



Province of
British Columbia
Ministry of
Forests

PEST MANAGEMENT PROGRESS

A summary of pest management activities in the
British Columbia Ministry of Forests.

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MORE CHANGES AND CHALLENGES!

We in forest health in the Ministry of Forest, like those in many other organizations, must adapt our approaches and goals, not only gradually, but at times, dramatically, as we encounter new challenges and opportunities.

The Forest Service is responding to several public concerns and issues, such as the rate of harvest and clearcutting. Many of these issues, and the resulting internal and external discussions, are leading to modifications of our forest health programs. For example, the issues of clearcutting, preservation of old growth trees, and leaving residues on harvested sites, are being addressed in our bark beetle and root disease management programs, and practices. Also we must continue to adapt to local forest and land resource uses, policies, and plans.

Another challenge is to tell people clearly and simply what we are trying to do in forest health. Even some of our colleagues have said that they believe that we intend to eradicate certain organisms - those that we used to call pests - regardless of their role in forest ecosystems.

We must clearly show how we will decide what, where, when, and how much damage to forest resources from insects, diseases, and animals, is tolerable, or acceptable, and where we will recommend management action. Also, we must show that we will try to prevent or suppress unacceptable damage only where and when the proposed treatment will not adversely affect forest land or ecosystems.

Forest health will possibly be relocated from Protection Branch to another branch which yet to be announced. Doubtless, we will face not only more challenges to adapt our program and people to a new organization, but also we might gain new resources to develop and implement better forest health subprograms.

- J. Muir, Protection Branch, Victoria.

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PEST MANAGEMENT PROGRESS

EDITORIAL AND COORDINATING STAFF

Publisher:	J. A. Muir	Protection Branch
Editor:	P. J. Humphreys	Protection Branch
Production:	M. Y. Matthews	Protection Branch

ADVISORS

Entomology:	P. M. Hall	Protection Branch
Forestry:	M. Wyeth	Silviculture Branch
Pathology:	J. A. Muir	Protection Branch
Pesticides:	J. F. Henigman	Protection Branch
Planning:	J. Crover	Integrated Resources Branch
Range Management:	R. B. Addison	Integrated Resources Branch
Research:	H. J. Benskin	Research Branch
Timber Management	D. G. McPhail	Timber Harvesting Branch

Address all correspondence to:

Ministry of Forests
Protection Branch
31 Bastion Square
Victoria, British Columbia
V8W 3E7

Attention Ms. P. Humphreys

PUBLISHER'S AND EDITOR'S NOTE

Pest Management Progress is intended to provide factual information on programs, projects and proposals by Ministry staff to the B. C. Forest Health Committee, chaired by the Chief Forester.

Contributions labelled with an appropriate subject heading should be submitted to the Regional Protection Officer, or Advisor who will edit and forward them to Protection Branch. Pest Management Progress is submitted to the Spring (May) and Winter (December) meetings of the 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.

PEST MANAGEMENT - GENERAL

Pest Management Progress Format. Readers no doubt noticed some changes in format to "Pest Management Progress" (PMP) in the last issue, and we are considering more, depending on readers' responses:

- 1) With the name change of the Forest Pest Review Committee to the Forest Health Committee of B.C., and because PMP is intended as a report of B.C. Forest Service activities, we propose that we change the name "Pest Management Progress" to "Forest Health Progress".
- 2) We are also considering the addition of feature articles, reviews, and/or short reports on technical or scientific aspects of forest health.

If you have any suggestions or ideas for improvements to PMP, please contact our editor or publisher.

- P. Humphreys and J. Muir, Protection Branch, Victoria.

Pest Control Project Reports. Thirty-one internal Protection Branch reports are being prepared on pest control contracts as part of the 1985-1990 Canada-British Columbia Forest Resources Development Agreement (FRDA). These projects were funded directly by the Ministry of Forests under the Intensive Forestry sub-program.

The reports cover a variety of surveys, control trials, problem analyses, treatment evaluations, and preliminary work on pest models, with emphasis on forest diseases.

Titles and authors of the proposed internal reports are tabulated in the Publications and Reports section of this issue of Pest Management Progress.

- J. Muir, Protection Branch, Victoria.

Forest Health Extension Forester. Bob DeBoo, former manager of the Forest Health Section at Protection Branch, has undertaken a one-year secondment to Forestry Canada, Pacific Forestry Centre, Victoria, as an extension specialist.

He will be working on a variety of issues, including the South Moresby Agreement, the Green Plan, and the new Forest Resources Development Agreement proposal. Bob is also assisting in the strategic planning activities of the Ministry of Forests Forestry Division for John Cuthbert, Chief Forester. Bob can be contacted at 363-0571 or 363-0600.

- J. Muir, Protection Branch, Victoria.

Hardwood and Vegetation Management Research Program of the Ministry of Forests. During 1990, funds became available through the Sustainable Environment Fund (SEF) Forest Renewal Initiatives Program (FRIP) to support vegetation and hardwood management research.

A. Vegetation Management

The objective was to establish a long-term coordinated research and extension program to improve the ability of forest practitioners to prescribe and implement vegetation management treatments.

In 1990/91, the Hardwood and Vegetation Management Technical Advisory Committee (HVMTAC) developed a Vegetation Management action plan identifying three priority areas for research:

- a) effectiveness of vegetation management treatments, emphasizing the relative effectiveness and cost of non-chemical treatments;
- b) short-term and long-term silvicultural benefits of vegetation management treatments; and
- c) impacts of various treatments on wildlife habitat range, and on long-term site productivity.

These priorities are being addressed through a variety of research projects. Those supported for funding in the 1990/91 Fiscal year were:

- C01 A review of available information and research needs for the use of manual brushing in B.C.
- C02 A review and analysis of literature and experience on sheep grazing as a vegetation management tool in temperate forests

- C03 Determination of nitrogen fixation by Sitka alder in the southern interior of British Columbia
- C04 Vegetation development and Douglas-fir growth in the Coastal Western Hemlock (CWHdm) biogeoclimatic subzone: ten and fifteen year results on the Blaney Chronosequence and Marc and East Creek watersheds
- C05 Participation in the Coordinated Research on Alternative Forestry Treatments and Systems vegetation management cooperative
- C06 Demonstration site for comparing cost-effectiveness of clearing saw treatments for brushing shrub-dominated plantations in the Interior Cedar-Hemlock (ICHa) biogeoclimatic subzone
- C07 Vegetation development following mechanical treatment and slashburning in Engelmann Spruce-Subalpine Fir (ESSFc) biogeoclimatic subzone of the Nelson Forest Region
- C08 A database for vegetation management trial information
- C09 Comparison of biological controls to other vegetation control methods in the Nelson Forest Region
- C10 Quantitative screening of the competitive effects of common coastal non-crop species
- C11 Integrated resource management of riparian ecosystems: a problem analysis
- C12 Evaluating the effects of vegetation management practices of wildlife habitat
- C13 Plant community shifts from operational forest herbicide treatments and their impact on wildlife
- C14 Impacts of site preparation on habitat utilization and availability for red, blue, and yellow listed wildlife species in the interior of B.C.
- C15 Influence of vegetation management on the diversity of plants, small mammals, birds, and furbearers

B. Hardwood Management

The long-term goal of the FRIP Hardwood management research program is to develop and support a co-ordinated research and extension program supplying relevant information and guidelines to hardwood and mixedwood managers.

General areas of interest included evaluating the role and function of hardwoods in long term site productivity, stand dynamics and biomass production, maintaining species diversity and improving stand health; also the incidence of firm wood staining, decay, and other forms of defects.

Priorities recognized by the Hardwood action plan include:

- o the impact of logging practices on stand health and regeneration
- o methods to assess decay in standing timber, and
- o pest management.

Hardwood projects supported for funding during the 1990/91 fiscal year were as follows:

- B17 Northern mixedwood forests, the carbon cycle, and sustainable production
- B18 Integrated aspen-forage resource management options in the Boreal White and Black Spruce (BWBS) biogeoclimatic subzone the effects of timber harvesting, cattle grazing and grass seeding on aspen and forage production
- B19 Establishment of long-term growth and yield installations for the study of the natural development of northern hardwood monocultures
- B20 Development of silvicultural techniques to maximize the productivity of native northern hardwood monocultures
- B21 International Union of Forest Research Organizations (IUFRO) meeting on ecology of mixed species stands
- B22 Analysis of cottonwood management problems and related research needs in British Columbia
- B23 Analysis of birch management problems in the Prince George Forest Region
- B24 Administration of the hardwoods and vegetation management research programs
- B25 Determination of the fitness of the hardwood resource for particular products
- B26 Sustainability of hardwood and mixedwood forest site values
- B27 A problem analysis of Hardwood management trends and effects on wildlife in B.C.
- B28 Changes in bird diversity and abundance following aspen clearcutting in the BWBS biogeoclimatic subzone
- B29 The diversity of bird assemblages in interior hardwood
- B30 Wildlife habitat management workshop for the southern interior

Continued funding under SEF is anticipated, and work will continue on these and other projects. For further information, please contact Dale Draper at 387-3226 or Phil Comeau at 387-3019.

- K. Hopkins, Research Branch, Victoria.

Values at Risk: Integrated Resource Management and Forest Health. In 1990, the Forest Health Program took a more prominent and active role in the integrated resource management decisions within the Kamloops Forest District. This change in role and focus was due, in part, to the following:

- (a) The need to set project priorities and make budget decisions based on values at risk where "value" and impacts could not be determined in dollars.
- (b) The increased activity of various bark beetles and the associated impact of cut block location and design on aesthetic values, recreation values, salmon habitat (Adams River), community watersheds, and wildlife resources.
- (c) The incidence of root disease and lodgepole pine dwarf mistletoe, and the realization of at least some of the impacts of these diseases on other resource values.

Resource values at risk are of prime importance in evaluating project priority within the District. The following prioritized list of values at risk are considered when planning and implementing forest health projects in the Kamloops Forest District:

- 1) Ecological reserves, recreation reserves, demonstration forests, wildlife reserves and other special reserves created and protected by Order-In-Council.
- 2) Community watersheds
- 3) Seed production areas, and research projects on Crown lands
- 4) Forest recreations areas - commercial
- 5) Forest recreation areas- non-commercial, provincial parks
- 6) Prescribed areas within a local resource use (Folio/Community Resource Management Plan) planning area
- 7) Forest Licence chart areas, Small Business Forest Enterprise Program chart areas, Woodlot Licence areas, vacant Crown lands.
- 8) Tree Farm Licences, Christmas tree permit areas
- 9) Private lands and leases
- 10) Federal lands, Indian reserves

- D. Piggin, Kamloops Forest District, Kamloops.

Forest Health Implications of Partial Cutting Silvicultural Systems on Dry Sites in the Coastal-Interior Transition Zone. A number of silvicultural system trials are underway in the Vancouver Forest Region. Two trials will take place in coast-interior dry Douglas-fir ecosystems that have experienced successive outbreaks of western spruce budworm, and periodic infestations of Douglas-fir and mountain pine beetle. Chronic root diseases such as laminated, armillaria, and black stain, also occur in these areas. Replicated trials of systems such as clearcutting, seed trees, and two densities of shelterwood, will be involved. Forest health specialists in the Region will examine and monitor how these treatments affect pest transmission and/or influence population dynamics. Pre-and post-treatment assessments will be made. At regular intervals, sample plots will be assessed to record changes in pest incidence and damage. The results will be used to develop forest health guidelines for partial cutting systems.

- D. Heppner, Vancouver Forest Region, Burnaby.

Dead Tops in Lower Mainland Conifers. During the summer of 1989 a number of calls were received from residents in the Port Moody area concerning dead and dying tops of large conifers. Douglas-fir, western hemlock and western red cedar were all involved. The dead tops ranged from 1 to 5 metres in length. On some trees the top-kill slowly progressed down the tree as the summer continued. A few trees died.

At first, because the symptoms seemed to have appeared all at once, it was thought to be related to the thaw/freeze event which occurred during the first few days of February, 1989. Some of the residents thought it was caused by air pollution from a B.C. Hydro thermo-electric plant that had just started operating that year. However, the Greater Vancouver Regional District air quality monitoring station at Port Moody did not detect any recent increase in air pollutants. On the few tops that could be examined, no causal insects or diseases were found. Disturbance of soil or drainage did not seem to be involved.

Later that summer and during the following summer (1990) similar symptoms occurred in various locations throughout the Lower Mainland, as far east as Rosedale. The current consensus of opinion is that these symptoms are the result of summer drought. Summers of the past five years or so have been quite dry. Lower Mainland conifers will be monitored again this summer.

- D. Heppner, Vancouver Forest Region, Burnaby.

B.C.I.T. Pathology Training Course. Norm Alexander of the B. C. Institute of Technology has restructured his forest pestology course so that its content more effectively serves forest health training needs. As part of the revamping, Jeff Beale and Jeff Fournier have been asked to help determine the course content and to lead the instruction. Four 15-student groups will attend four consecutive days of class and field sessions. Students receive training in root disease identification, ecology and control. Students are required to survey and develop a management prescription for a laminated root rot-infected block. Judging from the keen student response, the first session has been a resounding success.

- J. Fournier, Vancouver Forest Region, Burnaby, and
J. Beale, Protection Branch, Victoria.

Pest Incidence Surveys. The Kamloops Forest Region continues to inventory pest incidence and impact on its forest land base. In 1991, each district will stratify and survey one mapsheet (minimum) and an additional five will be done by the regional staff. The goal of this program is to have an accurate, area-based, statistical assessment of pest incidence and intensity, which will be available for all planning processes. These surveys will identify where gains can be made from practicing sound forest health strategies.

Two training sessions will be held in the Kamloops Forest Region (Vernon and Merritt) for all field personnel who will be conducting these surveys.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Pests of Young Pine. The first year of this jointly funded project is now complete. This project is an effort of both Silviculture Branch (F. Barber) and the Kamloops Forest Region. A compilation of all immature lodgepole pine areas was made and then sorted by biogeoclimatic zone and subzone; site class; natural versus planted regeneration; disturbance history; treatments, such as juvenile spacing; site preparation method etc. A sub-set of all these categories was then surveyed using the pest incidence survey methodology. The next phase, to begin this field season, is to establish plots in affected and control areas.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Roadside Tree Injury Survey. A meeting of the inter-ministry committee, and SoilCon and PheroTech companies, who are conducting the roadside tree and vegetation injury survey, was held April 11, 1991.

Regional and district offices of the Ministry of Transportation and Highways provided a list of sites, and the following 17 were selected for inspection by the contractor:

- Highway 97 south of Williams Lake (north shore)
- Dog Creek Road near Williams Lake
- Loon Lake Road, km 9-15.
- Loon Lake Road, km 25-28.
- Barnhardtvale Road
- Horse Lake Road from the west tip of the lake to Fawn Lake Road
- Chasm Mile, km 33-38
- 100 Mile House north, km 3-8
- Gold Bridge, km 57-75
- Gold Bridge, km 13-28
- Anarchist Mountain
- Highway 33, Carmi
- Hope Princeton
- Salmo-Creston, Stagleap
- Coquihalla
- Cranbrook, CPR Hill
- Williams Lake, Hwy 20, km 102.9.

The precise location, and land status of each site will be determined. If necessary, permission to enter private property, will also be obtained.

Historical information on salt use, pesticide/herbicide use, air pollution, insect and disease presence, etc., will be determined by questionnaire to agencies including, the Ministry of Transportation and Highways, the Ministry of Environment, Environmental Protection Section, and the Ministry of Forests.

The consultant expects to make initial visits to sites along Highway 3 and 33 between April 16 and 26. The more northerly sites will be visited between May 7 and 14. Itineraries will be available from J.van Barneveld.

- J. van Barneveld, Ministry of Environment, A. Planiden, Ministry of Transportation and Highways, and J. Muir, Protection Branch, Victoria.

Forest Nursery Pest Management Update. During the 1991 growing season, nursery pest management work will be extended to include the nursery planting site interface. Ani-pel, an animal repellent produced in Vancouver, will be applied to stock while in the nursery and again at the time of planting. The sites will be assessed to determine if animal browse has been reduced. This product is a nitrogen-based systemic which translocates throughout the plant giving the foliage an extremely bitter taste.

Some reforestation nurseries in Ontario have been using the plant growth regulator, paclobutrazol. Experiments with conifer seedlings have shown that this compound will significantly increase the survival of seedlings exposed to moisture and temperature stresses. Applications will be made to summer plant stock destined for drought prone sites.

Root rots, especially pythium and fusarium, can cause serious damage in container culture. There is increasing evidence that seedlings infected with root pathogens in the nursery may have poor plantation survival. A program to analyze seedling roots in reforestation sites for the presence of nursery related pathogens will be initiated.

Seed-borne fusarium inoculum can cause several seedling diseases. Preliminary surveys have shown that up to 11% of the seeds in some Douglas-fir seedlots are infected with fusarium. A program to screen seedlots for the presence of this pathogen is planned.

Agribrom, a bromine product that works primarily as an algicide, will be tested for threshold phytotoxicity on conifer seedlings at the Ministry test nursery. Agribrom

is applied at very low concentrations on a regular basis throughout the growing season. This product has potential as an algicide, fungicide and herbicide. Small operational trials at two Lower Mainland nurseries will indicate the possibility for control of nursery pest problems.

Trials to gain data for the registration of a *Bacillus thuringiensis* product for conifer seedling nurseries will be initiated. Alternatives to traditional boom sprayers such as foggers, misters and electrostatic sprayers for pesticide application will be investigated. Tests using silicon as a feeding supplement to induce foliar resistance to botrytis will be conducted.

- G. Shrimpton, Surrey Nursery, Surrey.

Forest Health Communications. Co-op student Don Urquhart is completing a four-month term in Williams Lake. Don has inventoried and organised all forest health photographs and slides, created an index and identified gaps in the material. He has also designed and created a series of display panels for use at public meetings and at training sessions.

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

FOREST ENTOMOLOGY

1991/92 Bark Beetle Program. All proposals for the funding of Ministry of Forests bark beetle related activities have been received and are being reviewed. Total requests amount to approximately \$5.2 million, while total funding available amounts to \$3 million. Within the available resources, activities and priorities will remain the same as in past years.

- P. Hall, Protection Branch, Victoria.

Bark Beetle Funding. A submission to Treasury Board in the fall of 1990 that requested continuation of the bark beetle funding on an annual basis was approved and the fund is now at the Ministry's target level of funding. This means that annual issue papers requesting continuation are no longer necessary. The intent for 1991/92, and thereafter, is to provide a maintenance level of funding to those districts with ongoing bark beetle problems and direct any remaining funds to priority special problem areas. Further, budgetting for beetle and other forest health activities will hopefully be made to conform with normal budgetting procedures and time frames.

- P. Hall, Protection Branch, Victoria.

Mountain Pine Beetle Task Force Report. The report from the Okanagan Mountain Pine Beetle Task Force has been completed and is available upon request. This series of documents provides a planning procedure for developing mountain pine beetle management approaches on a consistent basis. The intent is to have managers in all areas of the province with beetle problems utilize this approach so that similar situations are dealt with in a similar manner. There may also be opportunities to utilize this procedure for developing more comprehensive forest health plans in an integrated manner.

- P. Hall, Protection Branch, Victoria.

Boundary Forest District Technical Audit. A comprehensive technical audit of the mountain pine beetle management program in the Boundary Forest District was requested by the District and the Nelson Forest Region. The terms of reference for the audit were similar to those used for the Penticton Forest District audit carried out last year. Audit team members included an entomologist, a district manager, a regional timber officer, and a district resource officer for silviculture. All aspects of the District's bark beetle management activities were examined. The audit report will be submitted to the Region and District in early summer.

- P. Hall, Protection Branch, Victoria.

Mountain Pine Beetle Survives Record "Cold Snap" in Prince George Forest Region. The Prince George Forest Region experienced record cold weather in late December 1990 to January 1991. Temperatures went to -40°C , and on one occasion plunged to -46.1°C at the Prince George airport. Consequently, overwintering mortality studies were conducted in four forest districts to see if alterations were necessary to scheduled piling and burning operations and/or sanitation logging. Indoor rearing of beetles revealed that approximately 48% of mountain pine beetle larvae survived in trees that were sampled above the snowline (0-0.5 m). Based on these findings, control operations proceeded as scheduled.

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

Hazard-Rating Pine Stands for Mountain Pine Beetle. The most recent version of the Forestry Canada Shore and Safranyik rating system was used to provide an overview assessment of mountain pine beetle hazard conditions for some stands in the Robson Valley and Fort St. James Forest districts. In the Ft. St. James Forest District, the Sustut Local Resource Use Plan (LRUP) area was hazard rated, while in the Robson Valley Forest District, hazard rating was conducted on the Canoe-Valemount and Tete Jeune Cache LRUP areas, and the interface area between these LRUP's and Mount Robson Park.

The districts will use these maps to plan access development and harvest schedules, and to aid in resolving some major integrated resource management issues.

- S. Taylor, Prince George Forest Region, Prince George.

Population Index for the Douglas-fir Beetle in the Cariboo Forest Region. A survey of areas infested by the Douglas-fir beetle was conducted to determine whether beetle attack was increasing in the Cariboo Forest Region. Bark samples were taken from the boles of infested standing trees, trap trees, and windthrown trees. The bark samples were examined and the number of adult beetles, larvae and galleries were recorded. The bark beetle population index was calculated from the ratio, in the bark sample, of live beetle brood to the number of attacking parent beetles.

The average population index ratio for the Douglas-fir beetle infestation in the Region was 4.85. A population index of greater than 1.0 indicates an expanding population. The population index varied throughout the Region but was always greater than one. The infestation in the military training area near Riske Creek, is increasing (index = 6.0) and requires immediate attention, since no control measures have been implemented there for a number of years.

Beetle control measures should be continued throughout the Cariboo Forest Region. Samples collected at a height of 4.0 m on standing trees provide the best representation of beetle population. It is recommended that bark samples be collected at this height every fall to determine the population index.

- L. Rankin, Cariboo Forest Region, Williams Lake

Foliage Colour Change in Douglas-fir Beetle Infested Trees. Stands infested by the Douglas-fir beetle, *Dendroctonus pseudotsugae*, were surveyed during the fall in the Cariboo Forest Region to correlate the accuracy of the annual aerial pest survey with the beetle infestation intensity on the ground. Infested trees were located and monitored over a period of 6-8 weeks to determine the rate of colour change and needle loss associated with the beetle infestation. The distribution of currently attacked trees, made up of green, red or grey trees, and their colour changes, were recorded regularly.

A total of 72.2% of currently attacked trees were undetected by the aerial survey because trees that were either green or grey (total needle loss) were omitted from the aerial survey. The percent slope on which the infested trees were located was correlated with the amount of colour change and needle loss which occurred. The size of Douglas-fir beetle infestations located during aerial pest surveys must be multiplied by 2.6 to compensate for the amount of undetected current attack.

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

Helicopter logging of Douglas-fir Beetle Infested Trees on Horse Lake Ridge. A Douglas-fir beetle infestation on Horse Lake Ridge, overlooking the Village of 100 Mile House, in the 100 Mile House Forest District, as salvage logged using a Hughes 500D helicopter. This site is exceedingly visible from Highway 97 and the Village. Conventional harvesting of all accessible infested timber removed 350 cubic metres. Falling and burning of the remaining 157 inaccessible trees was planned. After falling and burning 52 trees at \$125 per tree, a decision was made to heli-log the remaining 105 trees.

The leftover infested trees were felled, limbed and bucked into pieces weighing no more than 545 kg. The stumps were peeled and larger branches, tops and chunks were burned. The cost of this operation was \$63 per tree. Each tree averaged 2.6 pieces for a total of 270 pieces. Six helicopter companies bid on the operation. The successful helicopter company removed the logs at a price of \$47 per piece. Turn around time averaged 1.8 minutes for the furthest sites which were 2000 metres away. The 545 kg limit was a satisfactory weight for the helicopter and all pieces were lifted successfully. Overall the heli-logging cost \$179 per tree.

Cost of the heli-logging could be reduced by:

1. Including all falling and bucking of trees in the helicopter company contract.
2. Allowing more time for preparation and bid tenders prior to project commencement.
3. Increasing the size of the project to allow for enhanced economies of scale.

- D. Wright, 100 Mile House Forest District, 100 Mile House.

Bowron Lake Park Blowdown Surveyed. Blowdown on more than 800 hectares of Bowron Lake Park was assessed in 1990 for spruce beetle outbreak risk by a task force of specialists from the Ministry of Parks, Forestry Canada, and the Forest Service.

Plans for this year include the deployment of about 400 lethal trap trees to contain the probable numbers of emerging spruce beetles; Lindgren funnel traps to monitor the spruce beetle flight; and surveys to monitor the effectiveness of trap trees, and to monitor beetle activity, both in blowdown areas, and in forests adjacent to blowdown.

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

Over-Wintering Bark Beetle Mortality in the Cariboo Forest Region. Information on winter survival of the mountain pine beetle in the Cariboo was collected from two forest districts. A total of 70 bark samples was collected and examined. Overwintering survival of the mountain pine beetle was 85% and 70%, for the Chilcotin and Horsefly Forest Districts, respectively. In samples collected from MSMA-treated trees in the Chilcotin, survival was less than 15%.

Douglas-fir beetle in the Cariboo is still at epidemic levels. Eight bark samples collected for Douglas-fir beetle in the 100 Mile House Forest District had 85% survival. The Williams Lake Forest District collected 20 bark samples from standing and windthrow trees. In the windthrow, overwinter survival was 69%, while survival was 44% in the standing trees. The difference was mainly attributed to the location on the tree where the samples were collected. On the windthrow trees the samples were taken as much as 4 metres along the bole from the base of the tree, whereas on the standing trees, samples had to be collected at the base, where attack is generally lower, and there is much more competition from woodborers.

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

Prince George Forest Region Special Issue Funding. A total of \$487,000 was spent in the Prince George Forest Region in 1990-91 on mountain pine and spruce beetle ground detection, pheromone baiting, monitoring, MSMA application and single tree disposal. Thirteen projects were undertaken in five districts, including regional activities.

Approximately \$1 million has been requested from the 1991-92 Special Issue Fund for 17 projects in seven districts. These funds will be expended on mountain pine beetle and spruce beetle projects similar to the above. As with last year's program, all activities will be monitored and/or audited by regional staff to ensure cost-effective expenditures.

- S.Taylor, Prince George Forest Region, Prince George.

Forest Health Crew Planned for Cariboo. Eleven high-school and university students will be hired and trained to conduct ground surveys for Douglas-fir beetle in July and August. Students will probe and mark trees for harvesting, and monitor traps in Williams Lake and 100 Mile Forest Districts. The crew will also carry out spruce leader weevil clipping for an operational trial in Horsefly Forest District.

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

Genetic Resistance to the White Pine Weevil in Sitka Spruce. Fifteen-year records of weevil attack at Sitka spruce provenance trial sites revealed large differences among provenances in percent of trees attacked and number of attacks per tree. This provenance variation in weevil attack was repeated in a clonal test, suggesting a genetic basis to weevil resistance. On average, provenances from high weevil hazard zones, and those from the Sitka-white spruce hybridization zones, showed a high level of resistance to weevil attack. Two provenances, Haney and Big Qualicum, showed high resistance to weevil and were also fast-growing. These are recommended as seed sources for reforestation at sites in high weevil hazard zones.

Selection and clonal screening of a large number of putative resistant trees is in progress. About 50 resistant clones can be released in 1996-97 for operational use.

- C. Ying, Research Branch, Victoria.

To Brush and Weed or Not to Brush and Weed? Regional free-growing standards dictate that a free-growing plantation must not be subjected to competing brush. However, there is a general belief that deciduous canopy removal will increase the severity of weevil damage, which may also make the stand non-free-growing. An attempt to quantify the effect of operational brushing and weeding on the annual attack rate of white pine weevil has recently been completed.

Four sites were examined in the Nass and Kitimat Valleys of the Kalum Forest District. At each site, weevil attack strip-surveys were conducted in stands that had been brushed and weeded, and in adjacent untreated stands. T-test comparisons showed that three to four sites in the treated stands had significantly greater (at $\alpha=.05$) numbers of post-treatment weevil attacks than the control sites. Unfortunately, control spruce leaders were significantly shorter than spruce growing without competing brush.

This summer, five replicate surveys will be established to compare weevil damage and leader growth in stands treated with normal brushing and weeding methods, stands in which brush has been removed in east-west strips, and untreated stands. These replicates will be located in the Nass and Kitimat valleys. This operational trial is a replicate of one established by Russ Cozens in the Prince George Forest Region.

These initial results suggest that an additional decision must be made before we prescribe brush and weed treatments in an area with a high weevil hazard. We should carefully judge whether the gains in height growth outweigh the potential volume and form reductions that will result from the increased intensity of weevil damage. Further work is required to quantify the cost/benefit analysis approach to this problem. Dr. Rene Alfaro's Spruce Weevil Attack Trial model may become an important component to this analysis.

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

The Effect of Spacing on White Pine Weevil Damage to Interior White Spruce. A study conducted on Sitka spruce by R. Alfaro and S. Omule in 1990, indicated that stand density had a significant influence on the level of weevil damage. Denser plantations sustained a lower intensity of attack, and had better tree form, than more open plantations.

Preliminary measurements on existing espacement trials in the Prince George Forest Region indicated that similar trends may exist in the interior of British Columbia. The intent of this study is to document these trends. If they are confirmed, minimum stocking standards on areas of high weevil hazard may have to be modified.

This project will be conducted in conjunction with Forestry Canada staff.

- S. Taylor, Prince George Forest Region, Prince George.

Warren's Root Collar Weevil Crisis is Over. University of British Columbia Forest Entomology MSc. candidate, Geoff Byford, has completed his report on the attack dynamics and chronic impacts of Warren's root collar weevil in young lodgepole pine plantations in the Kispiox Forest District. He dated individual weevil attacks on more than 1200 trees in four sites, stem mapping each site and doing stem analysis to determine the relationship of height growth to the intensity of weevil girdling and age of attack. Each rectangular plot extended 150 m from the margin into the plantation. After his exhaustive analysis, he concluded that there is negligible impact on height growth resulting from root collar weevil girdling, except when the stems are very young. This is very reassuring news after Geoff's 1990 survey of 30 plantations in the Kispiox showed every stand was attacked and attack rates approached 100% of the stems.

Another interesting result of Geoff's work was the discovery that the majority of weevil attacks began five years ago and have increased rapidly in each subsequent year. Because of the weevil's life cycle, it is not possible for the insect to survive in stumps long enough to create the observed population increases. The attack pattern within the stand examined indicated that the weevil was distributed evenly, so it does not appear that it had dispersed slowly into the stand from the mature timber on the plantation margin. This result differs from Dr. Herb Cerezke's landmark observations on the weevil in the Alberta foothills. Copies of Geoff Byford's report are available from the Prince Rupert Forest Region Forest Health Section.

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

Spruce Budworm and Spruce Beetle in Fort Nelson Forest District. The Fort Nelson Forest District presently has two major pests of concern: the spruce budworm, *Choristoneura fumiferana*, and the spruce beetle, *Dendroctonus rufipennis*. Spruce budworm is found throughout most of the District and records indicate that infestation levels have been cyclic since initial surveys were conducted in the 1950's. The most recent outbreak has been expanding for the past five years. During Forestry Canada's July 1990 aerial survey, 318 600 hectares of infested spruce were mapped. This was more than double the area mapped in 1989.

Approximately 525 hectares of mature white spruce seed production stands were aerially treated in June, 1990 with the biological insecticide, *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.).

A localized spruce beetle infestation was discovered for the first time in the District in January 1991 in a harvesting area east of Kotcho Lake. The infestation had been endemic until 1987-1988 when standing trees first began to be attacked. Fading foliage on most killed trees was evident only by late 1990. The licensee, Tackama Forest Products Ltd., subsequently conducted probes in the general area of the infestation. In those areas with the highest beetle population, a large number of conventional trap trees were deployed, and these will be harvested next winter.

In the summer of 1991 we plan to conduct aerial surveys and ground probes to better determine the extent of the infestation. A two to three year concerted trap tree program is anticipated, to reduce the beetle hazard.

- A. Boyer, Fort Nelson Forest District, Fort Nelson.

Spruce Budworm Control in the Fort Nelson Forest District. In June 1991, approximately 525 hectares of mature spruce seed production stands in the Fort Nelson Forest District will be treated with two aerial applications of the biological insecticide, *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) in an attempt to reduce defoliation and cone crop damage by the spruce budworm, *Choristoneura fumiferana*. Three locations, encompassing a total of five blocks, will be treated with an oil formulation of Dipel^R 132 at a rate of 2.4 L/ha. Contract tender bids for the aerial application are due on May 10, 1991. For further details, contact the undersigned.

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

Western spruce budworm. Approximately 4 500 ha of Douglas-fir in the Vernon Forest District will be treated with *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) to protect the foliage from budworm defoliation. The treatment site is in the Falkland/Paxton Valley area and encompasses good and medium growing sites which have been spaced, or are prime candidates for spacing. The area was severely defoliated in 1990, and to varying degrees in 1989. Therefore, this is an optimum time for treatment.

If the area is defoliated for another year without some protection, understory mortality will likely be severe on some sites and top kill will increase. In some of the spaced and selectively harvested areas, there is already noticeable mortality. Second instar larval sampling is in progress and will help delineate treatment areas and predict levels of defoliation in 1992. From the minimal egg mass sampling done, predictions are for moderate to severe defoliation.

- L. MacLauchlan, Kamloops Forest Region, Kamloops.

Douglas-Fir Tussock Moth. A total of 13 infestation epicentres have been identified after extensive egg mass surveys were conducted in many locations throughout the susceptible stand types in the Kamloops Forest Region. These centres are in two main clusters, one near the western end of Kamloops Lake, near Savona, and the other in the Hedley/Princeton area. Both these locations have long histories of tussock moth infestations. The total area of expected defoliation and/or treatment is likely to be no more than 400 ha.

Proposed treatments are as follows:

- 1) Savona Group: 8 epicentres, varying in size and ranging between light and moderate expected defoliation. Of these, the single, somewhat isolated spot north of Kamloops Lake will be left untreated to serve as a check on treatment efficacy. The three most western spots and the isolated spot southeast of the main group will be treated with Virtuss^R (the Canadian-made virus product); the remaining 3 spots will be treated with TMBioControl -1^R (the USFS product). All treatments will be applied by air (rotary wing).
- 2) Hedley/Princeton Group: 5 small epicentres, including a portion of Stemwinder Provincial Park and the township of Olalla. Three centres near Hedley are targetted for a pheromone confusion trial, to be carried out by Forestry Canada. This trial is intended to develop an alternative to virus use, thereby ensuring a selection of treatment options.

Unfortunately, to avoid contamination of the pheromone trials, the use of nuclear polyedrosis virus (NPV) is not possible. Therefore, a double application of *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) is proposed for Stemwinder Park to protect park values.

So far, all public reaction has been favourable with regard to the Forest Service carrying out a treatment program.

- P. Hall, Protection Branch, Victoria.

Spruce Beetle and Spruce Budworm in the Mackenzie Forest District. Aerial detection and ground surveys have indicated extensive infestations of the spruce beetle, *Dendroctonus rufipennis*, in the southwestern quarter of the district. A major flight of the two-year cycle beetle is expected in June of this year. Cooperative actions will be taken by Fletcher Challenge Canada Ltd., Finlay Forest Industries Ltd. and the Forest Service, to identify the majority of the infestation areas and to initiate control measures where necessary. Continued cooperative actions should reduce the infestations to a manageable level.

An outbreak of two-year cycle spruce budworm, mapped in the Ospika River Valley during the summer of 1989, is expected to reappear this year. Aerial and ground investigations of the area will be made to map and manage this infestation, if necessary.

- A. R. Kneeland, Mackenzie Forest District, Mackenzie.

New Balsam Woolly Adelgid Infestation. A new area of active balsam woolly adelgid infestation has recently been found on the east slope of Mt. George on the mainland coast, north of West Thurlow Island. The Forest Insect and Disease Survey Unit of Forestry Canada also found a new, very light infestation on mature grand fir just beyond the present quarantine boundary at Tribune Bay, Hornby Island. It appears that the balsam woolly adelgid infestation may be expanding on the British Columbia coast.

However, the new find on Mt. George, combined with areas of infestation on West Thurlow Island, which are both significantly isolated from the main area of infestation on southern Vancouver Island and the Lower Mainland, suggests that the balsam woolly adelgid might be more widely dispersed than previously thought. Detection at low population levels is very difficult. The recent expansion in Idaho also continues to reinforce concern that the adelgid will be introduced and established in the B.C. interior. In a 1967 report by Atkins (Forestry Canada - Information Report BC-X-12) a hazard rating map shows a high hazard zone, reaching as far north as Bella Coola, and eastward to the Okanagan.

- D. Heppner, Vancouver Forest Region, Burnaby.

Gypsy Moth. In 1990, pheromone traps caught single male moths in several locations. Multiple catches were found only on the Saanich Peninsula of Vancouver Island, where 95 male moths, and 12 females were captured. Fourteen pupal cases, and 36 egg masses were also discovered. All finds were in a concentrated area near the Victoria International Airport, where stands of conifer and deciduous trees are interspersed with open farm land. An eradication program will be undertaken in this area in the early summer of 1991.

Three ground spray applications will be made to a 37 ha core area, as well as three aerial applications over a 115 ha area. All sprays will be with *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) The chosen formulation is Foray[®] 48B produced by Novo. This is an aqueous formulation and has full registration in Canada. The application rate is still to be determined, but 40-50 BIU's (billion international units) per ha has been proposed. Permits have been submitted and advertising will be carried out according to the new Pesticide Control Branch requirements. The eradication program will be carried out by Agriculture Canada with support from the B. C. Forest Service, B. C. Ministry of Agriculture, and Forestry Canada.

Provincial trapping will continue in 1991, and the B. C. Forest Service will continue to assist where possible.

- P. Hall, Protection Branch, Victoria.

Entomology Summer Students in the Prince George Forest Region. Two students have been hired through the University Cooperative Education and Summer Youth Employment programs to assist with entomology projects in the Prince George Forest Region. A Co-op student has been hired from the Biology Department of Simon Fraser University, and a Summer Youth Employment student has been hired from the Forest Technology Program at the B. C. Institute of Technology. Students will assist the forest entomologist and forest health officer in a variety of insect control, operational research, and survey projects.

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

Cariboo Aerial Pest Survey. Results of the 1990 aerial survey are presented in the Tabulations and Graphics Section.

District staff will undertake a comprehensive aerial sketch-mapping survey this summer, with assistance from regional specialists. The entire region will be surveyed again, with areas of historically low pest incidence inspected at a less rigorous level. Some assistance from short-term contractors will be required.

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

FOREST PATHOLOGY

Pinewood Nematode Update. Restrictions on the movement of B.C. forest products into the European Economic Community (EEC) are continuing, and might be increased because of the pinewood nematode issue.

The EEC has required that all North American wood products imported to the EEC be kiln-dried to eliminate the nematode. A one-year reprieve was negotiated with some countries, notably the United Kingdom, based on a bark-free certification program that was developed for B.C. mills. The certification program is administered by the Council of Forest Industries of B.C., and Agriculture Canada Plant Health personnel, and reportedly is working well to date.

Negotiations and missions to the EEC countries are continuing in an effort to obtain a continuing exemption from kiln-drying for coastal B.C. mills.

A research project to develop more practical and economical methods for killing pinewood nematodes in wood products is also underway.

-J. Muir, Protection Branch, Victoria.

Forest Disease Surveys in Prince George Forest Region. The Prince George Forest Health section has hired four summer students under the Summer Youth Employment Program to work on various forest disease surveys in the summer of 1991. Two student crews will be assigned to the Robson Valley and Mackenzie Forest Districts to conduct the following surveys:

Robson Valley Forest District-Armillaria Root Disease Assessment in Plantations and Mature Forests:

- a) Assessing 30 - 40 young conifer stands in a two-stage survey near Kinbasket Lake. If armillaria root disease is found, a formal line survey will be conducted;
- b) Assessing proposed harvesting areas scheduled for the next 10 - 20 years. Ten stands will be surveyed using a line-intercept method;

- c) Comparing the incidence and intensity of infections in various cutblocks and unharvested areas to obtain an estimate of the future impact of *Armillaria* spp. if logging continues without regard to the disease; and
- d) Establishing at least five 1-hectare sampling areas, and stem-mapping and assessing all trees.

Mackenzie Forest District-Hazard Rating Young Lodgepole Pine Stands for Stem Rusts:

- a) Assessing 50 -60 stands for incidence of various stem rusts. The rate of spread will also be determined by dating samples of infections from each stand. The goal of this work is to create a hazard rating system based on biogeoclimatic criteria;
- b) Assessing lodgepole pine dwarf mistletoe eradication work and establishing control plots adjacent to treatment areas;
- c) Establishing a sanitation spacing trial if time permits.

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

Cranbrook Forest District Armillaria Operational Trial. Cranbrook Forest District is conducting an armillaria root disease operational trial near Fort Steele. This Douglas-fir site has a 94.8% armillaria incidence rate and is divided into four treatment areas:

- 1) Pushover logged with a backhoe. The logged material has been double-scaled to determine the volume gained by bucking the trees at, or below the ground line, versus bucking at the stump height used in conventional logging. Extra volume attributed to trees at, or just below standard merchantable limits, and to reduced breakage factors, was also determined.
- 2) Conventionally logged to the standard diameter limit. The logged material will be monitored in this condition.
- 3) Conventially clearcut logged with slash left in place. This area will be broadcast burned and monitored to determine the burn effect. It is hoped that the burn will induce rhizina root disease so that it can be determined whether rhizina acts as a biological control agent on armillaria.

- 4) **Control area.** Grass will be seeded and maintained for 20 years to prevent conifer regeneration. The duration of this study is anticipated to be 100 years.

- A. Krane, Cranbrook Forest District, Cranbrook.

Destumping for Laminated Root Rot Gets a Lift. Following a review of nearly 30 coastal root rot stumping projects of the past decade, it was found that stumping costs per hectare could be predicted from stand and site variables. The stumping cost per ha formula is a linear function using timber cruise-based, average Douglas-fir diameter ($>17.5\text{cm}$), and average percent slope for independent predictors. The formula is also convertible to prorata costs per cubic metre.

The stumping cost formula will simplify cost and benefit estimation for treatment of laminated root rot. The formula is presently applicable to coastal second growth Douglas-fir stands, treated with excavators. The cost/ha formula will be updated as new project data becomes available.

- J. Beale, Protection Branch, Victoria.

Laminated Root Rot Hazard Rating Trial. Jeff Fournier and Jeff Beale will combine forest cover inventory information with root rot incidence data collected from ground surveys to generate Timber Supply Block-wide hazard ratings. Disease incidence information that has been stratified on the basis of supply block, inventory type group, age class, site class and biogeoclimatic variant will be "matched" to cover labels of individual polygons.

The generated information will be used to produce colour-theme maps and an electronic data base that will ultimately be loaded on the geographic information system. The hazard values, as with those produced for the mountain pine beetle, will provide a long term planning tool for detailed survey efforts and for budgets. The theme maps will also aid in auditing Pre-harvest Silviculture Prescriptions.

- J. Fournier, Vancouver Forest Region, Burnaby, and
J. Beale, Protection Branch, Victoria.

Assessing White Pine Pruning in Salmon Arm. Jim Wright, Salmon Arm Forest District silviculturist, has devised a survey system to assess whether the white pine component of a forest stand should be pruned to reduce the impact of white pine blister rust. The survey consists of three parts: a pre-pruning survey; a slight modification to the pre-stand tending site description/prescription form (FS770); and a post-pruning survey.

Jim produced a data card for the pre-and post-pruning surveys and made modifications to the FS770 form. He successfully field-tested the survey last year. This year the survey will be included in all Salmon Arm Forest District regeneration survey contracts. The post-pruning survey can be rerun periodically to check the efficacy of the treatment. All pruning treatments of white pine in the Kamloops Forest Region will be handled as silviculture/protection trials.

- H. Merler, Kamloops Forest Region, Kamloops.

Coastal Western White Pine Seed Production. The first seed collections from the Texada Island seed production area (SPA) were made in the fall of 1990 from 64 trees cone-bagged in March 1990. Collections and seedlots are based on the blister rust conditions of the parent seed trees as follows:

- (1) healthy, blister rust-free,
- (2) blister rust present as non-lethal branch cankers and/or slowly developing bole cankers, and
- (3) blister rust present as slowly developing bole cankers with superior bark reactions.

Collections from trees with superior bark reactions were favoured as these trees have nearly reached merchantable sizes despite the occurrence of basal cankers.

Western white pine seed from the Texada Island SPA will be used to reforest areas infected with laminated root rot through the Small Business Forest Enterprise Program. Although white pine crops will be pruned it is hoped that bark reactions may reduce risk to blister rust. Forestry Canada is also running three to five selected trees through the blister rust resistance screening process in 1991, courtesy of Dr. Rich Hunt.

- J. Beale, Protection Branch, Victoria, and
R. Diprose, Sunshine Coast Forest District, Powell River.

Keep those Galls Away. A silviculture trial (SX 91402 K) was established with the assistance of Peter Lishman, Kamloops Forest District silviculturist, to study the effects of spacing and pruning on western gall rust in young lodgepole pine stands. The two treatments involved were spacing and removal of gall-infected stems, and spacing, removal of gall-infected stems and pruning of gall-infected branches. There was also an untreated control area.

Stand attribute measurements were taken before the treatments. Immediately after the treatments several fixed-radius permanent plots were established. These will be remeasured periodically.

- H. Merler, Kamloops Forest Region, Kamloops.

MAMMAL MANAGEMENT

Regional Mammal Specialist's Term Extended. Scott Harrison, Prince Rupert Forest Region mammal specialist, has had his term of employment extended for another six months. In that time, he intends to carry out numerous small-mammal projects that he has initiated throughout the Region.

Scott has been working diligently on the porcupine problem through his involvement in the fisher reintroduction program in the North Coast Forest District. He has also been analyzing the timber supply impacts of porcupine damage in the North Coast and Kalum Forest Districts, and preparing plans to establish permanent sample transects to assess annual porcupine damage rates. Scott has provided assistance to the districts by answering their questions on voles, and, to a limited extent, on wildlife habitat issues.

Scott is a valuable resource to the district managers in our Region. We intend to make his position permanent as quickly as possible. I encourage you to call Scott and find out first hand how a wildlife biologist can help you handle mammal pest problems.

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

RANGE PEST MANAGEMENT

Weed Biological Control Agent Releases in the Cariboo Forest Region. Distribution of weed biological control agents continues in the Cariboo Forest Region. Releases during the summer of 1990 are summarized as follows:

Agent Released	Weed Target	Releases	Sites
<i>Agapeta zoegana</i>	Spotted knapweed	3	3
<i>Urophora stylata</i>	Bull thistle	7	7
<i>Sphenoptera jugoslavica</i>	Diffuse knapweed	32	8
<i>Aphthona cyarissiea</i>	Leafy spurge	2	2
<i>Aphthona flava</i>	Leafy spurge	1	1
<i>Aphthona nigriscutis</i>	Leafy spurge	2	2
<i>Calophasia lunula</i>	Dalmation toadflax	1	1
<i>Metzneria paucipunctella</i>	Spotted knapweed	6	4
<i>Rhinocyllus conicus</i>	Nodding thistle	2	2
Total		56	

Releases of the *Agapeta zoegana*, a root feeding moth, were targetted to sites which could not be chemically treated due to adjacent water bodies.

Aphthona spp. have all been released on two major infestations of leafy spurge. One is located near Alexis Creek, and the other near Canoe Creek in the southern portion of the region.

Previous attempts to establish the defoliator moth, *Calophasia lunula*, have been unsuccessful. This might be the final trial. *C. lunula* appears to be susceptible to predators and is itself attacked by a parasitic wasp and fly native to British Columbia.

- C. Easthope, Cariboo Forest Region, Williams Lake.

Biological Control of Bull Thistle. In past years the Cariboo Forest Region has included bull thistle, *Cirsium vulgare*, as a minor target species in its chemical weed control program. This is no longer the case. Bull thistle has been removed as a target species from the Region's pesticide permit for weed control.

While perhaps the most successful means of bull thistle control will continue to be good site revegetation following disturbance, the Cariboo Forest Region's Range Section is examining the usefulness of the seed head attacking fly, *Urophora stylata*. The fly, first released in B.C. in 1973, has become well established in the warmer southwestern portion of the province. In this area, the fly will attack up to 95% of the seed heads on a site, and has reduced seed production by approximately 60%. Releases have been made at interior locations in the past but the results have not been well documented.

A research site was established in the Big Lake area of the Cariboo Forest Region in the spring of 1990, where the fly's success in establishment and survival is being monitored, along with its impact on weed density.

Initial establishment looked promising in the fall of 1990. The number of seed heads attacked averaged 10.7% with an average of 2.1 larvae per head. Overwintering survival, the big question in the interior, will be monitored in a few weeks.

- C. A. Easthope, Cariboo Forest Region, Williams Lake.

Biological Control of Bull Thistle. Four releases of a seed head fly, *Urophora stylata*, were made in 1990 in the McBride area. These releases will be monitored in 1991 for survival of the agent. Six more releases are planned for 1991.

- B. Johnson, Prince George Forest Region, Prince George.

Biological Control of Canada Thistle. One release of *Larinus planus* was made in the Vanderhoof area in 1990. This release will be monitored in 1991 for agent survival. One additional release is planned for the McBride area in 1991. In addition, one release of the gall forming fly, *Urophora cardui*, is planned in the McBride area.

- B. Johnson, Prince George Forest Region, Prince George.

PESTICIDES

Regionalization of the Pesticide Use Permit System. As reported in the fall edition of Pest Management Progress, the Pesticide Control Branch has decentralized the pesticide permit system to their six regional offices. In coordination with this, the Forest Service has regionalized its review of permit applications. Staff in Victoria will no longer review applications. The Pesticide Control Committee will continue to function in Victoria to ensure provincial pesticide use standards are met, and to facilitate permit review continuity between regions.

The regional reviewers of permit applications are as follows:

Prince Rupert Forest Region:	Lou Tromp
Prince George Forest Region:	Rob Bowden
Cariboo Forest Region:	Jane Perry
Nelson Forest Region:	Gerry Reichenback
Kamloops Forest Region:	Ron Gray
Vancouver Forest Region:	
Vancouver Island and	
Mid Coast Forest District:	Mel Scott
Vancouver Forest Region mainland:	Dick Knotts
Queen Charlotte Islands Forest District:	Del Williams.

Details associated with who in the regions will specifically be responsible for reviewing the different types of proposed pesticide treatments to vegetation, insects and noxious weeds will be resolved by the regions. As well, problems associated with the different regional boundaries of the Ministry of Environment and the Ministry of Forests will soon be resolved.

Permit applications from forest districts should be sent directly to the appropriate regional reviewer. The reviewer will forward the application to the appropriate regional Pesticide Control Branch manager. Forest licensee permit applications should be sent to the appropriate Pesticide Control Branch manager. The manager will forward a copy of the licensee's application, in referral, to the appropriate Forest Service reviewer for comment.

If you wish addition information on this regionalization of the pesticide permit system, please contact me.

-J. Henigman, Protection Branch, Victoria.

New Edition of the Forest Supplement to the Handbook for Pesticide Applicators and Dispensers. The new edition of the Forest Supplement has been turned over to the Pesticide Control Branch for printing. Copies of the new edition can be obtained from the Pesticide Control Branch regional offices. We will send copies of this new publication to all of the Ministry of Forests region and district offices.

- J. Henigman, Protection Branch, Victoria.

Metasystox-RR Minor Use Resistraton Expanded. As of March 22, 1991, Metasystox-R (PCP No. 7882) has been registered for sale and use against Douglas-fir, spruce and western red cedar cone, and seed insects. The following label directions apply to forest seed orchard and seed production stand applications:

1. As an annual spray, use 1-2 L product/100 L water against cone and seed insects such as gall midges, seed chalcids, cone maggots and cone midges in Douglas-fir and spruce. Applications should be made after conelets have closed but before they become pendant. For western red cedar apply at the first sight of insect egg hatch in the cones.
2. As a trunk injection technique, for Douglas-fir and spruce cone and seed insects, use 2 ml product/10-15 cm of circumference near the base of the tree. Apply 3 ml of product with a syringe to a 1x3 cm hole placed every 10-15 cm around the trunk. The application period is the same as for spray treatments.

For more information contact Don Summers or Bev McEntire, Silviculture Branch, Victoria, 387-1191.

- B. McEntire, Silviculture Branch, Victoria.

Bait Use and Registration. Over the past several years the use of attractant baits for bark beetle management has increased substantially. Until now, there has been no need for registration of the baits or for a pesticide use permit, even though the literal interpretation of federal and provincial legislation and regulations includes semiochemicals as pesticides. The position taken by the regulators has been to relax the regulations pending the development of a position on these biorational pest management products.

Pesticide Use Permits will not be required in the near future; however, this may change when Federal and Provincial regulators establish a position. The Forest Service has indicated its willingness to cooperate with regulatory agencies at the provincial and federal levels in developing reasonable guidelines for future use.

The Forest Service will also provide an annual report to the Pesticide Control Branch summarizing bait use in the province.

Use of anti-aggregant semiochemicals, especially when broadcast applied, will be done under federal and provincial permits only. If Forest Service support is requested by researchers for trials of semiochemicals, proof of permit application will be required as a condition.

- P. Hall, Protection Branch, Victoria.

Verbenone Program - 1991. The "definitive" test of verbenone (an antiaggregative semiochemical for mountain pine beetle control) will be done this summer season. A joint project with Simon Fraser University, Phero Tech and the B.C. Forest Service is being done in the Merritt and Penticton Forest Districts. To date, two methodologies have been applied:

- 1) ground application in the form of a tree-bait (bubble cap)
- 2) aerial application of polymer beads impregnated with verbenone

The bubble caps, which are deployed in a 10 m grid pattern, show the most promise. Results of previous year's trials are somewhat inconclusive due to the wide range of site and beetle conditions, but the overall effect of the verbenone appears to have been good. The verbenone beads, however, have not shown the promise first anticipated.

The 1991 experiments will be done in stands with a range of mountain pine beetle beetle attack levels in order to delineate the range of verbenone efficacy. The treatment block size will vary, depending on attack levels, area, and access. The goal is to have 20 replicates of the verbenone treatment, with a minimum block size of 3 ha and maximum of 10 ha. There will be a representative control block for every treatment block.

- L. MacLaughlan, Kamloops Forest Region, Kamloops.

Kamloops Forest District - District-Wide MSMA Application. The Kamloops Forest District submitted an application for a pesticide use permit for MSMA (monosodium acid methanearsonate, a pesticide used to kill beetles in felled trees) in January 1991. So far we have not received any negative comments. In fact, during the 30 day advertising period we received one rather strong letter of support from Sandy MacDonald of the Fish and Wildlife Branch.

If anyone applying for a new MSMA permit wants a copy of our Appendix 1 - "Additional Information for Forestry Applications", please give me a call.

The Pesticide Control Branch expects to issue a permit to us before the end of April 1991 - just in time to do our spruce beetle lethal trap trees.

- D. Pigin, Kamloops Forest District, Kamloops.

Pre-attack Injection of MSMA against Mountain Pine Beetle. In the Vanderhoof Forest District in 1991, approximately 60 lodgepole pine trees will be baited with mountain pine beetle semiochemicals. A portion of these will also be injected with 1/2-strength MSMA (160 g active ingredient /L) in late June, and the remainder of the baited trees will be left untreated to serve as checks.

The objectives of the trial are two-fold:

- 1) to re-confirm that mountain pine beetles will attack trees treated with 1/2-strength MSMA and not be repelled, and
- 2) to determine if this dosage of MSMA will successfully prevent brood maturation.

Plot trees will be examined for pitch tubes approximately once per week from early July until the termination of the adult beetle flight in August. In May 1992, all attacked pine will be felled and sampled in order to determine treatment efficacy.

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

AWK Oil Treatment of Mountain Pine Beetle in Prince George Forest Region. In June 1991, AWK oil (Agriculture Weed Killer ^R), a low content aromatic mineral oil with insecticidal properties, will be sprayed on lodgepole pine bolts infested with mountain pine beetle in order to test the product's efficacy in killing newly developing adults prior to their emergence. If successful, this trial will complete the efficacy data required for a minor-use registration of AWK oil against mountain pine beetle.

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

Insecticide Stem Implants Applied for White Pine Weevil Control on Interior

White Spruce. The purpose of this trial is to determine the effectiveness of dimethoate and oxydemeton-methyl in preventing white pine weevil attacks on interior white spruce. It is anticipated that this control technique, if successful, would be useful on spruce stands of high value. Three application rates will be tested and the duration of control monitored.

It is hoped that the results of this trial, in conjunction with similar work being conducted on the coast, will be used to pursue a Minor Use Product Registration for at least one of these products.

- S. Taylor, Prince George Forest Region, Prince George.

PEST MANAGEMENT PERSONNEL

**Forest Service Personnel fully or partly committed
to forest pest management activities**

Protection Branch

John Muir	A/Manager, Forest Health	Victoria	387-8740
Peter Hall	Forest Entomologist	Victoria	387-8742
John Henigman	Pesticide Specialist/ Vertibrate Pest Specialist	Victoria	387-8738
Vacant	Forest Pathologist	Victoria	387-8739
Jeff Beale	Forest Health Officer	Victoria	387-8763
Pat Humphreys	Forest Health Technician	Victoria	387-8737

Silviculture Branch

Mike Wyeth	Silviculturalist	Victoria	387-8922
Jacob Boateng	Brushing and Weeding Specialist	Victoria	387-8905
Nancy Densmore	Stand Tending Operations Forester	Victoria	387-8912
Don Summers	Seed Production Pest Mangement Technician	Victoria	387-3931
Bev McEntire	Seed Production Pest Management Technician	Victoria	387-8938
Gwen Shrimpton	Nursery Pest Management Officer	Surrey	576-9161
Dave Trotter	Nursery Pest Control Officer	Surrey	576-9161

Cariboo Forest Region

Region Staff

Hugh Freeman	Protection Officer	Williams Lk.	398-4445
Mark Hamm	Pest Management Forester	Williams Lk.	398-4441
Leo Rankin	Forest Entomologist	Williams Lk.	398-4439
Don Doidge	Forest Pathologist	Williams Lk.	398-4442
Jane Perry	Sand Tending Forester	Williams Lk.	398-4400
Chris Easthope	Range Agrologist	Williams Lk.	398-4396

Cariboo Forest Region Cont.

District Staff

Richard McKay	Resource Officer Protection	Chilcotin	394-4315
Glen Burgess	Resource Assistant Protection	Chilcotin	394-4215
Tom Matzen	Resource Officer Protection	Horsefly	620-3417
Dennis Asher	Resource Officer Protection	Quesnel	992-4400
Brad Powell	Resource Assistant Protection	Quesnel	992-4433
Barry Alexander	Resource Officer Protection	Williams Lk.	398-4339
Von Vickers	Fire/Pest Management Officer	Williams Lk.	398-4690
Mel Dodge	Resource Officer Protection	100 Ml. H'se	398-3812
Don Wright	Pest Management Officer	100 Ml. H'se	395-3812

Kamloops Forest Region

Region Staff

Lorraine MacLauchlan	Forest Entomologist	Kamloops	828-4177
Hadrian Merler	Forest Pathologist	Kamloops	828-4176
Ron Gray	Stand Tending Forester	Kamloops	828-4163
Phil Youwe	Range Resource Agrologist	Kamloops	828-4097

District Staff

Mike Hall	Resource Assistant	Clearwater	674-2265
Dave Piggin	Pest Management Officer	Kamloops	372-5832
Rick Swift	Resource Officer, Protection	Kamloops	372-5832
Nina Barber	Protection Clerk	Kamloops	372-5832
Margo Hollinger	Pest Management Officer	Lillooet	256-7531
Tom Lacey	Resource Officer, Protection	Merritt	378-9311
Harry Spahan	Pest Management Officer	Merritt	378-9311
Jim Mottishaw	Pest Management Officer	Penticton	492-8721
Murray Henry	Pest Management Technician	Penticton	492-8721
Dave Procter	Resource Officer, Protection	Salmon Arm	832-7153
Jim Wright	Resource Officer, Silviculture	Salmon Arm	832-7153
Eric Haupt	Pest Management Officer	Vernon	542-0264

Nelson Forest Region

Region Staff

Rick Stewart	Pest Management Forester	Nelson	354-6144
Don Norris	Forest Pathologist	Nelson	354-6143
Gerald Reighenbach	Stand Tending Forester	Nelson	354-6280
Jack King	Range Officer	Nelson	354-6243

District Staff

Dan Reiben	Pest Management Officer	Arrow	365-2131
Ross Elliot	Pest Management Officer	Boundary	442-5411
Art krane	Pest Management Officer	Cranbrook	426-3391
Rob Beugeling	Resource Officer	Golden	344-7500
Elizabeth Williams	Forest Health Technician	Golden	344-7500
Emile Begin	Pest Management Officer	Invermere	342-4200
Doug McMullin	Pest Management Officer	Kootenay Lk.	825-4415
Archie McConnachie	Resource Officer - Protection	Revelstoke	837-7611
Peter Martiniuk	Forest Health Technician	Revelstoke	837-7691

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	Pr. George	565-6123
Rob Bowden	Stand Tending Forester	Pr. George	565-6191
Ken Long	Range Officer	Pr. George	565-6138
Bruce Johnson	Range Development	Pr. George	565-6139
	Co-ordinator		

Prince George Forest Region Cont

District Staff

Dave Dunsdon	Resource Officer - Protection	Dawson Creek	784-2350
Rick Grayston	Resource Assistant - Protection	Dawson Creek	784-2350
Bruce Young	Resource Officer - Protection	Fort Nelson	774-3936
Alvin Boyer	Resource Assistant - Protection	Fort Nelson	774-3936
Lance Mitchell	Resource Officer - Protection	Ft. St. James	996-7131
Terry Corley	Resource Assistant - Protection	Ft. St. James	996-7131
Al Kneeland	Resource Officer - Protection	Mackenzie	997-2249
Clint Reiter	Resource Assistant - Protection	Mackenzie	997-3310
Lyle Mortenson	Forest Health Coordinator	Mackenzie	997-2200
Jim Massey	Resource Officer - Protection	Ft. St. John	787-3483
Dale Cinnamon	Resource Officer - Protection	Robson Valley	569-2265
Lloyd VanDerMark	Resource Assistant - Protection	Robson Valley	569-2265
Fred Turner	Resource Officer - Protection	Pr. George	565-7100
Bruce Doerksen	Resource Assistant - Protection	Pr. George	565-7100
Vacant	Resource Officer - Protection	Vanderhoof	567-6363
Mike Dittaro	Resource Officer - Protection	Vanderhoof	567-6363

Prince Rupert Forest Region

Region Staff

Steve Schmidt	Protection Officer	Smithers	847-7475
Tim Ebata	Forest Entomologist	Smithers	847-7479
Stephan Zeglan	Forest Pathologist	Smithers	847-7478
Bill Young	Pest Management Forester	Smithers	847-7477
Lou Tromp	Stand Tending Forester	Smithers	847-7514
Don Russell	Range Officer	Smithers	847-7443
Scott Harrison	Mammal Pest Specialist	Smithers	847-7717

District Staff

Erwin MacDermid	Resource Officer - Protection	Bulkley	847-7555
Gordon Munroe	Resource Officer - Protection	Cassiar	771-4211
Joe Katasonoff	Resource Officer - Protection	Kalum	638-3302
Kas Kopeo	Resource Assistant - Protection	Kalum	638-3290

Prince Rupert Forest Region Cont

District Staff cont.

Brian Atherton	Resource Officer - Protection	Kispiox	842-6581
Brian Simpson	Resource Officer - Protection	Morice	845-6200
Jim Highstead	Resource Assistant - Protection	Morice	845-6200
Bill Jackson	Resource Officer - Protection	North Coast	627-0457
Bill Davidson	Resource Officer - Protection	Lakes	692-2223

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

Terry Preston	Resource Officer - Protection	Campbell Rv.	286-3282
Eric Meyer	Resource Assistant - Protection	Campbell Rv.	386-3282
Greg Hemphill	Resource Officer - Protection	Chilliwack	794-3361
Brenda Koro	Resource Assistant - Protection	Chilliwack	794-3361
Pat Hayes	Resource Officer - Protection	Duncan	746-5123
Wade Matheson	Resource Assistant - Protection	Mid Coast	982-2621
Dan Powell	Resource Officer - Protection	Pt. Ibern	724-9205
Bob Pfannenschmidt	Resource Assistant - Protection	Pt. Alberni	724-9205
Clarence Friesen	Resource Officer - Protection	Pt. McNeill	956-4416
Tim Neal	Resource Assistant - Protection	Pt. McNeill	956-4416
Ron Diprose	Resource Officer - Protection	Sunshine C.	485-9832
Rick Machowski	Resource Officer - Protection	Qn. Char. Is.	559-8447
Brian Eccles	Resource Assistant - Protection	Qn. Char. Is.	559-8447
Keith Davis	Resource Officer - Protection	Squamish	898-9671

MEETINGS

Western International Forest Disease Work Conference. The 1991 annual meeting will be held at Silver Star Ski Lodge, near Vernon, B.C., August 5-9.

For local arrangements, contact Hadrian Merler, forest pathologist, Kamloops Forest Region. Rich Hunt, Pacific Forestry Centre, Victoria, is organizing the program. Don Norris, forest pathologist, Nelson Forest Region, and Ken Russell, forest pathologist, Department of Natural Resources, Olympia, Washington, are organizing a pre-conference trip from Washington through the southern interior of B.C. to view root disease-control operations and trials.

-J. Muir, Protection Branch, Victoria.

Western Forest Insect Work Conference. The 1991 Forest Insect Work Conference was held in Denver, Colorado, during the week of March 25th. This was a North American conference rather than a western region session. All work conferences (western, central, eastern, and southern) met together. The theme of the conference was "Meeting Pest Management Challenges in the 21st Century". Approximately 400 people attended from research and management agencies in the U.S., Canada, and Mexico. The conference was well run and informative. Summary notes and assorted documents are available from the undersigned.

The 1992 conference will be held in Penticton, B. C. at the Lakeside Inn during the week of March 2nd. A tentative program has been developed and circulated to a variety of parties. There is no set theme for the conference but workshops will cover a wide variety of forest health topics relating to forest insect management. Forest Service staff will hopefully be able to actively participate. A copy of the proposed program is available from the undersigned.

- P. Hall, Protection Branch, Victoria.

Soviet Gypsy Moth Workshop. Agriculture Canada and the B.C. Plant Protection Advisory Council sponsored a Soviet gypsy moth workshop in New Westminster on February 18, 1991. The workshop resulted from Agriculture Canada's concerns about the possible introduction of the Siberian and/or Soviet far east gypsy moth, *Lymantria asiatica*, biotypes. Hundreds of egg masses have been recently found on ships arriving in Vancouver from the east coast of the Soviet Union.

Dr. W. Wallner, of the U.S. Forest Service, who has spent a considerable amount of time in the Soviet Union studying the gypsy moth problem, was the guest lecturer.

There are several important differences between the North American (originally introduced from Europe) and Asian varieties that will have an impact on any future detection and control strategies. The most important difference is that the Asian female is a strong flier (the North American variety is flightless) and is attracted to light. Also the first and second instars of the Asian varieties are more vigorous than their North American counterparts and they prefer larch, as well as alder, willow and oak. They are also known to feed on wheat. Fortunately however, the Asian varieties seem to be equally responsive to pheromones and can be controlled with *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) and nuclear polyhedrosis virus (NVP).

Strategies were developed to tackle both the immediate problem of infested ships arriving in Vancouver and the long term problem of building a program that will effectively prevent the introduction and spread of the Asian gypsy moth.

- P. Humphreys, Protection Branch, Victoria.

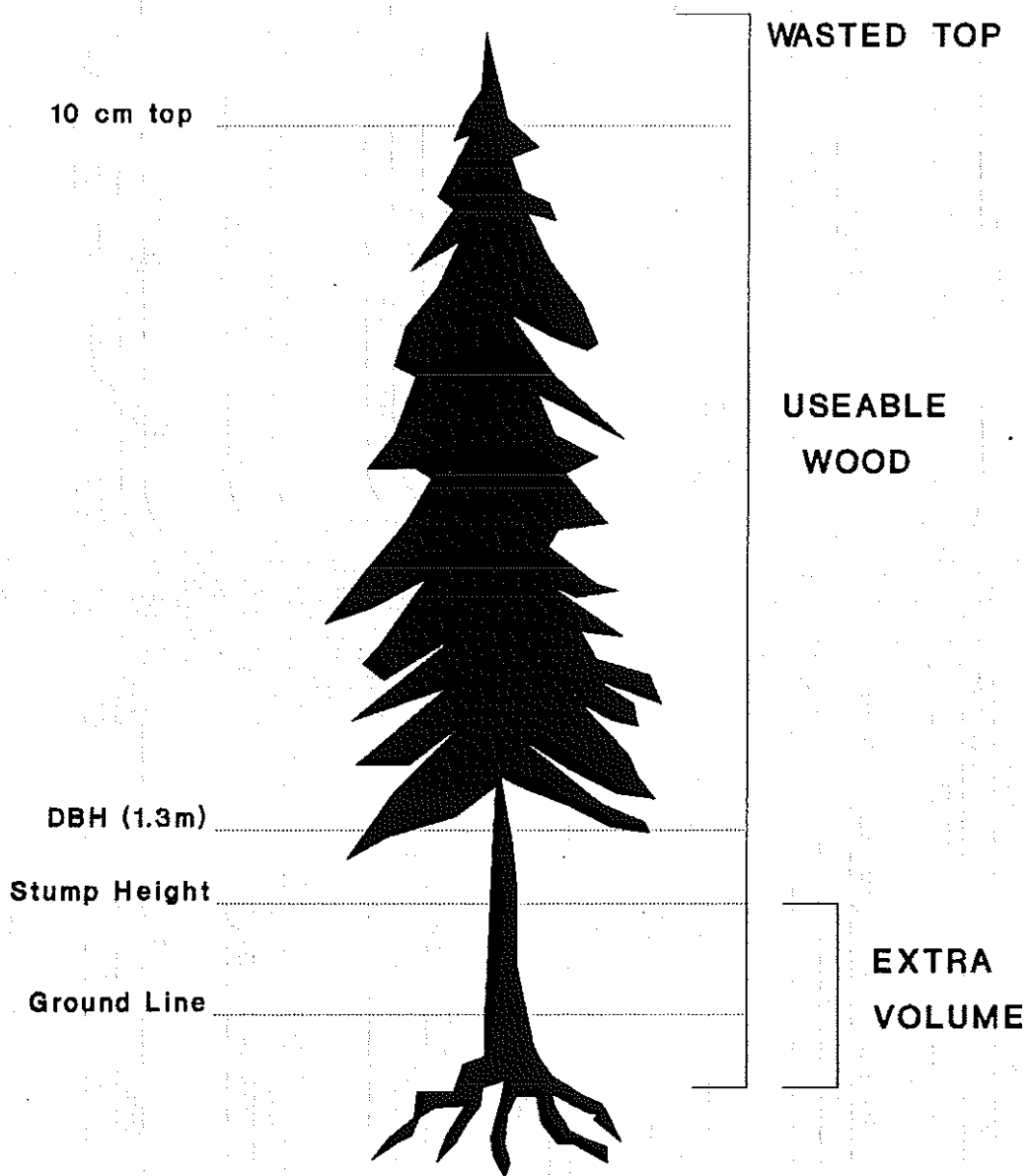
Dialogue with Regional Silviculture. A meeting with Prince Rupert Forest Region silviculture and forest health staff was held in March to discuss a number of pressing issues related to the collection of better pest information from silviculture surveys. Forest Health's plan for developing a system to make pest risk assessments before harvest or other treatments was also unveiled. A number of objectives resulted from this meeting:

- determining what pest data outputs can be obtained from the Integrated Silviculture Information System
- developing regional pest training packages for silviculture survey courses (including Pre-harvest Silviculture Prescriptions, Free-to-Grow and, Pre-stand Tending surveys)
- developing an operational method of including quantitative pest data collection in existing silviculture surveys.

These issues should be addressed both regionally and provincially this year.

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

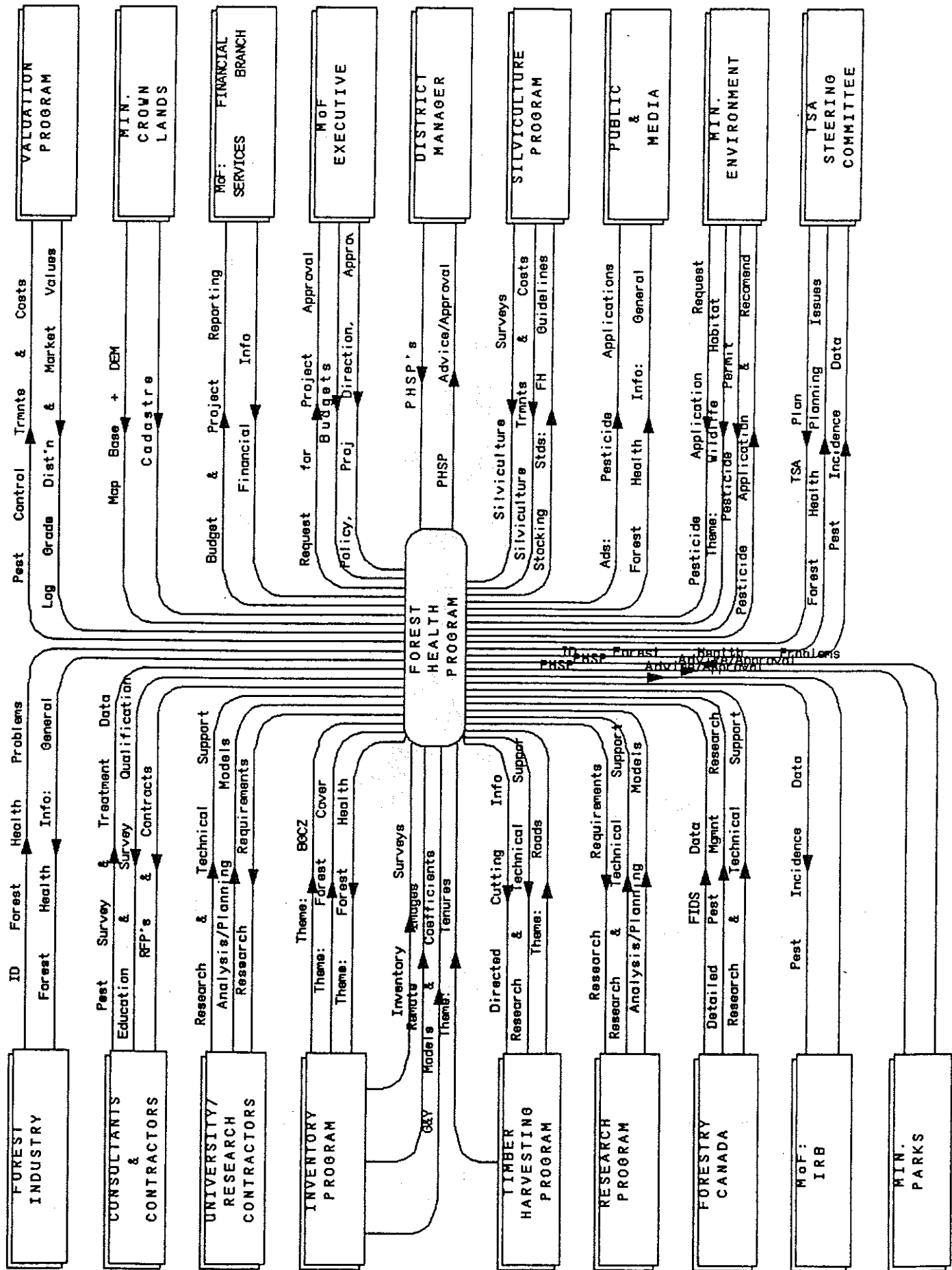
PUSHOVER LOGGING



Increased Recovery Due to Pushover Logging

Source: D. Norris, Nelson Forest Region, Nelson, and
A. Krane, Cranbrook Forest District, Cranbrook

Process and Data Flows Between the
Forest Health Program and External Agencies



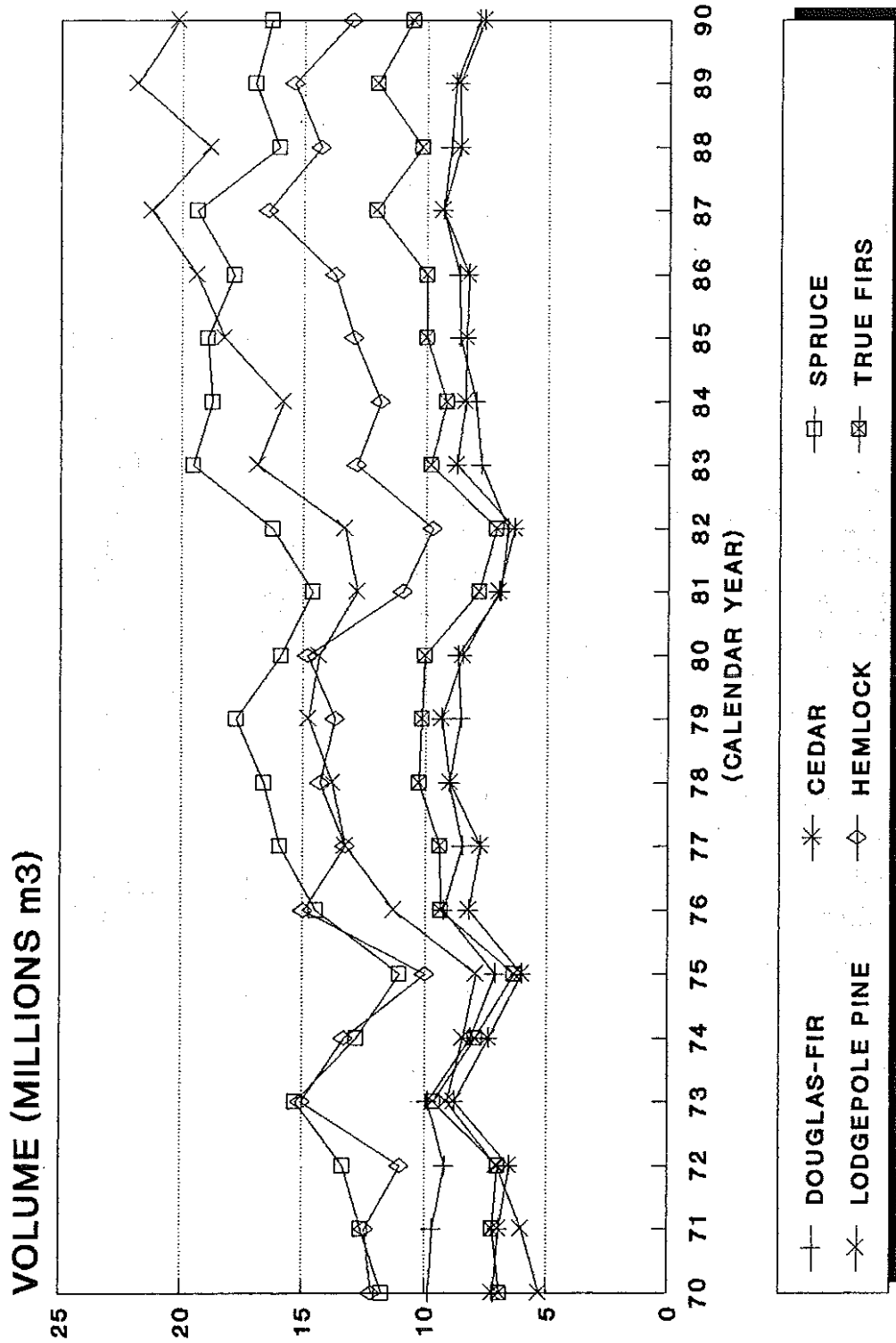
Source: Draft Diagram from the Forest Health Business Area Analysis

Results of the 1990 Cariboo Forest Region Aerial Survey.

Pest	1989		1990	
	area	volume	area	volume
	(ha)	(m ³)	(ha)	(m ³)
mountain pine beetle	2 980	16 879	388	2 347
spruce beetle	33	200	289	19 867
Douglas-fir beetle	3 287	23 279	2 473	22 158
balsam bark beetle	2 249	14 230	1 162	10 467
spruce budworm				
2-year budworm	5 118		8 435	
western hemlock looper			64	
forest tent caterpillar	1 621		3 807	
aspen defoliator spp			551	
flooding	190		391	
windthrow	335		1 685	
winter damage	86		2	
All	15 899	54 588	19 247	54 839

(Please refer to the article on page 24 of this issue)

TRENDS IN SPECIES CUT IN BRITISH COLUMBIA 1970-1990

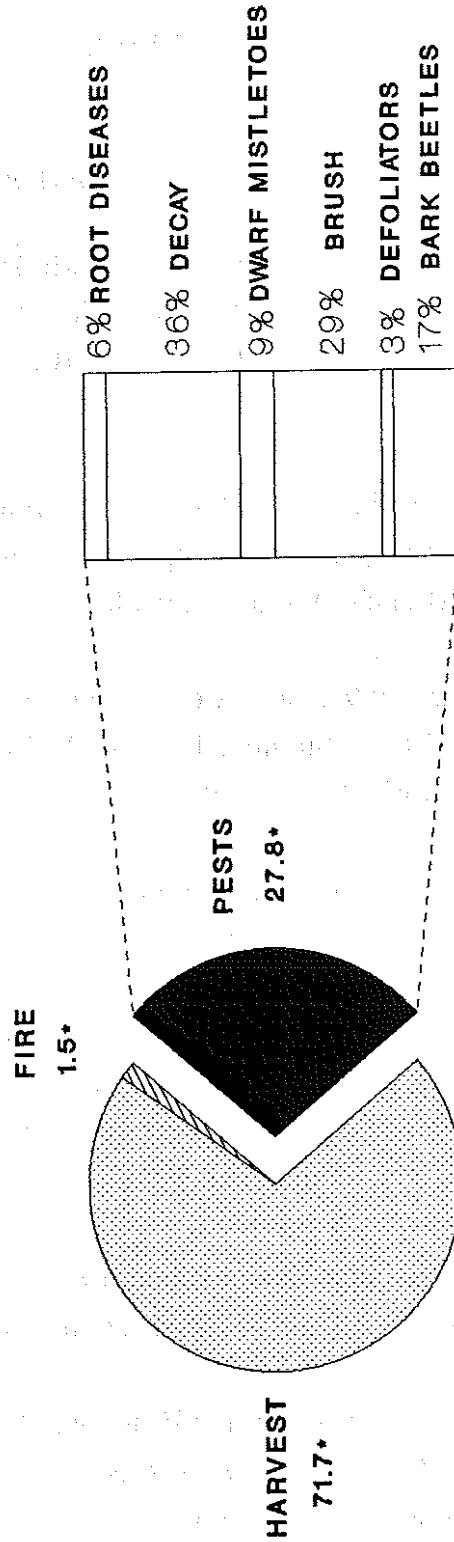


Source: BCFS

Source: Ministry of Forests, Timber Harvesting Branch

British Columbia

Average annual timber harvest, fire & pest losses
for the period 1986-1990



* Gross estimates in millions of cubic metres
(regulated lands only)

Source: Forestry Canada & B.C. Forest Service

PUBLICATIONS AND REPORTS

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- Adamson, M. E. 1991. Young Tree Pest Surveys in the McBride Forest District (Survey A) and in the Prince George Forest Region (Survey B). B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia PM-PB #77.
- Bloomberg, W. J. and G. V. Hawkins. 1991. Survey and Evaluation for Black Stain Root Disease in Young Coastal Douglas-fir Plantations. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 68.
- Byford, G. T. and J. A. McLean. 1991. Survey of Warren's Root collar weevil in the Kispiox Forest District. Summer 1989. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 71.
- Daust, D. 1991. Survey of Tomentosus Root Rot and Layout for Resistance Trial near Tercer Lake, Burns Lake, B.C. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 59.
- Ebata, T. 1991. Summary Report of Two Spruce Weevil Surveys in Twelve Plantations in the Kitimat Valley. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia PM-PB # 69.
- Hawkins, G. 1991. Port Alice Sulphur Dioxide Appraisal. B. C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 72.
- Hawkins, G. and N. Kunzli. 1991. Survey of the Efficacy of Root Removal Operations: Survey I. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 66.
- Jacobi, W. R. 1991. Studies on Black Stain Root Disease on Douglas-fir in coastal British Columbia. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 62.

- Kunzli, N. 1991. Survey of the Efficacy of Root Removal Operations: Survey II. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 67.
- Lewis, K. J. 1991. *Inonotus Tomentosus* Plot Excavations: Data Analysis and Conclusions. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 57.
- Lewis, K. J. 1991. Lodgepole Pine Dwarf Mistletoe Spacing Trials: 1988 Plot Remeasurement. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 61.
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- Martin, R. 1987. Halfway Western White Pine Pruning and Spacing Trial: July 1987 Remeasurement. B.C. Ministry of Forests Protection Branch. Victoria, British Columbia. PM-PB # 47.
- Martin, R. 1991. Establishment of Ingersoll Creek Western White Pine Demonstration Area. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 48.
- Martin, R. 1991. Selection of Western White Pine Trees with Potential Genetic Resistance To White Pine Blister Rust in the Beavermouth Seed Production Area. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 49.
- Martin, R. 1987. Ingersoll Creek Western White Pine Demonstration Area. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB #52.
- Martin, R. 1991. Establishment of Texada Island Western White Pine Seed Production Area. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 53.

- Maxwell, J. 1991. Hydraulic Excavator Stump Removal Productivity Trial. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 78.
- McCulloch L. 1991. Trial of a Regeneration Survey Modified to Assess Armillaria Root Disease. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 55.
- McCulloch L. 1991. A Pest Survey in Young Stands in the Prince Rupert Forest Region. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 76.
- Norris, D. 1991. Root Removal Trial at Columbia West Road for Control of Armillaria Root Disease. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 70.
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- Patterson, B. 1991. Wickman Creek Armillaria Survey Assessment. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 73.
- Pousette, J. 1991. Impact of Dwarf Mistletoe on Growth in Lodgepole Pine Trees. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 60.
- Schulting, J. 1991. Establishment of the Spacing Trial in Armillaria Root Disease-Infected Stands in the Merritt Forest District. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 56.
- Stock, A. J. 1991. Assessment of Pest Damage of Subalpine Fir Stands in the Bulkley TSA. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 54.

- Strathinnes Forestry Consultant Ltd. 1991. Satellite Image Forest Disease Interpretation for the Boundary-Arrow TSA. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 75.
- Sutherland, G. and P. McNamee. 1991. Demonstration of Model for Root Disease in B.C.: Example Scenarios for a Dry Site. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 79.
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- Thomson, T. M. and Associates Ltd. 1991. Root Disease Survey Methods: Phase II. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 64.
- Thomson, T. M. and Associates Ltd. 1991. Root Disease Survey Methods: Phase III. B.C. Ministry of Forests, Protection Branch. Victoria, British Columbia. PM-PB # 65.

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