Chilko Lake has spotted outside the area treated in 1991. An infestation detected last year on the inaccessible Homathko River, also in Chilcotin Forest District, remained approximately the same size.

Over 500 spot infestations were discovered in other districts. Preliminary ground surveys indicate populations have increased by a factor of eight to ten.

Douglas-fir beetle damage has increased slightly. While this beetle is still causing significant damage in the Cariboo Forest Region, management priority rests with mountain pine beetle.

No significant spruce beetle damage was detected.

Damage by western balsam bark beetle was severe in Franklyn Arm and Edmonds Creek areas in Chilcotin Forest District. Other infestations occurred throughout the Region.

Defoliation by western hemlock looper was heavy in the Quesnel Lake area of Horsefly Forest District. This is the most severe defoliation by this insect to occur in the Cariboo in the last ten years.

Defoliation by two-year cycle budworm was moderate in the Quesnel, Horsefly and 100 Mile House Forest Districts.

Forest tent caterpillar caused moderate to severe defoliation in the Horsefly and 100 Mile House Forest Districts.

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

Infestation area figures will be available in mid-December.

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

Spruce Budworm and Spruce Beetle in the Fort Nelson Forest District. The Fort Nelson Forest District continues to have two major pests of concern: the spruce budworm, ***Choristonsura fumiferana,*** and the spruce beetle, ***Dendroctonus rufipennis.***

The spruce budworm is found throughout most of the District and historical records indicate it has been cyclic here since the first surveys of the 1950's. For the second consecutive year populations have declined in our district. The area of budworm infestations fell 46% from 1991 to 132 000 ha of light defoliation in 1992. Overall drop in area affected by the budworm since 1990 is 266 000 ha. There were no areas along our major river systems mapped out containing moderate or severe defoliation. The light defoliation is along the Fort Nelson River north to the Liard River and into the North West Territories. Defoliation has also been recorded along the Liard River west to the Liard Hot Springs and Coal River. The area of highest budworm concentration is along the Fort Nelson River between Kula Creek and the Snake River. Control activities are detailed in the adjoining article.

The spruce beetle infestation continues in the Kotcho Lake area where it has been endemic since 1987. The primary objective of the licensee, Tackama Forest Products Ltd., will be sanitation harvesting of currently attacked spruce rather than salvage logging of trees killed by the beetle in 1990 or previously. Additional probing will be required to better stratify infestation levels and to prioritize harvesting of beetle-infested stands.

Trap trees felled in pre-developed stands appear to be working fairly well with moderate densities of beetle broods which are comprised on average of 75% fourth instar larvae, 20% pupae, and 5% callow adults. The trap tree program will continue for at least the next three years in order to curtail the adult population.

- S. Matlashawski, Fort Nelson Forest District, Fort Nelson.

Aerial Applications of *B.t.k* Against Spruce Budworm in Fort Nelson Forest District. In June, 1992, approximately 570 hectares of mature white spruce seed production stands in the Fort Nelson Forest District were treated with double applications of the biological insecticide, ***Bacillus thuringiensis*** Berliner var. ***kurstaki (B.t.k.)***, in order to reduce defoliation by the spruce budworm, ***Choristoneura fumiferana***. Four locations, encompassing a total of six blocks, were aerially treated with 2.4 L/ha of Foray 48B® (12.7 Billion International Units/ha). The ***B.t.k.*** applications were to peak 3rd and peak 4th instar larvae.

The range of prespray larval densities on understory sample trees was approximately 6-9 larvae per 100 buds. There was a 35% population reduction after treatment, adjusted for natural mortality. Current defoliation in understory treated areas was 9% compared to 23% in the check block. Defoliation in mature canopies ranged from 3-11% on treated blocks compared to 32% on the check block. Defoliation over approximately 132 000 ha in the District was classified as light in 1992 by the Forest Insect and Disease Survey rangers of Forestry Canada. Mature canopy branch samples have been sent to the Pacific Forestry Centre for a determination of egg mass densities. Once the latter information is available, a decision will be made this fall as to whether these stands will be treated in 1993.

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

Kamloops Forest Region Douglas-fir Tussock Moth Program. Pheromone trap catches and ground surveys for Douglas-fir tussock moth, ***Orgyia pseudotsugata***, egg masses in 1991 indicated that moderate to severe defoliation could be expected in a number of areas within the Kamloops Forest District (Table 1). In cooperation with Forestry Canada (Dr. Imre Otvos), the Region treated 650 hectares of forest with Virtuss® nuclear polynedrosis virus (NPV). Three areas received a NPV dosage rate of 10 L/ha. Two of these, Dome and Indian Gardens (Table 2), received full coverage. Sabiston Creek was treated in 50 metre alternate swath intervals. The NPV was applied on June 3, 1992, using an Hiller 12E turbine helicopter equipped with four becomist nozzles and a hank flow meter. The cost per hectare of the spray helicopter was $34.95. Three or four post-spray larval assessments were done at two week intervals following the virus application. As a final assessment of efficacy, egg mass surveys have now been completed in most of the treatment areas.

Table 1 **Annual average Douglas-fir tussock moths caught in pheromone traps in five districts within the Kamloops Forest Region.**

	Forest District				
Year	Kamloops	Vernon	Penticton	Merritt	Lillooet
1988	8.1	3.5		5.6	
1989	9.2	6.4		6.8	
1990	17.7	26.0		14.7	6.4
1991	37.0	20.3	40.7	39.5	21.3
1992	29.9	14.8	39.7	25.4	27.3

Table 2 **Locations and area (ha) treated in 1992 with Virtuss (NPV) in the Kamloops Forest District.**

Area	Hectares treated	Application (10 L/ha)
Dome area	150 ha	total coverage
Indian Gardens	450 ha	total coverage
Sabiston Creek	50 ha	alternate swath

Results of post-spray larval sampling from two locations were very good. By the third or fourth sampling period, 80 to 100% mortality was achieved (please refer to Table 3A located in the Tabulations Section). Egg mass surveys in the five Indian Gardens sites indicated that no defoliation will occur in 1993.

The total area defoliated by the tussock moth was approximately 18 700 ha, with 400 ha being severely defoliated. All visible patches of defoliation occurred in Douglas-fir stands located between Kamloops and Spences Bridge, near Hedley. Ground egg mass sampling will be completed in all areas of the Region by late November. Results to date indicate that there may be a low level of natural virus in some populations, as indicated by very low numbers of new egg masses in areas which were moderately to severely defoliated. Although lower or static numbers of moth catches (Table 1) were made in most districts, sites within each district varied from increasing populations to decreasing populations. Therefore it looks as if the Region can expect another year of tussock moth epidemics. (Dave Calder has been our only victim to tussockosis so far!).

- L. Maclauchlan, Kamloops Forest Region, Kamloops.

Cryptic shelters. Our Forest Health Officer in Lillooet Forest District, Margot Hollinger, was seconded to the Kamloops Forest Region office for six months to assist in two aerial spray programs. Her enthusiasm, good humour and common sense was invaluable and appreciated by everyone who had the pleasure of working with her. During her time in the regional office she began a cryptic shelters project which she will be using as the basis of her Registered Professional Forester report.

Cryptic shelters were placed in five districts to monitor Douglas-fir tussock moth populations. These artificial pupation, or cryptic shelters have been tried by the USDA Forest Service and seem to be valuable in predicting the early stages of a tussock moth outbreak. The current system of pheromone trapping and sequential egg mass surveys is extremely good at detecting building populations of tussock moth, but many spots are still missed. If the cryptic shelters are located within a population epicentre, cocoons or egg masses will usually be found in them.

In 1992 one shelter was placed at each pheromone trap location. In 1993 we will be placing the shelters in a 50 X 50 metre grid pattern at trap locations where a population seems to be building but where egg masses have not yet been located.

Unfortunately, nothing was found in the Kamloops and Lillooet Forest District shelters, probably because they were placed too late in the life cycle of the insect. The results from the other districts are summarized below:

Forest District	Location	No. Shelters Placed	Results
Vernon	West of Kalamaka Lake,	38	1 egg mass
	Dixon Dam Road		1 cocoon
Penticton[a]	Cedar Creek	25	2 cocoons
	Ashnola Road		7 cocoons
Merritt	East of Princeton	28	1 egg massr
	Hubcap Place		1 egg mass

[a] Not all shelters have been checked in the Penticton District.

- L. Maclauchlan, Kamloops Forest Region, Kamloops.

Kamloops Forest Region Western Spruce Budworm Aerial Spray Program. The goal of the forest health program is to maintain and promote a healthy and vigorous forest. As the land base on which we are and will be able to manage our forest resource for timber harvesting is growing smaller the forest health program is becoming increasingly important. The program looks for sound and environmentally acceptable methods to manage pest problems in the forest ecosystem. These methods include planting and growing of alternate or mixed species; various site preparation techniques; stand manipulations such as spacing, pruning and canopy manipulation; prescribed fire; and the judicial use of pesticides.

The western spruce budworm, ***Choristoneura occidentalis***, is an endemic native insect of British Columbia which occasionally reaches epidemic outbreak levels in our forests. Since 1900, at least six outbreaks of western spruce budworm have occurred in southern British Columbia. In 1992 we saw the 26th consecutive year of significant defoliation in the Kamloops Forest Region, and the eighth year of the current outbreak. The current outbreak reached its peak, in terms of total area affected, in 1987, when over 820 000 ha were defoliated. Moderate to severe defoliation occurred on approximately one third of this area. The estimated area of defoliation for 1991 (385 600 ha based on Forestry Canada reports) was approximately half of that occurring in 1987 but about two thirds, or 240 750 ha sustained severe defoliation. In 1991, the most damaging defoliation occurred in the Vernon and Penticton Forest Districts.

Considering the lodgepole pine timber losses that are presently occurring due to the mountain pine beetle, ***Dendroctonus ponderosae***, particularly in the Okanagan Timber Supply Area, we cannot afford to have another pest threaten the harvesting schedule or watershed, recreational, and other resource values in our forests.

Past forestry practices in the Interior Douglas-fir ecosystems have exacerbated the impact of the budworm. Selective harvesting and exclusion of natural fires has removed much of the ponderosa pine component leaving a predominantly Douglas-fir forest. In a more natural scenario, frequent ground fires would kill much of the Douglas-fir regeneration, promoting a higher proportion of ponderosa pine on these sites. Due to improved fire suppression techniques, and little stand tending activities in these ecosystems until quite recently, very dense regeneration of almost pure Douglas-fir has occurred in many forest stands. Particularly threatened by budworm outbreaks, are the dense, suppressed understory and intermediate forest canopy layers. The budworm larvae move from the overstory trees to the understory canopy and continue feeding on this more vulnerable layer. In a single canopy stand, these larvae would normally fall to the ground and die. However, in a multi-canopy stand they land on these successive layers of foliage thus increasing their survival, population density, and overall fecundity. As understory layers have a smaller foliage complement, it takes fewer larvae to totally defoliate and kill these trees. This combination of reduced tree species mix, fire-exclusion, and dense understory and intermediate canopies has created a high-hazard environment in terms of the budworm.

Further enhancing the budworm problem is the fact that eight of the past ten years have had the highest average mean temperatures in recorded history. Lepidoptera are extremely responsive to temperature fluctuations, and this warming trend has been beneficial to their success and detrimental to the overall health of our forests.

The Process

Budworm impact is most severe in uneven-aged stands in the drier ecosystems. In ecosystems where even-aged management is an option, this silviculture system should be encouraged. In ecosystems where uneven-aged management is the desired silviculture system, or is the only option, the creation of species mosaics should be considered. Other silvicultural techniques such as underburning, spacing, fertilization and pruning could also be prescribed. However, in conjunction with **any** silviculture treatment, direct control in years of outbreak conditions must be considered. It takes many years to convert a stand to the desired long-term condition and in the meantime, protective measures must be taken. The goal would be to maintain the integrity of a true multi-age stand but at a greatly reduced density.

Strategy

The strategy for managing western spruce budworm is documented in the 1991 Kamloops Forest Region Forest Health Plan. A brief synopsis of the management sequence is as follows:

1. Perform annual aerial detection surveys - map all budworm activity and categorize into areas of light, moderate and severe defoliation.
2. Document the integrated resource management (IRM) objectives for affected and susceptible areas.
3. Determine potential impact of the budworm on IRM objectives and make long-term forest health management plans (i.e. spacing/thinning, selective harvesting, fertilization, species conversion, etc.).
4. Prioritize areas for direct control (i.e. select stands which are most valuable in terms of IRM) and plan operational spray program.
5. Monitor egg masses in late summer/fall to verify that population will be in a given area the following year. This should be performed in conjunction with planning a control program. Areas chosen for sampling are prioritized according to integrated resource values and the history of budworm activity.
6. Prepare pesticide permits and start organizing the aerial spray program, including a public information/relations program.
7. Conduct spring second larval instar sampling to verify that populations are still as predicted.
8. Conduct aerial insecticide application and population monitoring/assessment.

Purpose of Treatment and Pesticide

The objective of the Kamloops Regional aerial spray program is to reduce the damage caused by the western spruce budworm in priority areas; **not** to eradicate the budworm. The pesticide chosen is ***Bacillus thuringiensis*** Berliner var. ***kurstaki (B.t.k.)***. ***B.t.k.*** is specific to Lepidopterans and has no harmful effects on non-target organisms or the environment. ***B.t.k.*** must be ingested by the insect to be effective and has a very short life in the field. The product chosen for the project, Foray 48B®, produced by Novo Nordisk Bioindustrials Ltd., is a water base formulation. The Foray 48B label was changed recently so that the avoidance of spraying over water is no longer required, even though in our application (as per the permit requirements) we **do not spray over water bodies.** This label change arises from the research done in eastern Canada where ***B.t.k.*** is sprayed in forests and recreation areas for control of eastern spruce budworm and gypsy moth. The research has shown there is no risk to fish or their insect food from ***B.t.k.***

We chose Foray 48B for the following reasons:

1. The Foray formulation is water based and has no stickers, spreaders or other additives to enhance its persistence. Foray relies on starches and sugars used to grow the organism. The starches and sugars are safe for human consumption. A variety of reports have been published on the allergenic and other medical effects of spray additives, none of which are present in Foray 48B.

2. Novo Nordisk is doing research and development in British Columbia to improve the effectiveness of our spray programs and to make their product suit the particular habitats and problems unique to Kamloops area forests.

Treatment Method and Timing

The 1992 ***B.t.k.*** application was done using four Cessna Ag-Cats, equipped with six AU 4000 rotary micronaire atomizers. Bell 206B helicopters were used to guide the spray planes and to monitor swath width and potential drift. The volume median diameter (VMD) obtained was 100-125 microns on average.

The ***B.t.k.*** was applied only when weather conditions were acceptable, i.e.:

- Wind speed averaging 8-12 km/h, or less
- Little or no precipitation for the eight hours prior to treatment
- Temperature $>2^{o}C$ and $<20^{o}C$ and relative humidity $>50\%$. (=Relative humidity must be above 50% to avoid evaporation and drift)

and when the insect development was optimum (peak 4th instar). Spray deposit was monitored with kromecote cards placed inside and outside of the spray blocks. Calibration of the 4 Ag-Cats was done at the Kamloops Air Operations Base.

Pre- and post-spray larval sampling was done in each spray block to assess efficacy of treatment. All other insect species present on the foliage during sampling was recorded, and their status (live/dead). Defoliation rating of 1991 and 1992 foliage was recorded at the time of larval sampling. All spray applications were done in the morning, starting at legal flying time (4:30) and continued as long as weather conditions permitted.

Ground crews were in constant contact with the Kamloops Air Operations Base or loading site, and with the helicopter spotter, who in turn was able to direct the spray pilots. Each block was marked with large helium-filled balloons to mark corners, block boundaries, water bodies and other landmarks of note. Aerial reconnaissance was conducted each morning prior to commencement of spraying to check that all balloon markers were in place and visible. Pilots were given an aerial reconnaissance of the spray blocks, maps, air photographs, and any other pertinent details prior to commencement of the spray program.

The spray program began on May 28th, and finished on June 12th, 1992.

1992 Results

A training session on all aspects of the budworm program was held in Kamloops in February, with the assistance of Stephen Nicholson from Novo Nordisk. Over 80 persons attended. Two public information sessions were held in the spring, one in Kamloops and one in Chase. The program was discussed at various user-group meetings in Vernon, Falkland, Lillooet, Kelowna and Penticton. Newspaper, radio and television media coverage of our program was extensive and very beneficial. Overall, the 1992 aerial spray program was very successful. A brief summary of the results are outlined below. Table 1 gives a recent history of spray programs in the Kamloops Forest Region. The 1992 ***B.t.k.*** application in Vernon was the first purely operational program. Before this time all applications of ***B.t.k.*** were operation trials to assess its efficacy in our particular forest types and to develop the most suitable procedures for achieving optimum foliage protection.

TABLE 1. History of aerial spray operations in the Kamloops Forest Region using *B.t.k.* products to reduce populations of the western spruce budworm

Year	Location treated with *B.t.k.*	Area treated
1986	Paul Lake Park (Kamloops Dist.)	200 ha
1987	Research plots & Paul Lk. Park (Kamloops Dist.)	890 ha
1988	Research plots (Kamloops, Salmon Arm), T.F.L. 49 (Vernon), Paul Lk. Park	1,849 ha
1989	Research plots (Salmon Arm, Penticton), T.F.L. 49	550 ha
1990	No program	0 ha
1991	Vernon District	3,000 ha
1992	Kamloops, Salmon Arm, Vernon, T.F.L. 49 (606 ha), Penticton, Lillooet Districts, Ellison Park, Paul Lk. Park	35,918 ha

Vernon Forest District was aggressive in proceeding with their program despite a lack of funding support and succeeded in opening the doors to the 1992 program. Table 2 summarizes the total areas treated in each forest district, or special area and the quantity of ***B.t.k.*** used.

TABLE 2. Summary of total litres of *B.t.k.* used and hectares sprayed throughout the Kamloops Region in 1992.

Treatment Location	Litres *B.t.k.*	Ha Treated
Kamloops District	22,518	9,383
Penticton District	8,154	3,398
Salmon Arm District	32,312	13,422
Vernon District	19,617	8,174
Lillooet	823	343
Research	800	333
Fletcher Challenge Canada	1,456	606
B.C. Parks	622	259
TOTAL:	**86,302**	**35,918**

The mortality caused by ***B.t.k.***. in the 1992 spray project was very good. ***B.t.k.*** is typically variable in terms of budworm mortality because of such factors as an uneven aged, multi-level forest canopy; a one-time treatment, rather than two spray treatments; and uneven insect development and early bud mining.

In our region, we evaluate our success based on three parameters, namely, insect mortality, reduction of defoliation of new foliage, and overall reduction in defoliation and increased tree vigor after sequential years of treatment.

Tables 3 and 4, located in the Tabulations Section of this issue of Forest Health Progress, summarize the results of the Kamloops Forest Region ***B.t.k.*** applications in terms of insect mortality.

The calculations for mortality only take into the consideration the number of live larvae present in each of the samples. In our sampling procedure, we also tally the number of "moribund" insects. These are infected with ***B.t.k.*** but have not yet died.

A preliminary cost breakdown of the 1992 aerial spray program is outlined in Table 5, also located in the Tabulations Section. Only the actual spray operations costs are listed. Various pre-planning activities such as egg mass sampling and second instar larval sampling are omitted. Many of the larger budget items such as the purchase of ***B.t.k.***, awarding of the aerial spray contract, and a regional contract for helicopter support are administered by the Region but funded by Silviculture Branch. Equipment is purchased through the Region and distributed to the districts accordingly. All contracts for ground crews and spray efficacy sampling are issued by the participating districts.

1993 Plans

The budworm population has moved again this season to new areas within the Region. The Merritt Forest District saw a significant rise in both area and intensity of infestation. The budworm has been a chronic problem in the Lillooet Forest District, but in the last two years it has moved beyond its historic range and has started to impact some high value stands. Therefore the Lillooet Forest District will be increasing its control program in 1993. The total size of the 1993 infestation will remain about the same as in 1992, but its location will change slightly. The proposed area to be treated with ***B.t.k.*** in 1993, by district, is as follows:

Forest District	Proposed spray area (ha)
Salmon Arm	5 000
Kamloops	8 000
Vernon	3 000
Penticton	3 000
Merritt	5 000
Lillooet	4 000
TOTAL	28 000

- L. Maclauchlan, Kamloops Forest Region, Kamloops.

FOREST PATHOLOGY

Five-Year Remeasurement of Regional Root Disease Trials. This summer three tomentosus root rot trial sites were remeasured for the first time since their establishment in 1986 and 1987. One of these sites is located near Tercer Lake in the Lakes Forest District. It was established in order to study the possible effects of tomentosus root rot on three different planted species (i.e. spruce, lodgepole pine, and Douglas-fir) during the life of the stand. Another trial, located near Atrill Creek in the Bulkley Forest District, was established to examine the success of spruce regeneration after destumping of a known tomentosus root rot site. Neither of these plantations is old enough yet to yield any results.

Another trial in the Bulkley Forest District focuses on the spread of ***I. tomentosus*** in a plantation established in 1963. Plots were established in tomentosus root rot centres in order to track disease spread rates and tree mortality over time. During the remeasurement, all trees within a 10 m distance from plot centre were mapped and will be evaluated at five-year intervals. Results from this year are being analyzed.

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

Tomentosus and Silvicultural Systems. One of the components of the Date Creek silvicultural systems trial involves the examination of the impact of tomentosus root rot on stands harvested using clear-cut and partial cut systems. Date Creek is located in the Interior Cedar-Hemlock (ICH) biogeoclimatic zone of the Kispiox Forest District. All of the 16 stands selected for various harvesting regimes were surveyed in early 1992 for tomentosus using a line transect survey. The survey was limited to external visual indicators and symptoms as no permanent damage to the trees was allowed. Surveyors were instructed to note all occurrences of tomentosus during the timber cruise.

This summer and fall, nine of the stands were harvested using systems which retained 0%, 30%, or 70% of the natural forest cover. Three more stands will be logged during the winter. Next summer, we hope to resurvey the transect lines and gather more accurate data on tomentosus by examining stump tops and coring roots. This data should allow us to compare the efficacy of three different survey methods - timber cruise, visual assessment root disease transects, and post-harvest surveys. Consideration will be given to establishing permanent plots in the partial cut and control stands to monitor root disease activity over time.

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

Decay Fungi in the northern Interior Cedar-Hemlock Biogeoclimatic Zone. As part of the stand reconstruction project undertaken by Phil LePage and Ian Cameron at Date Creek in the Kispiox Forest District, samples of dissected trees are being assessed for the presence of decay fungi. Species being examined include hemlock, spruce, lodgepole pine, true fir, cedar, and birch. After the trees are mutilated for wicked and unseemly research purposes, suspicious tree "cookies" are photographed and then shipped to Eric Allen at Pacific Forestry Centre in Victoria. There Eric attempts to extract viable cultures of decay fungi which may inhabit the wood.

It is hoped that the identification of successful cultures will allow an insight into how and when decay fungi are established in various tree species. Coupled with individual tree measurements, we may be able to reconstruct stand dynamics for Interior Cedar-Hemlock Biogeoclimatic Zone forests. Analysis of the photographs should indicate precisely how much stem wood is affected and how rapidly structural degradation occurs.

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

Workshop on Tomentosus Root Rot and Pine Stem Rusts. A summer workshop on tomentosus root rot and pine stem rusts was held near Houston in the Morice Forest District. The two-day workshop was conducted by Dr. Kathy Lewis of Industrial Forest Service of Prince George and arranged by the Continuing Education office at the University of Northern British Columbia.

The 20 industry, Forest Service, and contract personnel in attendance were treated to the latest information on identification, survey, and management techniques for both tomentosus root rot and pine stem rusts and cankers. Several field stops were scheduled in order to demonstrate techniques and allow theory to be put into practice.

The success of this workshop may spark more workshops that will focus on other regional problems such as dwarf mistletoes and decay fungi.

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

Pushover Logging in the Pendleton Lake Area. A stand located near Pendleton Lake has been selected for a pushover logging trial. The block has two different timber types, one with a spruce/pine/cedar component, and the other with a Douglas-fir/spruce/ cedar/hemlock component. The trees are 100-120 years old and 19-28 metres in height. The site classification is medium. The stand is highly infected with armillaria root disease, with 36% of the trees showing symptoms.

The area will be harvested using two systems: pushover logging in the infected area, and conventional logging in the other areas.

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

Depletion Plots Reveal Red Needle Retention Times For Dead Balsam. In the fall of 1986, regional inventory staff, under the direction of regional forest health staff, installed four permanent depletion plots in age class 8 balsam leading stands in the Bulkley Forest District. Each plot contained approximately 100 trees of all diameters and age classes. The intent was to determine the rate of balsam mortality caused by the western balsam bark beetle and the length of time that red needles were retained on the dead balsam. The maximum needle retention time has been estimated to be five years, based on observations by Don Doidge, Cariboo Forest Region pathology specialist. To determine the rate of annual balsam mortality using aerial detection is nearly impossible without an accurate estimate of average needle retention times.

After six years of remeasurements, it appears that the period of needle retention is highly variable and ranges from one to six years. This fall, 40 recently attacked trees (i.e. green and red trees containing live brood) occurring outside of the original plots have been added to increase the needle retention study sample size. This study will be continued for at least three years and next year will also include an assesssment of natural regeneration growth.

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

Armillaria Root Disease in the Cariboo Forest Region. The Cariboo root disease saga has come to an end. I know that all you people who have been following this stirring tale over the years will be disappointed, but as the cliche goes - "all good things"...etc. The main points have been made, namely that armillaria root disease is a major problem in some areas and that anyone taking actions that modify the forest ecosystem, such as harvesting, spacing, etc., should be aware that armillaria could confound their attempts at successful regeneration and/or enhancement. Armillaria is present in all the forest districts in the Cariboo Forest Region.

This summer a couple of survey methods were tested for ease and accuracy of armillaria detection. Both methods were successful, but one was much faster than the other.

At the start of the season a 100% survey was used. Survey lines were spaced 20 metres apart and every tree between the lines was examined. A lovely map was produced, but this method was extremely time consuming, and of course totally unnecessary in areas where no armillaria exists.

The other survey method involved the use of 100 metre spacing to determine the percent incidence of armillaria. If no armillaria was detected, then the block was considered to be free of the disease. If armillaria was found, a transect survey with lines 40 metres apart was performed and a sketch map was produced. For the majority of the blocks, the 40 metre transect and sketch map method was adequate.

A total of 12 blocks were surveyed during the summer in both unharvested and selectively harvested stands. Of these, 10 were in the Interior Douglas-fir (IDF) Biogeoclimatic Zone. Three of these IDF blocks were infected by armillaria, ranging from a 3-23% infection level. Two blocks in the Interior Cedar Hemlock (ICH) Biogeoclimatic zone were also surveyed. The ICH Pendleton Lake block, near Mahood Lake, had 36% infection.

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

Mitchell Bay Armillaria Root Disease Study Site. A block located at Mitchell Bay on Quesnel Lake was selectively logged in 1967 and planted in 1968. Its major timber types are Douglas-fir, birch, cedar, and spruce. The stand is 21-40 years old and 19-28 metres high with a medium site classification and a crown closure of 16-25%. In the past, this area has been the focus of many surveys. It has a high incidence of white pine weevil with 15% current attack, and over 50% cumulative attack in its spruce component. In 1982, Fred Newhouse suggested that no harvestable crop would result because of the weevil infestation. Newhouse also identified armillaria root disease and estimated that it was spreading at a rate of 70 centimetres per year from several infection centres. He recommended that the armillaria disease centres be surveyed and a buffer zone established by removing some of the Douglas-fir. If this was not done, he suggested that the block be used a a research plot to examine the effects of armillaria root disease on a plantation.

The block was surveyed again this summer and armillaria infection centres were found mainly on the northeastern part of the block. Armillaria centres occupied two hectares or 11% of the total area. Tomentosus root rot is also present on the site, occupying one hectare or 5% of the area.

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

The Pop-up Spacer. The Tree Max pop-up spacer has recently been tested in the Golden Forest District. Prior to working in the Golden Forest District, the Tree Max operators had already gained much experience in Invermere. After the hydraulics were fixed, and the operators were trained in silviculture needs and requirements, the productivity and quality of the work improved markedly. Improvements were often visible on a daily basis. Original costs were over $2500 per ha in stands that were marginally suitable for the equipment. By the time the operators left Invermere, costs had dropped to approximately $1200 - $1400 per ha.

The stand that was spaced in the Golden Forest District contained 3,000-10,000 stems per hectare of lodgepole pine. Approximately 15.5 hectares were treated in 94 hours. Pruning and pop-up spacing were done for an estimated cost of $1,030 per hectare. A time-motion study was performed on a 7 ha patch in the Golden area in early November by FERIC.

Silviculture Branch funded the $12,000 per month rental for two months. If the contractor were to purchase the Tree Max, the hourly rental would be around $40 per hour and the above mentioned per ha cost would be reduced to approximately $817.

In order to test this piece of equipment, Branch also supplied additional funds to have it transported from Sweden, installed, and provided with factory support.

Since this patented spacer is the only one of its kind that is designed to pull roots out of the ground, and thereby possibly control root disease at both the spacing and logging stage, I believe it was well worth the $50,000 investment made so far. It was envisaged that at the end of the two month trial, the Forest Service would decide if the equipment would do the job for us, and if so, the contractor would decide whether or not to buy the Tree Max.

Preliminary results indicate that it can space 2-3 m tall or taller stands effectively and economically, especially as its swampers, required by Workers Compensation Board and included in the all found cost, can also do pruning, fertilization, forage seeding or ungulate forage rejuvenation, at little extra cost. We need to test its selection harvesting capabilities especially in Douglas-fir/lodgepole pine stands where lodgepole pine is often infested with both mountain pine beetle, and armillaria root disease. Conventional selection harvesting and spacing techniques will continue to enhance our armillaria problem whereas pop-up selection harvesting provides a potential solution.

Further trials are planned in the Kootenay Lake Forest District Meadow Creek area where a 25-year-old Douglas-fir plantation is suffering 60% root disease mortality. Trials are also planned for two areas in the Boundary Forest District.

If both of these contracts go ahead the contractor can arrange to purchase the Tree Max and we can complete the tests we need to fully analyze the potential of this machine - the only machine that currently provides any potential solution to our root rot problems. The return on the investment to bring the Tree Max to British Columbia will also be maximized.

- D. Norris, Nelson Forest Region, Nelson.

MAMMAL DAMAGE

Vole Population Monitoring Projects. Two contracted projects are under way with University of British Columbia researcher, Dr. Tom Sullivan, to investigate vole population fluctuations. The locations of the sampling studies are Boston Bar, Chilliwack Mountain, Squamish and Kimsquit.

We are developing operational methods to sample vole population fluctuations. It is expected that with such methods, districts experiencing chronic vole damage could monitor local area population fluctuations and schedule planting to coincide with diminishing vole populations. If seedlings are allowed a chance to become established for at least a year or two before being damaged, they are much more likely to survive. As well, the application of an alternative food source, such as seeds, may be correctly timed using population monitoring information.

Reports from these two research projects should be available in the spring of 1993.

- J. Henigman, Silviculture Branch, Victoria.

Porcupine Tree Damage in the Nelson Forest Region. Tree damage, caused by porcupine feeding, is a concern to staff in the Nelson Forest Region. I was able to view an area in the Kootenay Lake Forest District where the damage was very severe. Jim Annunziello, District silviculture resource officer, indicated that such damage was quite widespread. Apparently porcupines prefer Douglas-fir, larch and pine but not western hemlock as they do in the Prince Rupert Forest Region.

Some monitoring for mammal damage, including porcupine, has begun in the Cranbrook Forest District, however, no quantitative information on mammal damage is yet available from the Region. There appears to be real interest in initiating monitoring projects in a number of the districts. Some of the monitoring methodologies developed in the Prince Rupert Forest Region may be applicable to Nelson.

- J. Henigman, Silviculture Branch, Victoria.

Squirrel Damage Control Studies in the Vernon Forest District. In the Vernon Forest District, feeding damage by red squirrels in spaced and/or fertilized stands of lodgepole pine has a serious impact on tree survival, growth, and yield. Damage to trees is currently being reduced by applying sunflower seeds during the period of damage, from May to early July, as a diversionary food, thus protecting susceptible stands. This treatment is now generally considered to be operational under most circumstances. Dr. Tom Sullivan of the University of British Columbia has been in charge of studies involving sunflower seed treatments.

The drawbacks of the diversionary food treatment include the ongoing cost of treatment and the potential of encouraging even higher population levels of squirrels.

Alternative ways to deal with the squirrel tree feeding problem are currently being studied by Walt Klenner, of the Kamloops Forest Region Research Section. He is attempting to determine whether it may be possible to reduce feeding damage by pruning stands and eliminating cover. The treatments should cause the squirrels to emigrate from the treated areas or be increasingly preyed upon by predators.

In the District, a number of lodgepole pine stands have been spaced and others spaced and pruned in order to attempt to drive the squirrels away. Some treated stands have been fertilized as well, to see how that may affect the squirrel's behavior. The treated stands will be compared to untreated or simply fertilized stands.

The objectives of this study are to evaluate the impacts of tree pruning, spacing, and fertilization on the extent and intensity of feeding damage by squirrels. During the study the level of feeding damage will be measured, squirrel behavior and survival will be studied, and tree growth will be measured.

- J. Henigman, Silviculture Branch, Victoria.

Small Mammal Population Monitoring in Partial Cuts. Do voles create havoc to seedlings in partial cuts as they do in some clearcuts? This question, among others more academic, spawned the small mammal population monitoring project that was performed this summer by Simon Fraser University Biology co-operative education students Troy Kimoto and Nicole Nordstrand. The monitoring occurred in 16 blocks established by regional research staff at Date Creek in the Kispiox Forest District. The Date Creek mega-project examined the effects of 100%, 70%, and 30% overstory removal on vegetation, wildlife, hydrology and other factors.

Longworth live traps were placed in 7 x 7 m grids in each block and eight blocks per week were sampled. Voles and mice caught in the traps were ear-tagged and then released. Trapping began in late May and continued until the first week of November. Trapping grids were removed prior to harvest and replaced one week after harvest to provide nearly continuous population estimates. Trapping will resume in April when the snow has melted and will continue in a similar fashion for the next four years. This is the first detailed tracking project examining harvesting effects on red-backed vole and deer mice populations. Preliminary results have shown an increase in vole populations in the clearcuts immediately following harvest which may be due to several factors. Another surprising result is the discovery of a vole migrating for a distance of over 1 km. A detailed establishment report and summary of 1992 trapping results will be available this winter.

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

Weasel Urine Dispensed in the Morice Forest District. University of British Columbia Forestry Wildlife Master's degree candidate, Linda Zimmerling, conducted a trial this summer to test the efficacy of a synthetic urine weasel attractant in limiting populations of voles in newly established plantations. The study was conducted near McBride Lake, 85 km south of Houston and consisted of several paired treatment and control blocks each containing 12 x 12 m live trap grids. The weasel odour was contained in plastic release devices that were spread over the plantations by hand. Unfortunately, vole populations were extremely low so the focus of the study was shifted to examining the effect of the attractant on the more abundant deer mice. Preliminary results indicate that deer mouse populations in the treated plantations were significantly lower than in the control plantations. Linda will be writing her thesis this winter and can be contacted through Dr. Tom Sullivan at the University of British Columbia Faculty of Forestry.

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

PESTICIDES

MSMA Insecticide Usage to be Reviewed. The insecticide MSMA, produced by United Agri Products (U.A.P.) as the product Glowon®, has been used for 10-15 years to control bark beetle infestations. MSMA is injected into bark beetle trap trees to kill the insects. The product was registered years ago in Canada and is used only in British Columbia for bark beetle control.

While there have not been any known problems with the use of MSMA in British Columbia, recently some concerns have been expressed about the chemical's environmental fate and toxicological properties. We have determined that the registration package for the product is deficient in study assessments compared to current Agriculture Canada registration requirements.

Because of similar concerns in the United States, the producers of MSMA have recently completed a number of important study assessments on MSMA to satisfy the needs of the U.S. Environmental Protection Agency. We expect to be able to review summaries of these studies soon.

U.A.P. plans to continue to make Glowon available and is encouraged by its parent company to expand the market for MSMA.

In a meeting held in Kamloops in October, various users of MSMA, and representatives of U.A.P., and the Pesticide Management Branch, reviewed the use of MSMA. It was agreed that a package of information would be developed to describe what is known about the chemical and to clarify its economic importance to forestry in the control of bark beetles.

The only practical alternative to the use of MSMA involves falling and burning the beetle trap trees. This technique is comparatively very expensive. Foresters would like to have other practical alternative treatment methods developed. As part of an agreement made at the Kamloops meeting, the development of alternative treatment methods will be pursued.

We are confident that MSMA will continue to be used effectively and safely in British Columbia for years to come. During this time, we plan to enhance our knowledge of the chemical and the best way to use it. As alternative treatment methods become available we will re-evaluate our MSMA usage.

- J. Henigman, Silviculture Branch, Victoria.

B.t.k.* Studies and Publications.** In the past months three new projects focused on the bacterial bio-control agent, ***Bacillus thuringiensis Berliner var. ***kurstaki (B.t.k.),*** have been undertaken.

A monograph summarizing all available published literature on ***B.t.k.*** has been written by Ms. Sandy Vanderveen, under the direction of Dr. Imre Otvos, of Forestry Canada. It is entitled Environmental Review and Current Status of ***Bacillus thuringiensis*** for Control of Defoliating Forest Insects. The document has been widely reviewed and will soon be published. We hope to have the document available in the next few months.

A publication entitled Microbiological and Epidemiological Surveillance Programme to Monitor the Health Effects of Foray 48B ***B.t.k.*** Spray has been jointly released by the Ministries of Health and Environment, Lands and Parks. The work was commissioned by the B.C. Forest Service and Agriculture Canada. The findings of the study, conducted during the time of the Asian gypsy moth control program in Vancouver, were that there were no public health affects identified as being caused by ***B.t.k.*** Further, the only health affects attributable to ***B.t.k.*** and noticed on personnel applying the spray were symptoms such as nose, throat and eye irritation, dry skin and chapped lips. No days of work loss were related to ***B.t.k.*** exposure.

A study contracted by Forest Health, to examine the effects of ***B.t.k.*** on an aquatic insect community is now being completed by Limnotek Research and Development Inc. The field portion of this work was completed this summer in a creek in the Port Renfrew area near Victoria. The research study involved assessing the toxicological impact of three dosages (normal operational rate, 10 times normal, and 100 times normal) of ***B.t.k.*** on various fish food invertebrate organisms commonly inhabiting British Columbia's west coast streams. The method of study involved the use of streamside flow troughs, containing a stream gravel substrate and colonized with naturally existing invertebrates. By applying different treatments to the troughs, it was possible to compare the impacts of the treatments on the stream organisms. The final report of this research will be available in the new year.

Information on these three ***B.t.k.*** projects is available from the author.

- J. Henigman, Silviculture Branch, Victoria.

Ciba Geigy Inc. Initiates Commercial Production of Trichogramma. During September, I visited a pilot plant in Guelph, Ontario, set up by Ciba Geigy Inc. to produce trichogramma parasitic wasps. Ciba Geigy is a large Switzerland based company that produces chemicals, pharmaceuticals and various pest control products. The company is interested in developing biological pest control products. This pilot plant, set up in collaboration with the University of Guelph, will be attempting to market trichogramma wasps as a bio-control product for agriculture and forestry insect control.

Trichogramma are very tiny chalcid wasps that parasitize the eggs of various moths and butterflies. So far, successful rearing of trichogramma requires the eggs of a live host, and this limitation has made commercial production of the wasps difficult. Ciba Geigy's current production involves growing the wasps on live hosts, however, they are very committed to developing an artificial egg for the wasps to use for egg laying. The trichogramma product is composed of parasitised moth eggs that are full of ready-to-hatch wasp eggs. Once liberated, the wasps quickly develop and seek out other moth eggs to parasitise. In temperate or boreal climates, that cover most of southern Canada, the wasp would not survive through the winter.

The current market for Ciba Geigy's wasps is European corn borer control. The company has long-range plans to expand production and offer spruce budworm control using the wasp.

- J. Henigman, Silviculture Branch, Victoria.

Recommendations of the Stakeholder Committee on New Directions in Pesticide Management. During the spring and summer of this year, the Pesticide Management Branch has facilitated the development of recommendations to substantially modify the pesticide management program.

A group of stakeholders was selected and over a few meetings reduced to the following members:

- B.C. Federation of Agriculture;
- Integrated Vegetation Management Association of B.C.;
- Professional Pest Management Association of B.C.;
- Alliance of B.C. Organic Producers;
- Council of Forest Industries of B.C.;
- Union of B.C. Municipalities;
- Western Indian Agricultural Corporation;
- B.C. Environmental Network;
- B.C. Ministry of Agriculture, Fisheries and Food;
- B.C. Ministry of Health; and
- B.C. Ministry of Forests.

This group of stakeholders could not finally agree on exactly who should be considered stakeholders, nor could they agree on funding for non-government members. However, during three meetings basic technical objective recommendations were agreed to. The following are the main points of the recommendations:

To promote integrated pest management activities in British Columbia by:
- encouraging and promoting a reduced reliance on pesticide use (a 25% reduction);
- encouraging and promoting the implementation of treatment strategies that are part of an integrated pest management program;
- co-ordinating the promotion of pest management initiatives with other government agencies and private organizations;
- documenting existing integrated pest management activities in British Columbia;
- identifying integrated pest management strategies used elsewhere that could be used in British Columbia;
- encouraging and funding research into new and existing integrated pest management methods (a $200,000 fund);
- developing policy, legislative, procedural and regulatory initiatives to promote integrated pest management and pest management planning; and
- ensuring that training for pesticide applicators includes integrated pest management theory and practice.

To regulate the sale and use of pesticides in British Columbia and monitor their effects on human health and the environment by:
- as part of the overall review of British Columbia's environmental legislation, reviewing the existing pesticide provisions and integrating them into the comprehensive environmental protection legislation prepared by the Ministry;
- increasing efforts to review, monitor and enforce pesticide regulations involving application on private property;
- continuing to evaluate the pesticide permit application process and identify ways to make it more responsible, efficient and participatory;
- ensuring that the Pesticide Management Program is able to effectively review, monitor and enforce regulations involving pesticide application on public lands;
- developing training standards and requirements to ensure certified applicators and dispensers are able to apply and dispense pesticides in a manner that protects human health and the environment;
- developing and introducing a program for certifying the trainers and conducting certification training courses for applicators and dispensers;
- ensuring that vendor license and applicator certificate holders are in compliance with regulations and conditions of licensing and certification;
- developing regulations to require that pesticide application records are kept by all certificate holders;
- promoting the development of a practical disposal and/or recycling program for unused and unwanted pesticides and for pesticide containers;

- promoting the protection of food and environmental quality by:
  - increased monitoring and reporting of the pesticide residues in food and the environment,
  - publishing residue standards and guidelines, and
  - informing pesticide users on how to prevent contamination from occurring;
- ensuring that pesticide residues remain below recognized safe levels; and
- co-ordinating the program's pesticide regulatory efforts with those of other governmental agencies and private organizations.

To inform the public about risks, integrated pest management, and regulatory issues associated with pesticide use in the province, the Pesticide Management Program will develop and maintain a comprehensive communication plan which outlines the following key activities in detail:

- promote and conduct workshops on integrated pest management in collaboration with other organizations;
- inform the public that certification courses are both available and advisable, and are required under certain circumstances;
- produce and distribute information and educational material;
- produce and distribute a newsletter to inform pest managers and interested people about current issues and developments in pest management;
- ensure that the public has an opportunity to comment on permits and/or pest management plans prior to their approval; and
- develop, implement and enforce legislation requiring public notification of pesticide uses on private and public lands.

Finally, recommendations were offered on the restructured Pesticide Management Advisory Committee. This Victoria Committee would advise the Minister of Environment, Lands and Parks on policies principles, regulations and guidelines regarding pesticides and integrated pest management in relation to environmental and human heath concerns. Further, it would assist the administrator of the Pesticide Control Act in the maintenance of the pesticide permit process. Membership would be limited to 12 people representing organizations. Half the membership would be from government and the other half would be from private organizations.

A complete text of the recommendations is available from the author.

- J. Henigman, Silviculture Branch, Victoria.

Forest Pesticide Applicators Certification Course Instructors' Manual. An instructors' manual for the forest pesticide applicators certification course has been written. This manual will allow teachers who have a general knowledge of forestry and of pesticide use to deliver an applicator course in a way that is comprehensive and consistent with other teachers. The manual, written for Forest Health on contract by Robin Mullett of Agri-Woods Consulting Ltd., contains instructions and recommendations to teachers to ensure that the course content and a practical schedule is adhered to. To further assist teachers, the basic overhead projector teaching aids are included in the package as well.

- J. Henigman, Silviculture Branch, Victoria.

Neem in the Trees. A trial was conducted in the Kamloops Forest Region to determine at what stage in western spruce budworm development neem had the most effect. Presently, ***Bacillus thuringiensis*** Berliner var. ***kurstaki (B.t.k.)*** products such as Dipel® or Foray 48B® are applied to control the budworm but the greatest difficulty in ensuring the success of these treatments is timing of application. Due to the bud-mining habit of early instar budworm larvae, the timing of application of ***B.t.k.*** is critical and often difficult. The larvae must be feeding in the open and/or at the 4th instar stage of development, in order to pick up the droplets of ***B.t.k.*** on the foliage. In any given year the phenology of the trees and insect can be greatly different. In years when the trees are "ahead" of the budworm, meaning they have fully flushed while the insects are still in 2nd or 3rd instar larval development stage, the application timing is fairly easy and efficacy is increased. However, the more common scenario is that the larvae remain well protected inside the swelling bud well into the 3rd instar and even 4th instar stage. By the time the trees have fully flushed and the larvae are feeding in the open, significant defoliation has already occurred.

A product such as neem that could penetrate the developing bud and be ingested by the budworm larvae while they feed inside would greatly reduce the damage caused by this insect. The neem trial was conducted as part of a cooperative project with Dr. Murray Isman of the University of British Columbia, and Dr. Staffan Lindgren of Phero Tech, to compare the efficacy of neem applied to Douglas-fir when budworm larvae were in their bud-mining stage to its efficacy when applied at the open-feeding stage.

Four sites were chosen in the vicinity of Lyons Lake. Lyons Lake is approximately 20 km north of Kamloops and is located in the IDFxh biogeoclimatic subzone (i.e. very dry submontane interior Douglas-fir). All sites were located within a 1 km radius of each other. The fifth site, Lanes Creek, was located west of Lyons Lake across the North Thompson River and was also in the IDFxh subzone. Three sites (Lyons-1, Lyons-2 and Lanes) were treated in mid-May (Table 1) when the larvae were in the bud-mining stage. The remaining two sites, Lyons-4 and Lyons-3, were treated June 8th and 9th, respectively.

Table 1. Location and treatment dates of neem trials.

Location	Site	Sample	Date
Lyons	1	pre-spray	15-May-92
	1	1st post-spray	30-May-92
	1	2nd post-spray	15-Jun-92
Lyons	2	pre-spray	19-May-92
	2	1st post-spray	30-May-92
Lyons	3	pre-spray	9-Jun-92
	3	1st post-spray	15-Jun-92
	3	2nd post-spray	26-Jun-92
Lyons	4	pre-spray	8-Jun-92
	4	1st post-spray	15-Jun-92
	4	2nd post-spray	24-Jun-92
Lanes	1	pre-spray	15-May-92
	1	1st post-spray	6-Jun-92
	1	2nd post-spray	16-Jun-92
	1	3rd post-spray	24-Jun-92

Trees were numbered as to site, and treatment, neem or control. Five control trees and 10 treatment trees were selected at each site. Trees chosen as controls were the same height as treatment trees, but located far enough away from treatment trees so as not to be affected by the neem spray. Trees selected for the trial averaged 3 m in height.

A dilution of neem (6 ml/litre water) was applied to 10 understory Douglas-fir trees using back-pack sprayers. The neem was applied to the drip point to each tree, approximately 1 litre of solution per tree. The emulsifier was applied in a similar manner (6ml emulsifier/litre water) to all control trees on the same date that the neem was applied.

The day before each treatment, a pre-spray assessment was done on all trees. The early treatments at the bud-mining stage yielded the most promising results. All other applications, made later in the development of the budworm, showed little efficacy. Due to a naturally declining budworm population, the corrected mortality estimates were low. In trials proposed for 1993, higher concentrations of neem will be used.

Table 2. Results of Neem application on understory Douglas-fir trees to reduce western spruce budworm population, by treatment time and site.

Trtmt	Site	Time	Fettes 1992	Live / m²	Dead / m²	Fettes Avg.
B.t.k.	Lanes	pre	1	50.73	0	1.8
B.t.k.	Lyons-1	pre	1	117.17	0	
B.t.k.	Lyons-2	pre	1	52.29	0	
B.t.k.	Lyons-3	pre	4	115.95	4.9	
B.t.k.	Lyons-4	pre	2	80.36	0.69	
B.t.k.	Lanes	1st post	3	6.96	12.26	2.2
B.t.k.	Lyons-1	1st post	1	30.61	0.28	
B.t.k.	Lyons-2	1st post	0	15.76	0.9	
B.t.k.	Lyons-3	1st post	4	52.23	22.89	
B.t.k.	Lyons-4	1st post	3	40.82	22.64	
B.t.k.	Lanes	2nd post	2	5.02	0.53	2.75
B.t.k.	Lyons-1	2nd post	2	37.94	1.66	
B.t.k.	Lyons-3	2nd post	4	0	0	
B.t.k.	Lyons-4	2nd post	3	0	0	
B.t.k.	Lanes	3rd post	2	17.05	0.27	2
Control	Lanes	pre	1	64.45	0	1.6
Control	Lyons-1	pre	1	143.97	0	
Control	Lyons-2	pre	1	83.63	0	
Control	Lyons-3	pre	3	120.58	1.31	
Control	Lyons-4	pre	2	52.19	3.83	
Control	Lanes	1st post	4	24.7	2.79	2.8
Control	Lyons-1	1st post	1	55.15	0	
Control	Lyons-2	1st post	1	27.72	0	
Control	Lyons-3	1st post	5	102.56	4.32	
Control	Lyons-4	1st post	3	40.23	7.8	
Control	Lanes	2nd post	2	12.64	1.4	3.5
Control	Lyons-1	2nd post	4	54.64	4.53	
Control	Lyons-3	2nd post	5	0	0	
Control	Lyons-4	2nd post	3	0	0	
Control	Lanes	3rd post	3	37.93	2.17	3

PERSONNEL

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Andrea Inwards	Forest Health Technician	Boundary	442-5411
Liz Goyette	Forest Health Officer	Cranbrook	426-1700
Al Pollard	Resource Officer - Silviculture	Golden	344-7500
Kevin Edquist	Forest Health Officer	Golden	344-7500
Emile Begin	Forest Health Officer	Invermere	342-4200
Doug McMullin	Forest Health Officer	Kootenay Lk	825-1132
Peter Martiniuk	Forest Health Technician	Revelstoke	837-7611
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	Pest Management 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 Kroby	Resource Assistant - Silviculture	McBride	569-3748
Barb Marshall	Resource Assistant - Silviculture	McBride	569-3723
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
Terry Corley	Resource Assistant - Protection	Ft. St. James	996-7131
Andy Pakrastins	Resource Officer - Silviculture	Mackenzie	997-2200
Chris Broster	Forest Health Technician	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
Steve Lindsay	Resource Officer - Silviculture	Ft. Nelson	774-3936
Mark Greene	District Silviculturist	Ft. Nelson	774-3936

PRINCE RUPERT FOREST REGION

Region Staff

Gary Lloyd	Silviculture Officer	Smithers	847-7511
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

District Staff

Jane Lloyd-Smith	Resource Officer-Silviculture	Bulkley	847-7624
Bill Camenzind	Audit Forester	Bulkley	847-7628
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	Invremental 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
Dave Nakashoji	Forest Health Technician	Morice	845-6200

Debbie Janning -Stewart	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
Jeff Fournier	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 Silviculturalist	Chilliwack	794-2100
Brenda Koro	Forest Health Technician	Chilliwack	794-2100
Rob Furness	District Silviculturalist	Duncan	746-2700
Nancy McCrea	Silviculture Planner	Mid Coast	982-2000
Ron Sorensen	Resource Officer - Silviculture	Pt. Alberni	724-9205
Chuck van Hemmen	Resource Officer - Silviculture	Pt. McNeill	956-5000
Ron Diprose	Forest Health Technician	Sunshine C.	485-9831
Mark Salzl	District Silviculturalist	Qn. Char. Is.	559-8447
Earl Spielman	District Silviculturalist	Squamish	898-2100

MEETINGS

Mountain Pine Beetle Interagency Meeting. An Interagency Mountain Pine Beetle Meeting was held in Jasper, Alberta on October 22, 1992. Attendees included staff from the Alberta Forest Service, Jasper National Park, Switzer Provincial Park, Mt. Robson Provincial Park, Forestry Canada (Edmonton), Weldwood (Alberta), and the B.C. Forest Service (Prince George Forest Region and Robson Valley Forest District). Each agency provided an update on the status of current infestations, survey efforts, and control tactics. Such meetings enhance interagency awareness of pests common to several jurisdictions and help develop a co-operative strategy for control measures. The Alberta Forest Service will compile the minutes/action points and these should be available soon. A second meeting may be planned for agencies sharing common borders between southern Alberta and British Columbia. For further information on the above contact the undersigned.

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

1990-1992 Ambrosia Beetle Task Force Study - The 1990-1992 Ambrosia Beetle Task Force Study carried out by University of British Columbia Forest Entomology, MacMillan Bloedel Ltd. and Phero Tech Inc., showed that MacMillan Bloedel Ltd. lumber values were degraded by $11,000,000 during 1991. Most of the damage to logs occurred in the forest settings before the wood had been loaded out. Degrade studies in eight sawmills showed degrade losses that ranged from $77/m^3 for D/H grade Douglas-fir sawlogs to $8.17/m^3 for gang yellow cypress logs. The estimated losses for the coastal forest industries is in the order of $120,000,000/annum.

The results from the Task Force, including details of ambrosia beetle biology, trapping results in the Point Grey Booming Ground area, seasonal patterns of attack on logs and the degrade studies in the sawmills have been summarized in a 20 minute videotape entitled, Tiny Beetles - Expen$ive Ta$te$. Copies can be ordered from Biomedical Communications at University of British Columbia (822-4819).

- J. McLean, Forest Sciences, University of British Columbia.

Ed. Note: John McLean is a longtime member of the Forest Health Committee

40th Western International Forest Disease Work Conference. From July 13-17, I was fortunate enough to attend the 40th WIFDWC meeting held at Fort Lewis State College in Durange, Colorado. This meeting is the largest gathering of forest pathologists in western North America and this year was no exception. Representatives from the U.S. Forest Service Forest Pest Management and Research groups, state forestry departments, private industry, universities, Forestry Canada, and Mexico were in attendance.

This article will serve as a summary of key highlights of the conference. The full proceedings should be available by late this year. A copy can be obtained for $10.00 (US) from Ken Russell, Forest Health, Washington State Dept. of Natural Resources, Olympia, Washington, 98504. Copies of previous years proceedings are also available.

A large component of the first session was devoted to examining pest effects at the landscape level. This incorporated presentation and discussion of various practices used to survey, catalogue, retrieve, and use information pertaining to pest occurrence at a large scale. Examples of pest inventories being inserted as Geographic Information System layers were demonstrated, as well as a new system for modeling forest stands to predict visual impact under certain management regimes. The system, called "INFORMS", is being developed by the Methods Application Group in Fort Collins, Colorado.

One program in which the U.S. Forest Service is deeply involved is forest health monitoring. The scope of this program is nation-wide and involves with the installation of what are, essentially, detailed forest health permanent sample plots in all national forests. Plot installation has only occurred in the last two years and many technical problems are still being solved. This program is closely akin to the proposed forest health inventory being tested in the Arrow Timber Supply Area this summer.

Two recent developments in the area of identifying root disease fungi were presented. The first, from Geral McDonald (U.S. Forest Service, Moscow, Idaho), clarified the protocols for identifying different intersterility groups of armillaria root disease in culture. A sample display of 'testers' was set up to demonstrate typical diagnostic features - i.e. banding, gaps, production of pseudothecia, etc. - between isolates. Such testing allows for the determination of root disease variation within a sampled area.

The second development was from Hal Burdsall (U.S. Forest Service, Forest Productivity Lab, Madison, Wisconsin). In using SERA immunological techniques to determine differences between fungal isolates, this group has adopted a method which does not require sacrificing an animal for the harvesting of antigens. Egg whites from chickens injected with the isolate in question are used instead. This method allows for rapid testing of numerous combinations of unknown fungi in order to make positive species determination (e.g., ***I. tomentosus*** vs. ***P. pini***). One egg white is sufficient to perform thousands of tests.

On the PROGNOSIS front, an annosus root disease submodel has been created by Susan Frankel, (U.S. Forest Service, San Francisco, California). This submodel is still being calibrated and tested for the southwest United States, but as previous experience shows, it will probably evolve a number of variants to cover other geographic areas where annosus root disease is a concern. Current submodels for PROGNOSIS include armillaria root disease, dwarf mistletoe, mountain pine beetle, and western spruce budworm.

On the topic of annosus root disease, a recent study conducted by Blakey Lockman (Oregon State University, Corvallis, Oregon) in central Idaho indicated that, as with other spore-dispersed root diseases, there can be a number of clones located within a single stand. However, single clones may spread significant distances over time solely by root-to-root transmission. It appears that ***Heterobasidium annosun*** fits somewhere between ***Phellinus weirii*** and ***Armillaria ostoyae*** (low) and ***Inonotus tomentosus*** (high) in terms of producing discrete infection centres (i.e., clonal variation within a stand).

A potentially significant new problem has appeared in clonal orchards of ***Populus*** along the Columbia River in Washington and Oregon. An outbreak of ***Melampsora laricipopulina*** and ***M. medusae*** (eastern form) has occurred in several orchards established by private industry. ***M. medusae*** has been particularly severe on hybrid poplars causing defoliation on many clones. More significantly, inoculation tests of ***M. laricipopulina*** on various species shows ***P. trichocarpa*** is extremely susceptible. This could present serious problems if the rust migrates north. More background on this outbreak can be obtained from George Newcombe or Gary Chastagner (Washington State University, Pullman, Washington).

Ellen Gohen (U.S. Forest Service, Portland, Oregon) and Eric Allen (Forestry Canada, Victoria, B.C.) have spent the last year studying diseases on red alder. They have concentrated mainly on defect-inducing fungi and their indicators. Early indications are that decay fungi entering through branch stubs or wounds are often compartmentalized and that red alder is quite resilient to such incursions, even in trees that externally appear quite demented.

A new method for assessing root disease on a large scale was presented by Sue Hagle (U.S. Forest Service, Missoula, Montana). The method and end product are similar to that obtained by the satellite imaging process developed in the Nelson Forest Region. The U.S. method, however, uses a comparison of crown closure derived from aerial photos to type out areas suffering from various levels of root disease.

From the panel on incorporating forest health information into forest planning, it appears that the U.S. Forest Service is no further ahead than the B.C. Forest Service. Forest health data is often of poor quality and rarely does a mechanism exist in the planning process to evaluate the impact of pests on various management strategies. Forest health, as an issue, is often regarded as a low priority in the creation of national forest plans.

Sue Hagle also gave an excellent presentation on the 'Sustainable Ecological Systems' concept being espoused in U.S. Forest Service Region 1. There, the regional forester supports a planning process that is based on 'ecology first' concepts and processes at the landscape level rather than at a stand or block level. The importance of maintaining ecosystems within tolerances established by nature is emphasized. We have often discussed the necessity for a similar adjustment to our own planning system but have had little success. It is encouraging to see strong support for such a change at a high managerial level.

The next WIFDWC is scheduled for next August or September in Boise, Idaho. I encourage all interested people to consider attending as representation from the B.C. Forest Service is usually quite low. A joint meeting with the entomologists has been approved for 1994 in Albuquerque, New Mexico. In 1995, the WIFDWC meeting is slated for Kalispell, Montana.

Anyone wishing additional background on any of the topics presented should phone me or make direct inquiries to the parties listed.

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

TABULATIONS

TABLE 3. Average larval mortality estimates due to *B.t.k.* in the Kamloops Forest Region. Larval mortality for each District is an average of all spray blocks within each District.

Forest District	Sample time[a]	Avg. % mort	Avg. Corr. mort[b]	Avg. control mortality
Kamloops	1st	58.1	40.1	55.0
	2nd	75.0	63.8	30.5
	3rd	82.0	63.0	56.6
	4th	90.1	63.7	85.7
Salmon Arm	1st	36.5	34.3	12.0
	2nd	71.3	45.1	44.7
	3rd	80.4	48.2	61.1
	4th	85.0	60.9	57.2
Vernon	1st	51.7	27.1	42.7
	2nd	74.3	41.9	59.8
	3rd	91.5	58.1	79.9
Penticton	1st	38.2	26.9	20.8
	2nd	65.0	51.3	36.8
	3rd	67.6	47.5	28.2

[a] Sampling times represent the post-spray larval assessments which were done at approximately 5-7 day intervals following the ***B.t.k.*** application.

[b] Corrected mortality is calculated by incorporating the natural mortality seen in the control areas into the mortality estimate.

TABLE 4. Penticton Forest District budworm mortality estimates by block

Forest District	Sample time[a]	Avg. % mort	Avg. Corr. mort[b]	Avg. control mortality
Smethurst	1st	47.0	17.8	57.9
	2nd	60.2	44.0	41.3
	3rd	69.3	39.4	49.4
Gillard	1st	75.2	71.8	11.9
	2nd	89.5	86.8	20.4
	3rd	82.3	85.2	-19.5
Bellevue	1st	56.5	50.7	11.9
	2nd	67.3	59.0	20.4
	3rd	70.5	75.3	-19.5
Arawana	1st	25.9	23.1	6.5
	2nd	44.4	27.0	39.8
	3rd	62.1	44.9	44.8
Spring Lk.	1st	8.4	17.7	9.1
	2nd	32.6	40.3	29.0
	3rd	54.1	19.6	61.2
Steward Cr.	1st	52.9	7.4	
	2nd	91.3	73.3	
	3rd	80.9	37.6	
Shuttleworth	1st	1.6	0.0	27.7
	2nd	69.7	28.8	70.1
	3rd	53.8	30.7	52.7

a Sampling times represent the post-spray larval assessments which were done at approximately 5-7 day intervals following the ***B.t.k.*** application.

b Corrected mortality is calculated by incorporating the natural mortality seen in the control areas into the mortality estimate.

TABLE 5. Cost breakdown of 1992 western spruce budworm aerial spray program.[a]

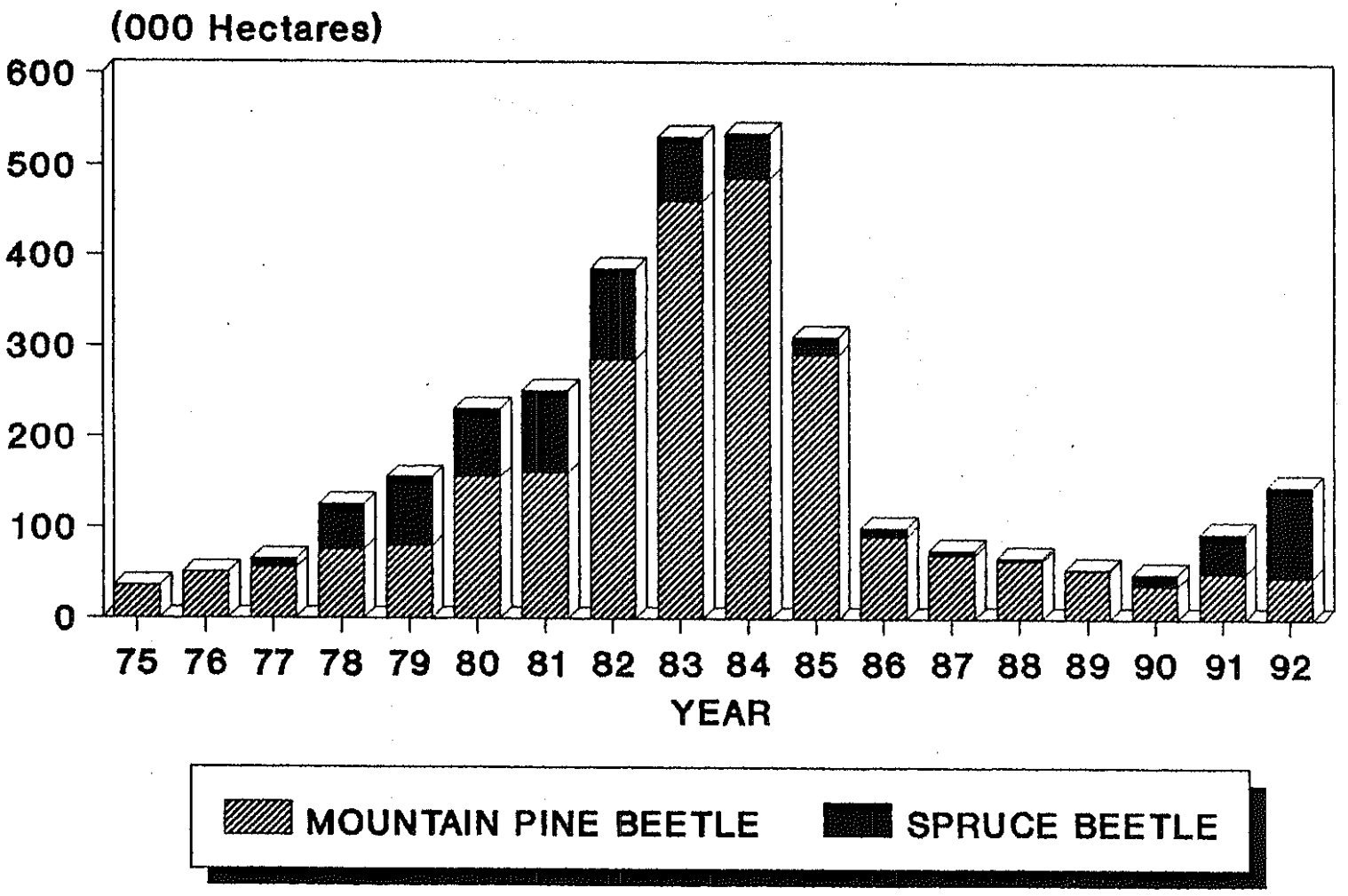
Item	Description	Unit cost	Total Cost
B.t.k.	Novo Nordisk Bioindustrials Ltd. 91 208 litres shipped	$3.97/l	$362,105.23
Aerial Application	Northern Mountain Helicopters Ltd.	$3.00/ha	$105,936.00
	4 Grumman Ag Cats @ $2100/day for 30 day minimum guaranteed	$2,100.00 /day	$252,000.00
	plus hectarage charge (35,312 ha sprayed)		
Support helicopter	Cariboo Chilcotin Helicopters Ltd. (hourly rate plus fuel) Kamloops/Vernon/Salmon Arm/Lillooet	$505.00/hr (111.7 hrs)	$65,890.01
	Canadian Helicopters Ltd. Penticton Forest District	$593.32/hr (24 hrs)	$15,440.00
Ground crews	Block layout & corner marking on spray days (all forest districts)		$72,358.39
Equipment	Balloons		$17,992.12
	Pruner heads		$848.33
	Pruner adapters		$357.30
	Baskets & rims		$374.84
	Helium (estimate)		$1,378.64
	Weather equipment		$7,268.35
Pre- & Post-spray Efficacy Sampling	Pre-spray sampling and layout	$32.75/ha	$34,453.00
	Post-spray sampling (estimate)	$15.27/ha	$47,924.33
	Journal Voucher from B.C. Parks for spray of Paul Lake & Ellison Park		($10,000.00)
	TOTAL COST:		**$970,326.54**
	TOTAL COST PER HA:		**$27.68**

a Certain costs are only estimates as final reports are not yet in from all districts, and some costs are not included such as advertising, public information, displays, training, and other miscellaneous expenses.

Table 3A Results from the 1992 virus spray program against the Douglas-fir tussock moth in the Kamloops Forest District.

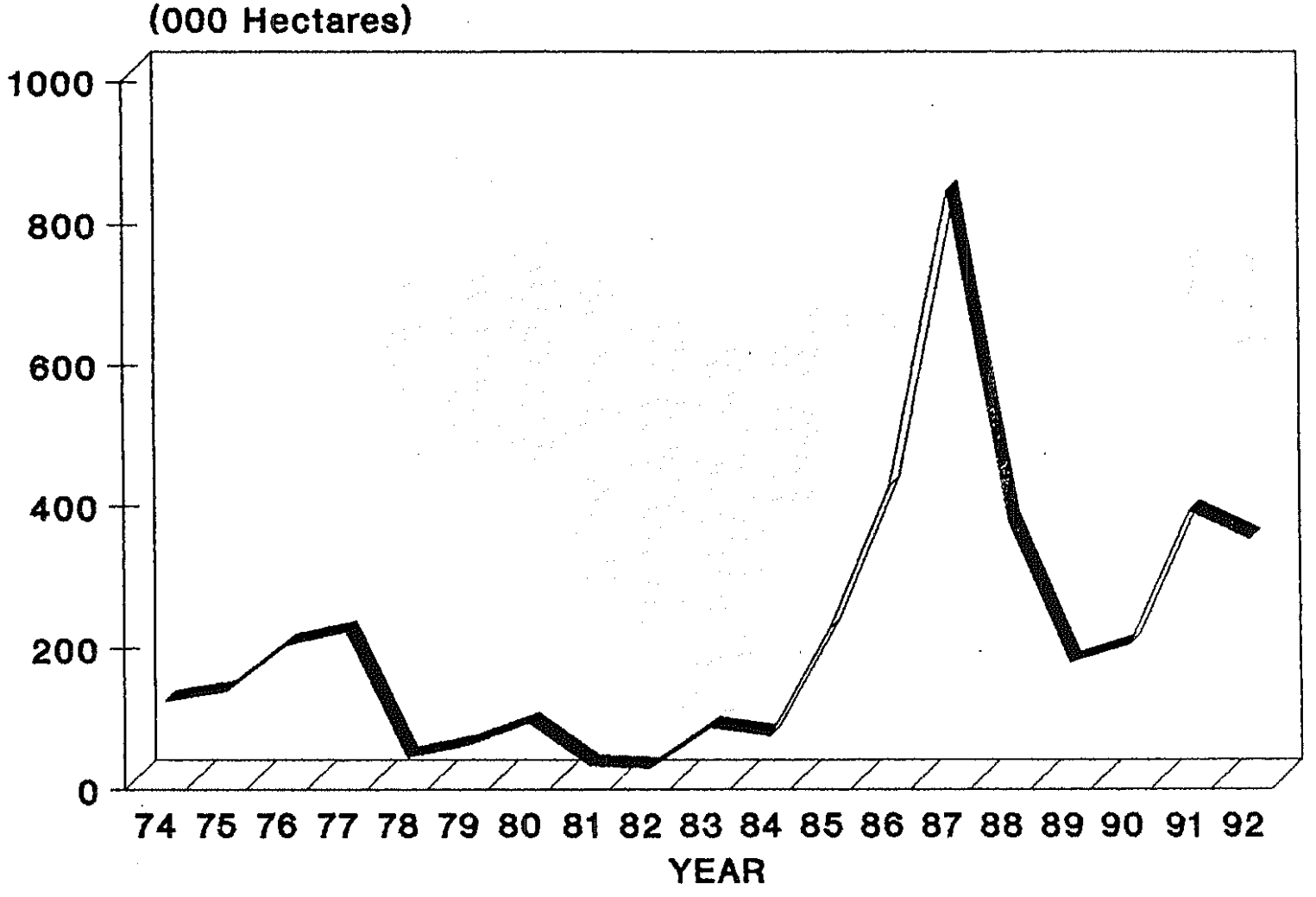
Treatment Block	Sampling time		Average no. larvae per m2		Mortality from pre-spray to post-spray (%)
	Timing	Date	Healthy	Infected	
Dome area	pre-spray	2-Jun-92	32.3	0	
	1st post-spray	18-Jun-92	9.2	4.6	71.5
	2nd post-spray	1-Jul-92	3.3	1.9	89.8
	3rd post-spray	16-Jul-92	2.0	2.6	93.8
Indian Gardens Site 1	pre-spray	2-Jun-92	33.9	0	
	1st post-spray	18-Jun-92	7.0	3.9	79.2
	2nd post-spray	1-Jul-92	15.0	9.5	55.8
	3rd post-spray	16-Jul-92	1.9	4.3	94.5
Indian Gardens Site 2	pre-spray	2-Jun-92	9.2	0	
	1st post-spray	18-Jun-92	5.7	2.3	38.4
	2nd post-spray	1-Jul-92	6.8	2.6	26.6
	3rd post-spray	16-Jul-92	1.5	3.9	83.7
Indian Gardens Site 3	pre-spray	2-Jun-92	9.4	0	
	1st post-spray	18-Jun-92	5.0	1.6	46.8
	2nd post-spray	1-Jul-92	5.5	0.3	41.5
	3rd post-spray	16-Jul-92	2.5	4.6	73.4
	4th post-spray	5-Aug-92	0.1	0.3	98.9
Indian Gardens Site 4	pre-spray	2-Jun-92	0.4	0	
	1st post-spray	18-Jun-92	0.3	0.3	37.5
	2nd post-spray	1-Jul-92	0.4	0.5	6.3
	3rd post-spray	16-Jul-92	0.6	0.6	0
	4th post-spray	5-Aug-92	0.0	0	100.0
Indian Gardens Site 5	pre-spray	2-Jun-92	30.0	0	
	1st post-spray	18-Jun-92	10.0	2.6	66.8
	2nd post-spray	1-Jul-92	4.3	4.3	85.7
	3rd post-spray	17-Jul-92	0.6	2.8	98.0
	4th post-spray	5-Aug-92	0.2	0.6	99.3

AREA UNDER ATTACK BY BARK BEETLES
1975-1992



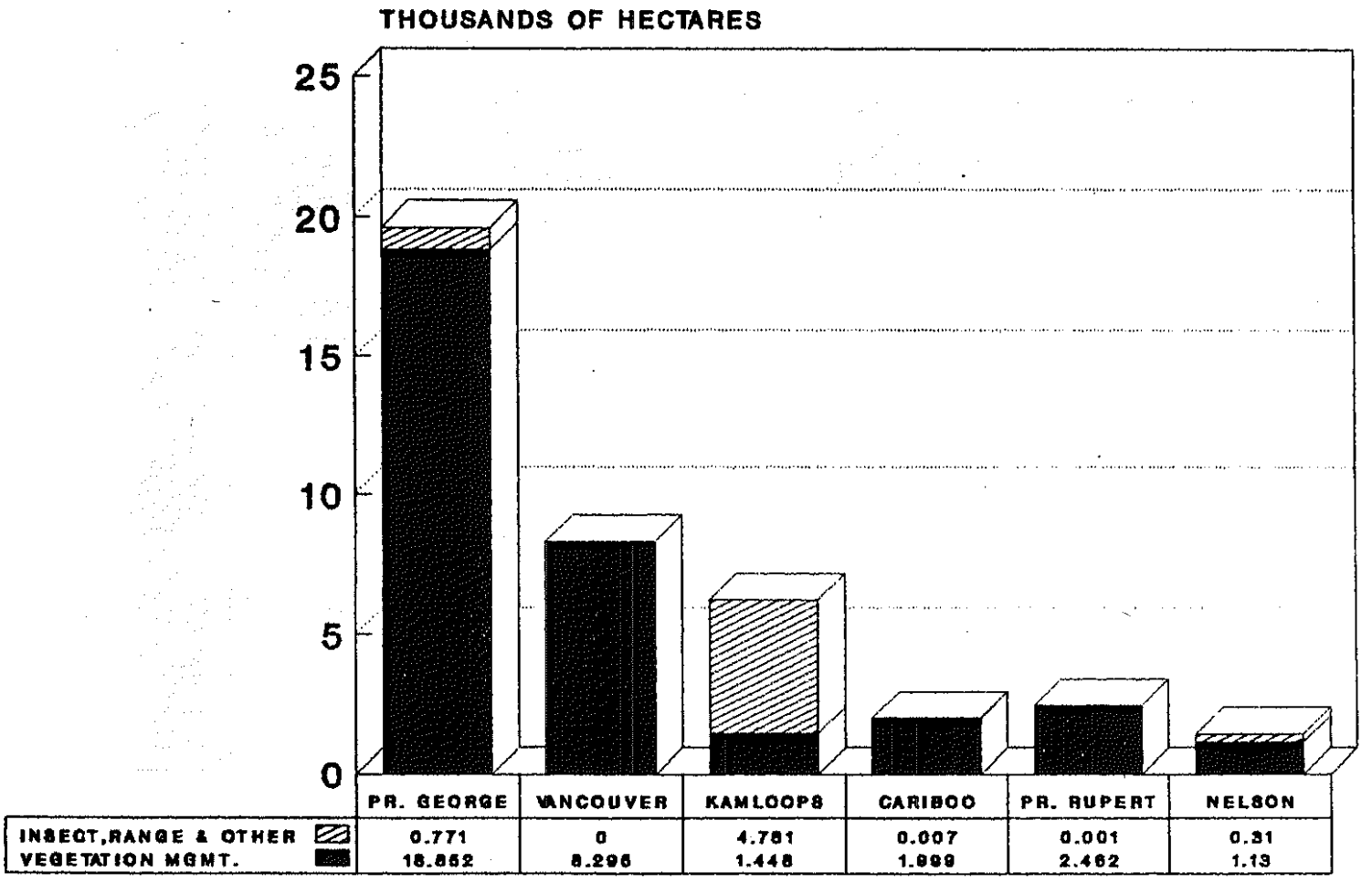
Source: Forestry Canada, Forest Insect & Disease Survey

TRENDS IN VISIBLE DEFOLIATION OF DOUGLAS FIR CAUSED BY THE WESTERN SPRUCE BUDWORM IN BRITISH COLUMBIA (YEARS 1974-1992)



Source: Forestry Canada, Forest Insect & Disease Survey

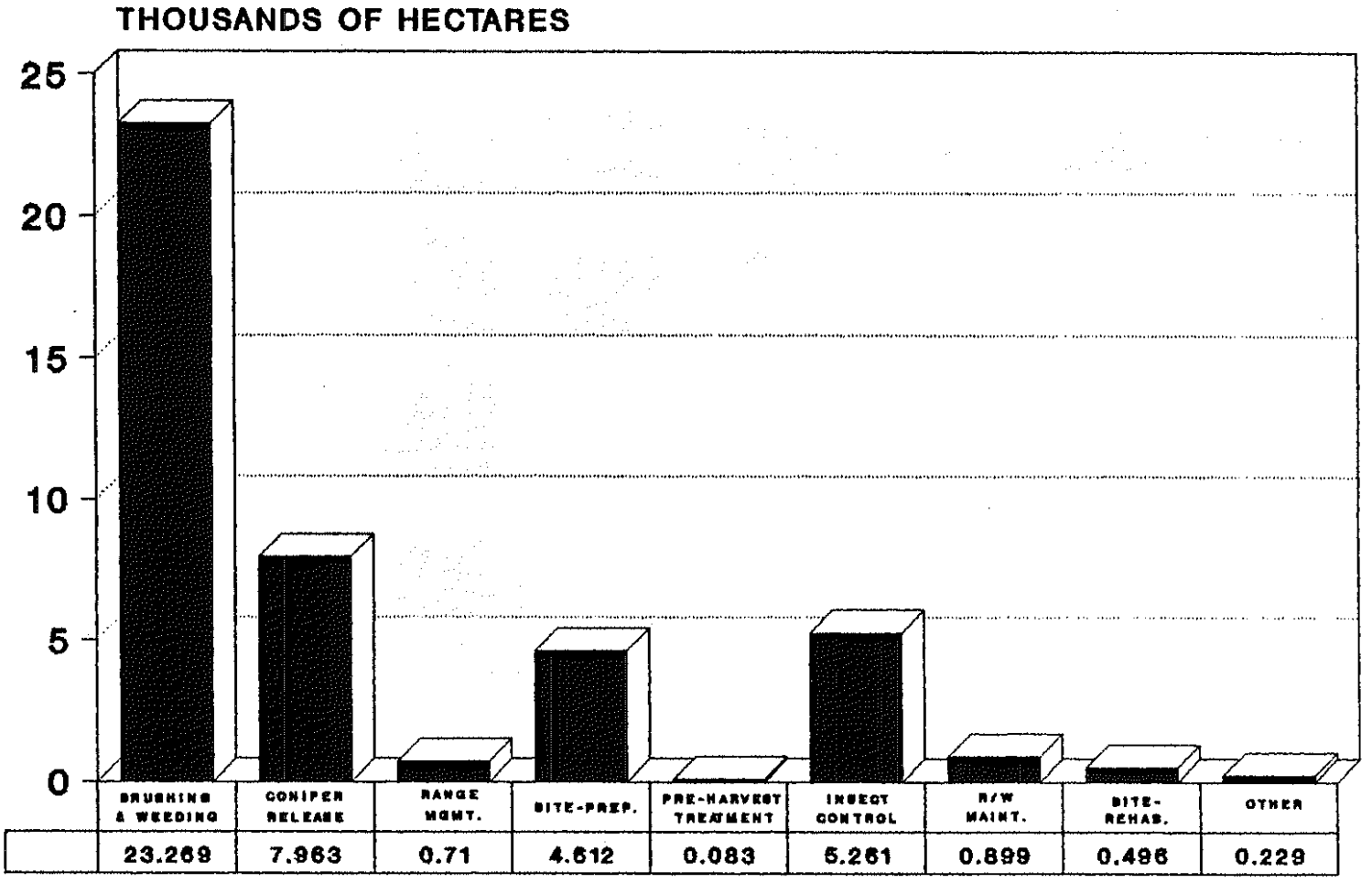
AREA TREATED WITH PESTICIDES
PROVINCIAL SUMMARY BY FOREST REGION 1991



Source: B.C. Ministry of Forests &
and B.C. Environment, Lands & Parks

[1] B.C. Forest Service & Industry Combined

PROVINCIAL SUMMARY OF AREA (ha) TREATED WITH PESTICIDES BY CONTROL PURPOSE, 1991 [1]



Source: B.C. Ministry of Forests and B.C. Environment, Lands & Parks

[1] B.C. Forest Service & Industry Combined

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British Columbia Ministry of Forests. 1992. Spruce Weevil Symposium Proceedings. March 12, 1992, Inn of the West, Terrace B.C. Prince Rupert Forest Region, Silviculture. Smithers, British Columbia.

Norris, D., R. Stewart and J. Muir. 1992. A Survey of Suspect Forest Sites for Root Diseases and Other Damage in Southeastern British Columbia. British Columbia Ministry of Forests, Nelson Forest Region. Nelson, British Columbia.