
Pacific Forest
Research Centre
Victoria, B.C.
Program Highlights
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Forestry Service
Environnement Canada
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Cover Picture.
PFRC researcher injects growth hormone to stimulate bud development.

Michael H. Drinkwater
Director

Research scientists at the Pacific Forest Research Centre share a concern for the environment; they strive to give priority to projects aimed at the development and supply of sound scientific information and methods for continued effective production, protection and utilization of the forest resources, consistent with current economic conditions.

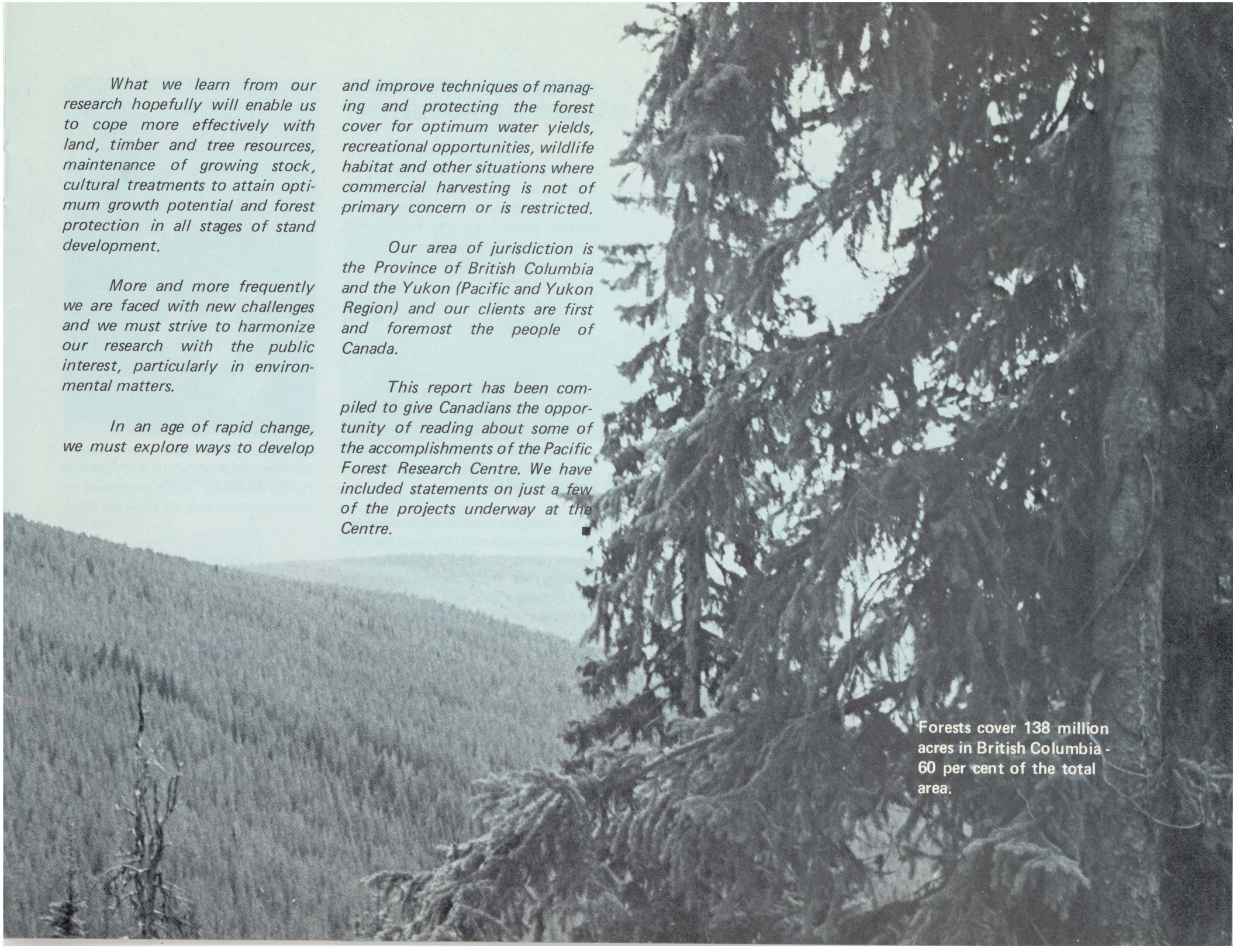
What we learn from our research hopefully will enable us to cope more effectively with land, timber and tree resources, maintenance of growing stock, cultural treatments to attain optimum growth potential and forest protection in all stages of stand development.

More and more frequently we are faced with new challenges and we must strive to harmonize our research with the public interest, particularly in environmental matters.

In an age of rapid change, we must explore ways to develop and improve techniques of managing and protecting the forest cover for optimum water yields, recreational opportunities, wildlife habitat and other situations where commercial harvesting is not of primary concern or is restricted.

Our area of jurisdiction is the Province of British Columbia and the Yukon (Pacific and Yukon Region) and our clients are first and foremost the people of Canada.

This report has been compiled to give Canadians the opportunity of reading about some of the accomplishments of the Pacific Forest Research Centre. We have included statements on just a few of the projects underway at the Centre. ■



Forests cover 138 million acres in British Columbia - 60 per cent of the total area.

Building A Better Forest

WESTERN HEMLOCK TREE IMPROVEMENT

In the laboratory, control-pollinated seeds were successfully produced on water-cultured detached branches. Although seed set was considerably reduced and the mature seeds were only half normal size, the resulting seedlings grew vigorously. A further study, designed to enhance cone production on clones of western hemlock, was initiated last spring, at PFRC Cobble Hill genetics research plantation. About 175 6-year-old rooted cuttings were given, intravenously, various treatments of gibberellins or auxin, in combination with a soil fertilizer treatment. Results will be known when positive identification of resulting seed- and pollen-cone buds become possible.

Heights and cone production data were collected for seedling and clonal research stock outplanted at Cobble Hill. Also, the assessment of 6-year height data was completed for all plantations comprising the western hemlock population study.

A paper on the status and potential of western hemlock tree improvement will soon be published in the Proceedings by the University of Washington, College of Forest Resources. It covers the results of PFRC studies on genetic variation, control-pollinations, pollen storage, inbreeding, vegetative propagation and the production of seeds and cones from rooted cuttings. ■

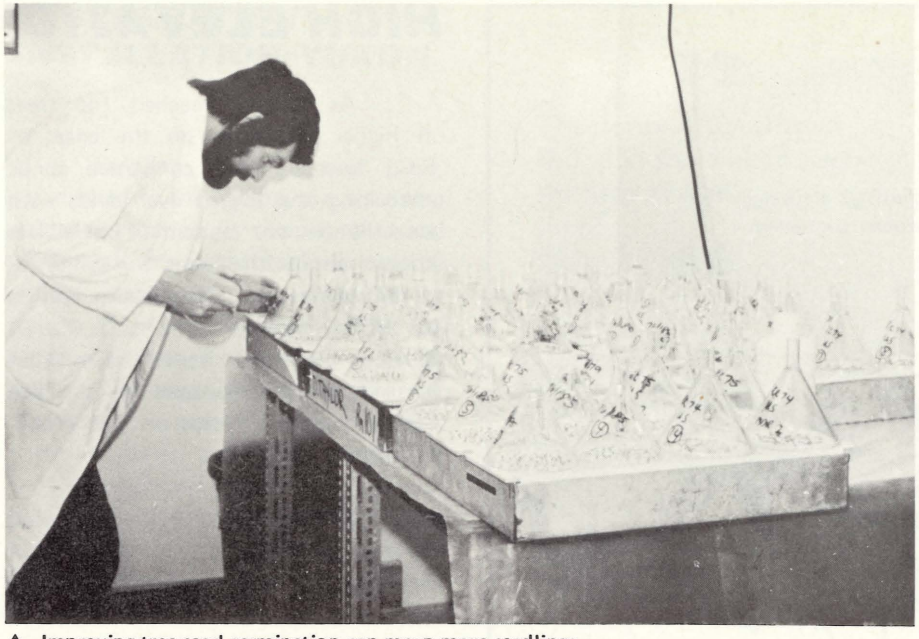
Δ Enhancing cone production by controlled pollination is a study undertaken by tree geneticists.

OECD SEED CERTIFICATION

PFRC is involved in the OECD (Organization of Economic Cooperation and Development) Scheme for the certification of forest tree seed moving in international trade. There is an increased interest in seed certification and greater insistence by OECD-member countries that seed be imported in compliance with the scheme. As a result, representatives of the European Common Market and several European countries visited the PFRC to discuss the operation of the scheme in B.C./ Yukon.

Cone crops for most species in the region were much improved over the past several years, and the PFRC certified many lots of "source-identified" seeds collected by seed-exporting companies.

Forest Tree Seed Certification Under the OECD Scheme: 1970-1975 Summary Report. British Columbia/ Yukon Territory, by R.F. Piesch, PFRC Rep. BC-X-156. ■



△ Improving tree seed germination can mean more seedlings.

CONE AND SEED WORK

A cooperative experiment was established to test the effectiveness of gibberelin (GA 4/7) and auxin, alone and in combination, with and without girdling, on cone enhancement in Douglas-fir seed orchards. Treatments were applied to two seedling orchards, Koksilah and Quinsam (Campbell River) and two grafted orchards, Caycuse and Quinsam, during the spring of 1975. Cone counts were made in the fall of 1975 and in the summer of 1976, and all cones were collected the following October. Results of the preliminary cone counts showed more male and female cones by GA 4/7 at Koksilah and Caycuse than at Quinsam orchards. Girdling and/or auxin did not further enhance cone production.

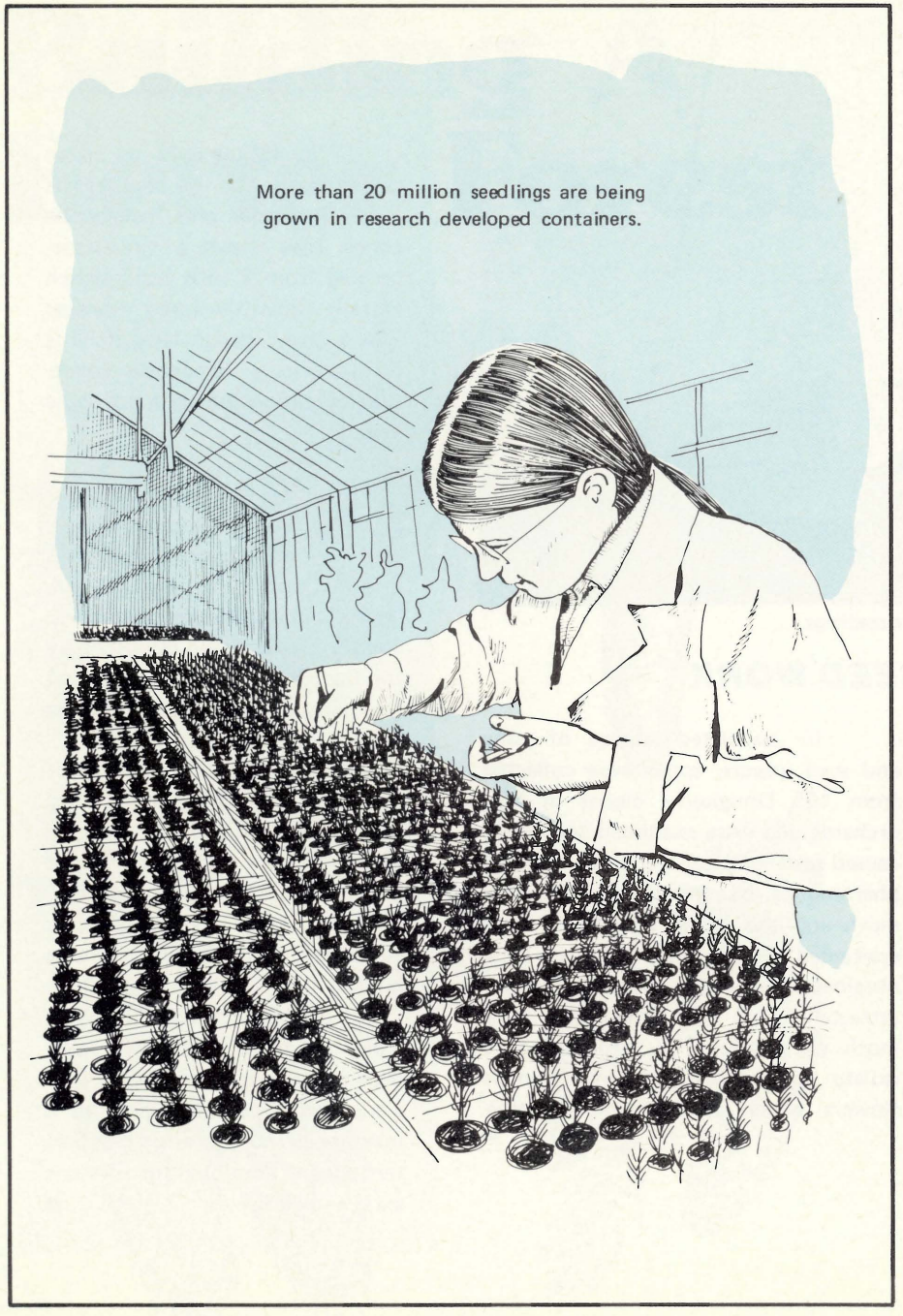
In associated studies of cone and seed insects, cones were collected from 165 Douglas-fir clones in seed orchards and were examined for insect-caused seed losses. Other studies on sex pheromones of the Douglas-fir cone moth and the spruce seed worm were continued; promising results were obtained for both species. Primary attractants of the Douglas-fir cone moth were studied by attempting to isolate volatile materials from female flowers which attract female moths. ■

SEEDS & CONES

So far as jobs go, cone collecting is not the pick of the crop. In a given area, collectable cones may have a time-lapse, ranging from 2 to 8 years, which literally drives the forest manager "up a tree," particularly if he is involved in a large-scale collection operation during a bad cone year.

Guideline to Collecting Cones of B.C. Conifers. This comprehensive, well-illustrated manual provides information on planning and conducting cone collection operations. Jointly prepared and published by the Canadian Forestry Service and the British Columbia Forest Service.

Rating and Reporting Cone Crops. PFRC researchers are working closely with the B.C. Forest Service to obtain cone crop forecasting, rating and reporting on a systematic basis. The two agencies publish a bulletin entitled "Cone Crop Bulletin-British Columbia/ Yukon Territory," which may become an annual series. It provides the forest manager with a measure of cone crops of important species developing in different areas and elevations. ■



HIGH ELEVATION REFORESTATION

As loggers reached for trees in higher elevations on the coast of B.C., foresters were concerned about restocking the logged over lands with amabilis fir or "balsam". **Little was known about the trees suitability as a restocking tree. Cooperative studies by PFRC foresters and B.C. Forest Service personnel have shown that balsam can be managed to produce the next crop of trees on our mountain slopes.**

Relying on natural regeneration systems to produce the next crop of trees on our environmentally-sensitive, high-elevation sites, artificial regeneration options are also being studied. **Nursery growing methods were successfully developed for amabilis fir, noble fir, yellow cedar and mountain hemlock. All species were ready for outplanting after a 40-week period in a container nursery, less than half the time it would normally take to produce such stock with conventional methods.**

Seedling survival and growth of planted trees on dry, rocky habitats of coastal high-elevation forests is characteristically poor. Inoculating these seedlings with mycorrhizae (fungi that lives with and on a seedling's root system) may be vital to healthy development of young trees on such sites. Research in this field is currently underway at PFRC. ■

△ High elevation logging means more problems.

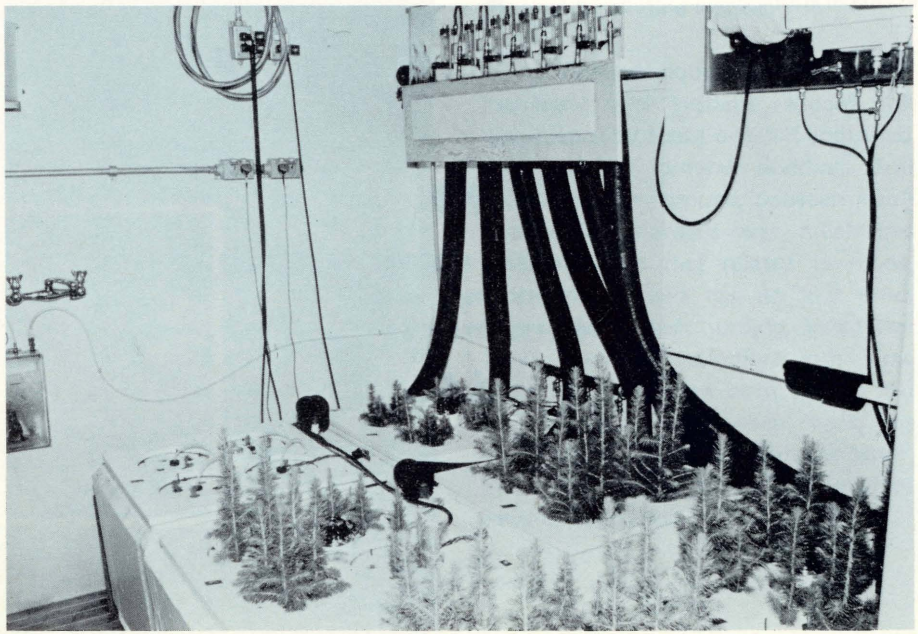
STUDY OF SOIL TEMPERATURE EFFECTS

Early root growth constitutes a fundamental factor in survival and growth of outplanted seedlings and is governed partly by soil temperature. A study showed that significant changes in soil temperature result from removal of insulating surface organic layers. Used in the study system are six water baths in which water temperature can be independently controlled to +0.1°C by regulating an immersion heater and the inflow of chilled water. The baths are insulated polyethylene laundry tubs on casters, with an outer shell of fibreglass. Experimental seedlings are grown in stainless steel cannisters immersed in the baths. The system is operated within a controlled-environment chamber so that air temperature, humidity and light can also be regulated. ■

REGENERATION INSTALLATION- YUKON

Seedling and planting trials, established in the Yukon, are providing evidence that soil temperature and depth of the water table constitute critical factors in regeneration of spruce forests on the Yukon river terraces. The nature and origin of those forests indicates the need for site preparation methods, which raises planting spots above the height of land. Examination of natural regeneration points to high potential for natural regeneration of burned-over sites in upland areas. ■

> "The forest resources of B.C. and the Yukon need the help of man."



Special chambers assist researchers in ▷ growing seedlings under natural conditions.

WORLD DIRECTORY OF TREE SEED WORKERS

Over 770 researchers are listed in a new directory of tree seed workers, issued by the Canadian Forestry Service in cooperation with the International Union of Forestry Research Organizations. The 134-page directory lists the names, addresses and special interests of scientists and other professionals concerned with the problems of seed production and procurement for reforestation and replenishment of the world's forest resources. The purpose of the directory is to encourage and facilitate better communication among the hundreds of researchers involved in solving perplexing tree seed problems. Representatives from more than 100 countries are listed. ■

GRANT AND CONTRACT SUPPORTED RESEARCH

Science Subvention grants were given in support of research on the phenology of bud development in white spruce (Dr. J.N. Owens, University of Victoria), precocious flowering of Douglas-fir and lodgepole pine through the application of gibberellins (Dr. R. Pharis, University of Calgary), and pollen storage and testing (Dr. D. Ballantyne, University of Victoria). Several papers have been prepared for publication.

A contract was awarded to MacMillan Bloedel Limited to study the influence of competition from nearby trees on the selection of western hemlock plus trees. ■

ROOTED CUTLINGS

A feasibility study for producing reforestation stock from rooted cuttings of yellow cedar seedlings was continued. Cuttings rooted well, with or without hormone treatment. The time of year during which they were removed from the seedlings (January, August or December) was not critical.

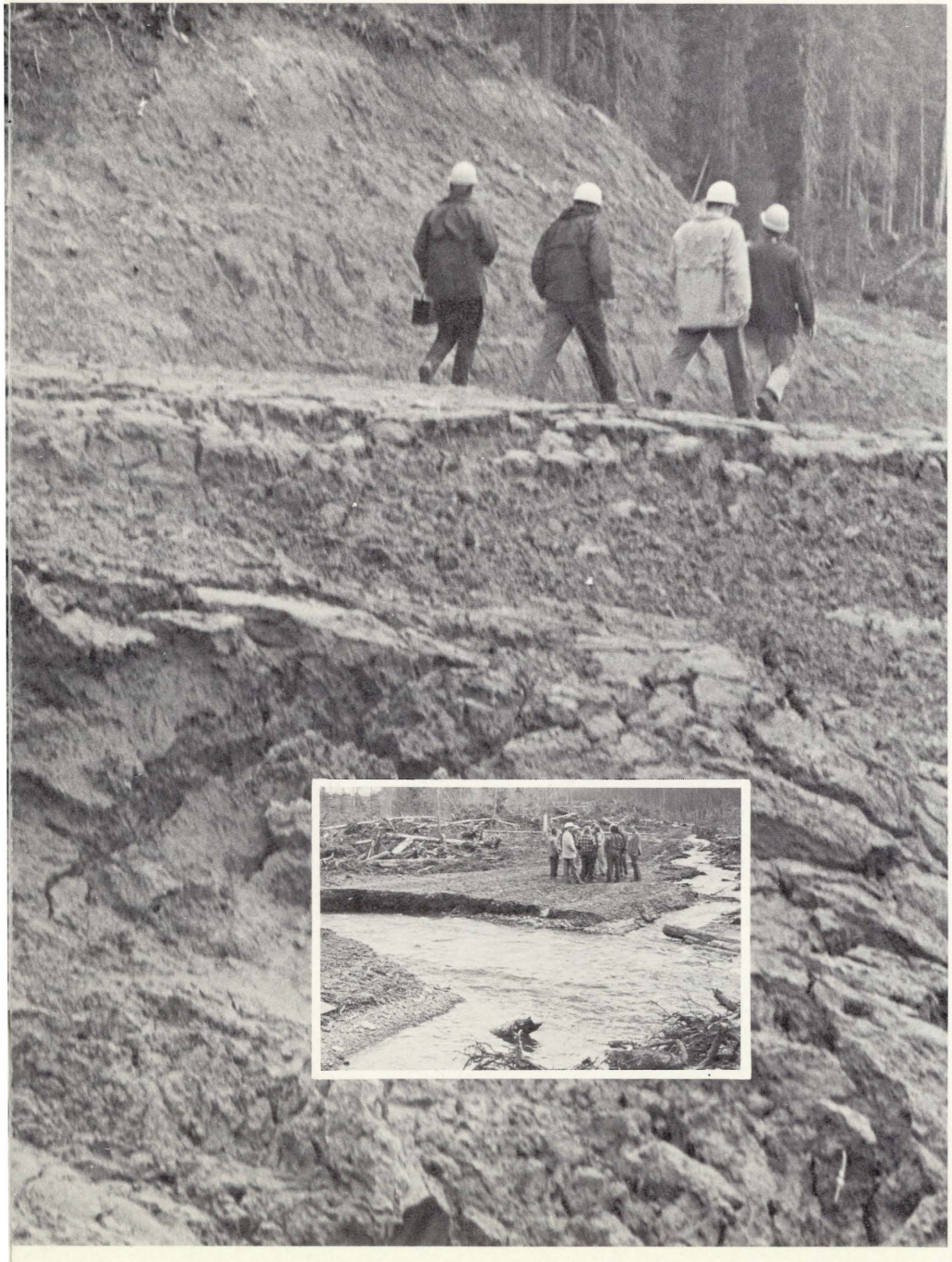
Further studies were undertaken on the rooting of western hemlock cuttings from young and old trees in relation to fungicide and hormone treatments, size of cuttings, retention of basal leaves and time requirement for rooting. A report reviewing the use of rooted cuttings in reforestation is in preparation. ■

CONE RAKE

A prototype aerial cone rake, invented by John Walters, a UBC Research Forester, designed to be lowered over cone-bearing tree crowns by helicopter; and, upon retrieval, the cones would be raked from the branches and retained in baskets. The idea seemed solid until the PFRC and the B.C. Forest Service made a test run in a Douglas-fir stand near Duncan. Their decision: the concept was good--but needed significant modifications. ■

"Discovering a better way is the primary goal of forest researchers."

◁ Studies in the growing of seedlings from rooted cuttings are underway at PFRC.



Environmental Forestry

EFFECTS OF LOGGING ON STEEP HILLSIDES

Results of a study to determine the effects of clearcut logging on steep slopes in the Nelson Forest District showed that most soil disturbance was caused by ground skidding operations on bare ground (average 45 per cent of the clearcut area) and the least by skyline logging.

Ground skidding on snow and high-lead cable systems reduced soil disturbance by about one-half compared with summer ground skidding. Soil disturbance on ground between haulroads and skidroads was much less extensive than that related to roads, but was increased two to four times by broadcast slash burning, Vegetative cover increased steadily with time following logging on both burned and unburned surfaces between roads, but was higher after 11 years on the latter, as a result of a greater initial cover of residual vegetation.

Excluding planting, areas between roads in unburned clearcuts and road surfaces in both burned and unburned clearcuts were satisfactorily restocked with new and advanced regeneration after about 9 years. Surfaces between roads in burned clearcuts were not satisfactorily restocked up to 10.5 years later, the average age of the oldest burned clearcuts examined. Differences in vegetative cover and stocking of regeneration were noted among biogeoclimatic zones. Examples of soil erosion were recorded and described. Efforts are now being directed toward determining the effects of logging-related soil disturbance on future forest productivity and related forest land uses. ■

◁ Research can help reduce environmental damage being caused on sensitive sites.

SHAWNIGAN LAKE PROJECT

A 6-year study shows that thinning and fertilization improves forest production, without harming the environment.

Tests conducted at Shawnigan Lake on Vancouver Island revealed that application of 488 kg n/ha of urea, plus heavy thinning, gave a volume growth response that was 188 per cent greater than that for untreated control areas. Data, however, will continue to be collected for several years so that greater understanding of tree response and environmental impact can be obtained.

Foresters are faced with an increasing demand for wood and forest products. This demand, combined with the removal of forest land for recreation, powerline rights-of-way and other alternate uses, necessitates the intensification of forest management for wood production. However, foresters must be aware that the management practices applied will not result in serious environmental harm.

The 'Shawnigan Lake Project' is a study to investigate the effects of thinning and fertilization on a 26-year-old Douglas-fir stand.

A research team studied tree growth, undergrowth and soil responses to various treatments, and have shown that thinning has a major effect on soil water and light regimes, causing increases in photosynthetic production of trees. Better tree nitrogen status, as a result of fertilization, increases the photosynthetic potential of the foliage, as well as the mass of foliage.

Studies of undergrowth plants and shrubs show that thinning and, to some extent, fertilization of the forest increases density, height and vigor of undergrowth, and that prediction of above-ground biomass is possible from visually estimated per cent ground cover. ■

△ Thinning helps but not as much as fertilization.

◁ Six-year growth response to 26-year-old Douglas-fir.

EFFECTS OF LOGGING ON WATER QUALITY

A recent study shows that log harvesting in an Interior watershed resulted in measurable but minor changes in stream water quality. This was detected during the second year after harvesting.

The recent expansion of timber harvesting at higher elevations in the Okanagan basin has prompted concern over possible impacts of forestry operations on water quality in the area. Of particular concern are deterioration of quality of water for drinking and nutrient enrichment of lakes.

ACCEPTABLE LEVELS

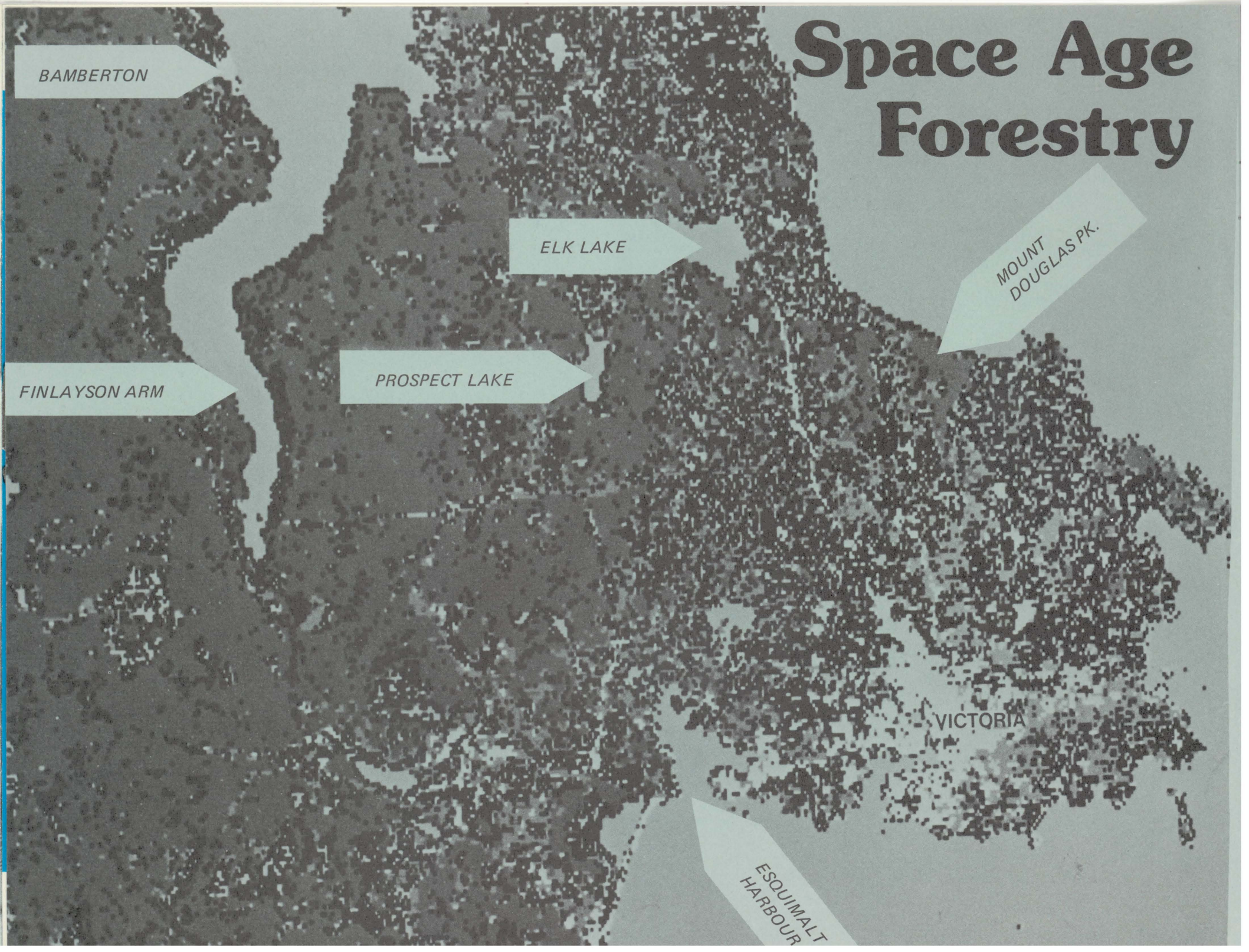
Based on control data from adjacent streams and from reports on both harvesting and slash burning effects for other areas in North America, the water quality changes observed, including sediment levels, were generally within the natural range of variation for the study area (upper Penticton Creek watershed) and comparable or lower in magnitude to those found elsewhere.

Also, the quality of water in Dennis Creek was not impaired for drinking, although the color of the creek below the logged area did exceed the desirable standard for drinking water for a portion of the study period. This increased color would not be harmful from a health standpoint, but would alter its aesthetic appearance.

Dennis Creek was not enriched with nutrients, which would stimulate excessive plant growth. The primary plant nutrients, nitrogen and phosphorus, remained at very low levels. ■

Improved logging methods have reduced damage to water systems. ▷

"A better understanding of the wonders of nature will help prevent environmental damage."


Space Age Forestry
BAMBERTON
ELK LAKE
MOUNT DOUGLAS PK.
FINLAYSON ARM
PROSPECT LAKE
VICTORIA
ESQUIMALT HARBOUR

COMPUTERS PROVIDE AID TO FORESTERS

A sophisticated computer, electronically hooked to two orbiting satellites that pass high above B.C., can tell scientists and resource managers what is actually going on in the environment.

Drs. Jim Lee and Robin Quenet and computer specialist Don Hunt developed techniques that enable foresters and land managers to use satellites in a wide range of environmental tasks. The studies will permit policy makers and government leaders to develop sound environmental decisions based on up-to-date 'visual' facts as provided by the satellites.

From satellite images, the computers will be able to classify where various species of trees are in a forest, predict the degree of runoff after trees have been logged, and show where game animals are to be found.

Damage to the environment caused by man-made activities will be recorded, as will natural changes such as floods, slides, amounts of snowfall, build-up of marshes and reduction of water supplies.

Dr. Lee, who has developed a system for the Yukon Territories, said that by using information supplied by the satellites, costs can be cut considerably. He added that for a detailed inventory, however, lower flying aircraft will still be necessary.

"In 10 years," he concluded, "satellites may be so refined that they may be able to determine the moisture content of soil. Once you can do that you will be able to predict the growth of trees and crops." ■

◁ Image of lower Vancouver Island taken from resource satellite.

COMPUTER SERVICES

System analysists and computer programers provide forest researchers with modern day technology for gathering data, analysing experimental results, simulating ecological systems, and processing imagery data transmitted by satellites and other monitoring sources.

Computer equipment consists of a PDP 11/45 with a running RSX 11D operating system.

△ Digital printout from computer.

PHOTOS FROM SPACE AID LAND MANAGERS IN THE YUKON

The overall objective of a project, designed to use remote sensing images (photographs from space) to distinguish different levels of land classification in the Yukon Territory, is to establish a classification of the land useful for planning and managing the natural resources. Broad ecoregions were delineated through the use of unenhanced LANDSAT images.

A study was initiated to describe Land Systems by investigating the distribution and correlation of landforms, soils, vegetation communities and permafrost in the Liard River Ecoregion. This analysis permits many interpretations, such as potential productivity, wildlife habitat, sources of construction material, construction problem areas and plant succession. A sampling of the accessible landforms with extrapolation to the entire ecoregion through remote sensing interpretation is anticipated.

A separate study included enhancement and analysis of LANDSAT imagery, use the Image 100 machine for recognition of forest types. Eight categories can be distinguished: pure spruce, pure pine, mixed pine and spruce, mixed conifer and hardwood, pure hardwood, wetlands, water and bare soil. The reliability of this analysis has not been determined, nor has the productivity of the forest types been established. Associated with this study is the advancement of a data retrieval system.

Seven sites have been located in the Yukon as part of the Northern Tour for the International Soil Science Society Convention to be held in 1978. Responsibility for the vegetation on these sites is included in this project. Most species have been collected and identified and are included in the Guidebook under production. ■

Analyzing the Landscape

Analyzing the landscape with the objective of improving man's ability to make decisions that will not harm the environment is a major activity of Pacific Forest Research Centre researchers.

Basic land-management studies in which the overall quality of life for Canadians, not only the value of forest products, is the ultimate criterion for decision making.

The studies, usually produced in cooperation with other government agencies, provide the planners, land managers and elected decision makers with comprehensive information about natural resources and their potential as related to the increasing demands for housing, employment and recreation facilities. ■

Biogeoclimatic Mapping

A triple kick at the cat

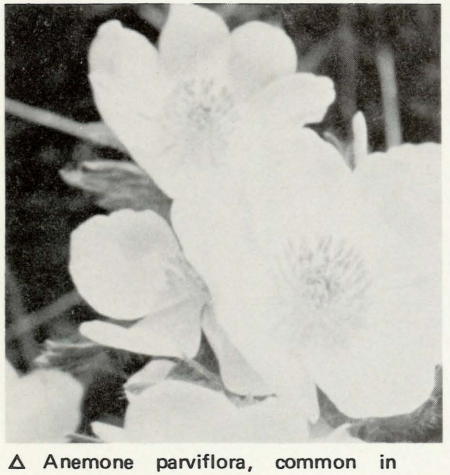
In relation to the B.C. Land Inventory Program, vegetation maps, at a scale of 1:50000, were completed for Southern Vancouver Island, south of 49oN latitude. The work involved aerial reconnaissance, air photo interpretation, abstraction from forest-cover maps and field investigations. The area was divided into four zones: Coastal Douglas-fir, Coastal Western Hemlock, Coastal Western Hemlock-Amabilis fir and Subalpine Mountain Hemlock. The Subalpine Mountain Hemlock Zone was divided into Forest and Krumholtz subzones. The basis for separation was the expected

△ Specialists are required.

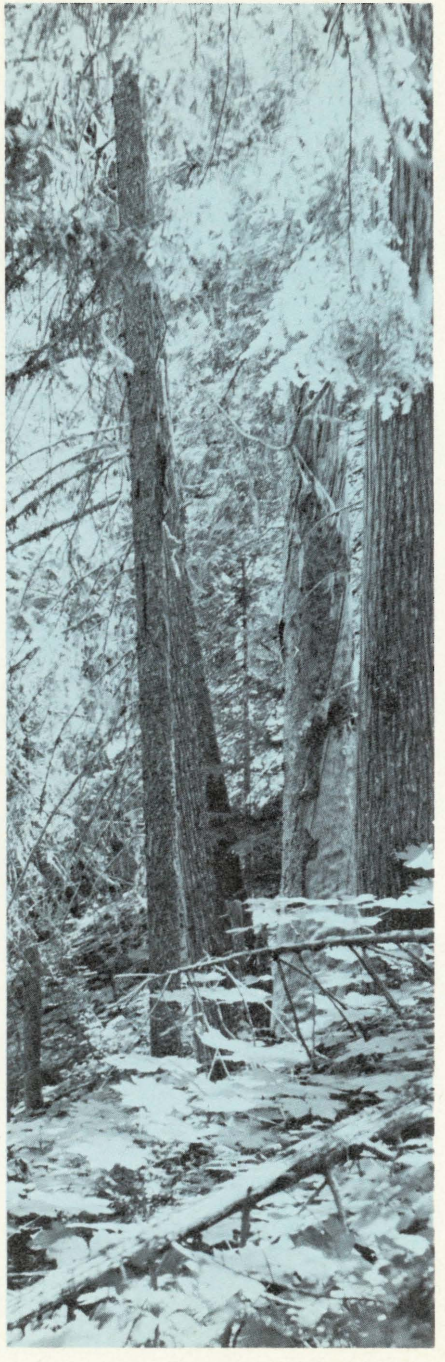
The Yukon is very sensitive to man's activities. ▷

climatic climax tree species on a normal site for the area. Coincident with the vegetation survey, a soil survey was conducted by Environmental Land Use Committee personnel. There was a correlation between the Douglas-fir Zone and Brunisol soils, Western Hemlock Zone and Humo-ferric Podzols and Western Hemlock-Amabilis fir Zone and Ferro-humic Podzols. The understory vegetation was recorded at 366 ground observation points according to species and coverage. These data were subjected to a statistical analysis which separated the plots into 34 possible species groups.

In cooperation with the Canadian Wildlife Service, a visit was made to Triangle Island to investigate a possible correlation between vegetation communities and nesting sites for shore birds, primarily Cassin and Rhinoceros Auklets.



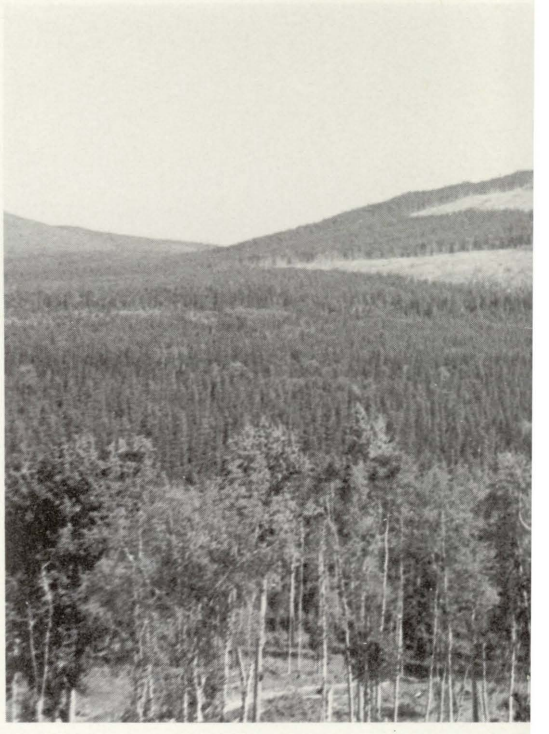
△ Anemone parviflora, common in meadows and on slopes.



Typical site Vancouver Island. ▷

The study gained emphasis because nesting colonies of Rhinoceros Auklet along the west coast occur here, and the high possibility of oil tankers passing close to the island could jeopardize them. Auklets nest in burrows dug into fairly steep banks, although the Cassin Auklet also colonizes moderately steep upper slopes and ridges. The banks on Triangle Island support a mosaic of plant communities, some dominated by Tufted Hair-grass, others by Salmonberry, Salal, Newcombe's Saxifraga, Crowberry or Lady-fern. Western Crab-apple, the only tree species, was common in Salmonberry thickets on the relatively flat top of the island but was seldom over 1.5 m tall. Numerous auklet burrows occurred along the steep western bank, which was the primary focal point of the study, but time did not allow a sufficiently detailed study to establish a correlation between the number of burrows and the vegetation type, or if both species of auklet used the same vegetation types indiscriminately. ■

> **"Man's needs must not be at natures expense."**



Environmental Impact

Everyone should be seriously concerned with the quality of our environment, as it hits us all where we live. Global in scope, the environment touches all phases of human endeavour. ■

△ British Columbia has a variety of sensitive sites.

ENVIRONMENTAL IMPACT STUDY ....VANCOUVER ISLAND

An environmental impact and terrain analysis study of 2,000 square miles on northern Vancouver Island was undertaken by PFRC Land-use specialists. The investigation included examining marine deposits for the purpose of defining boundaries of maximum marine encroachment during the last glacial period. The study also involved an extensive helicopter survey of the inaccessible Kilpala and Artlish watersheds. The purpose was to check surficial material and soil development in order to provide essential biophysical and land capability information.

Specialists also checked out peculiar air photo patterns on the west side of Malcolm Island and found that the patterns were the result of lacustrine and/or marine deposition subjected to periods of wave washing and fluvial activity during and immediately after glaciation.

All land use studies were primarily concerned with developing information that will enable resource managers with the necessary background to formulate sound management plans. ■

PUBLICATIONS

Reports on biophysical studies:

The Salt Spring Island report (BC-X-99) is an evaluation of environmental and vegetational characteristics and their relationships. ■

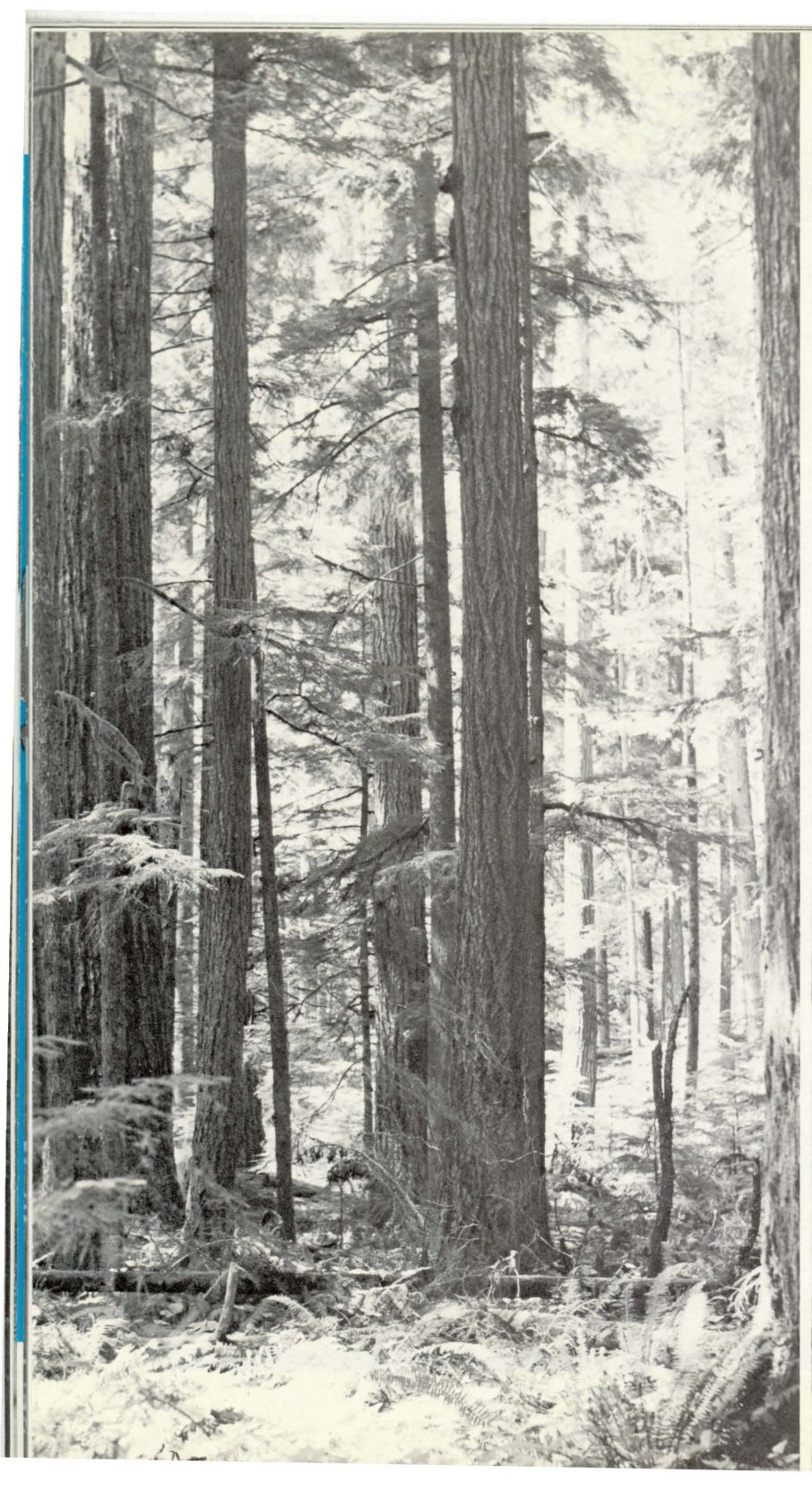
The Highland Landscape (BC-X-119) is an ecological evaluation of land suitability for urban development in the southern portion of Highland District, Capital Region of British Columbia, where 3,500 acres of forest land were designated for future high-density urban development. ■

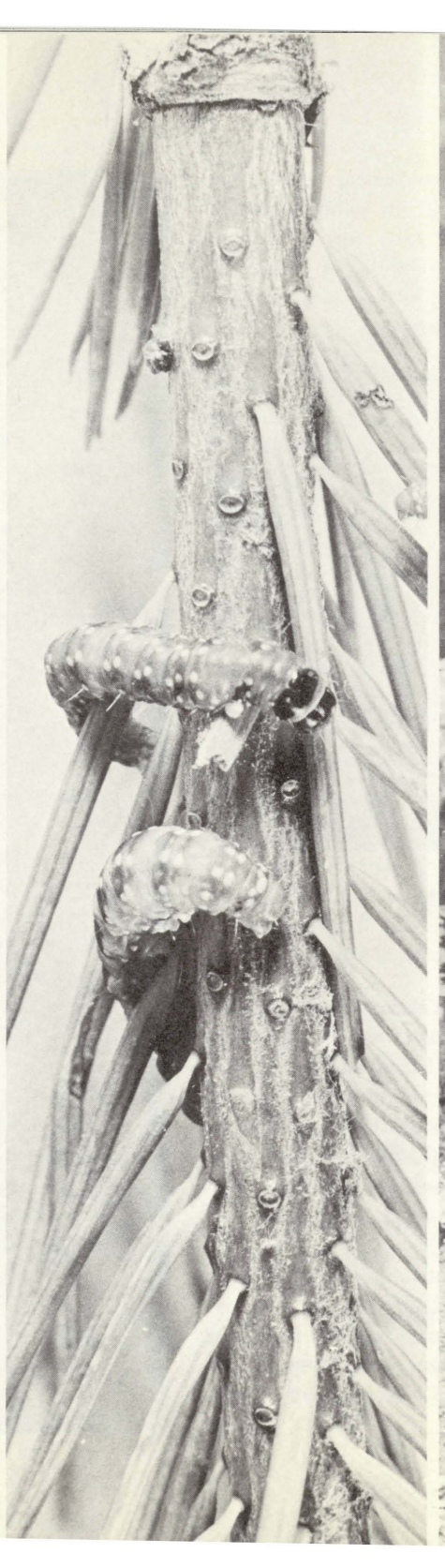
Bowen Island report (BC-X-122) is a study initiated on request of the island's residents, Greater Vancouver Regional District and the Islands Trust, because Bowen Island, being within a 1-hour drive from downtown Vancouver, is under heavy recreational and development pressures. ■

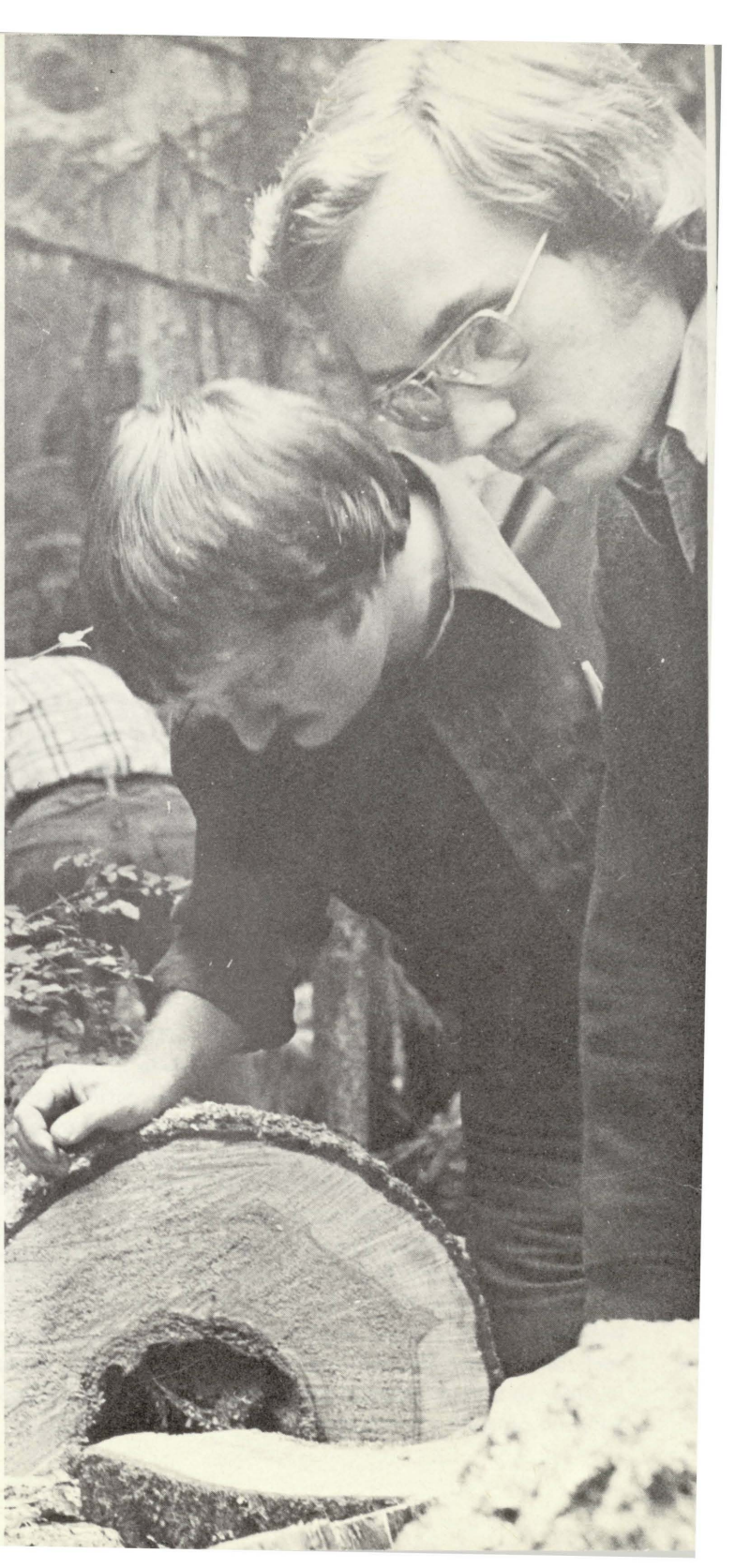
Native vegetation in British Columbia Capital Region study (BC-X-140) documents the distribution of plant communities in the eastern portion of the Capital Regional District. ■

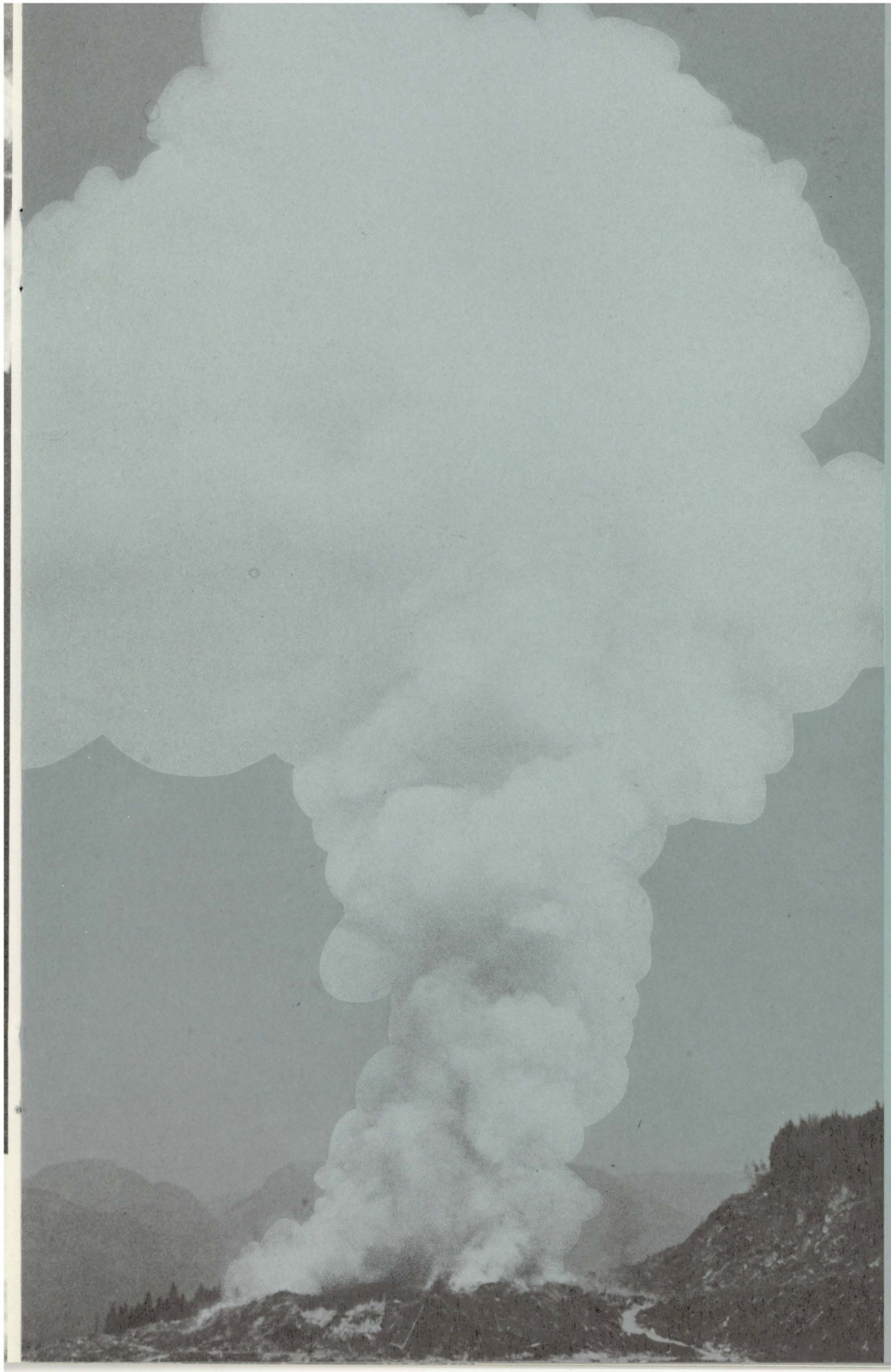
Western Community is located about 10 miles west of Victoria. The population of the area is expected to increase from 22,000 to 54,000 by 1995. The report (BC-X-153) is an analysis of the present environmental and vegetational characteristics of 11 landscape units occurring in the area, in terms of their suitability for urban development and resulting social costs. ■

Ecoregions of the Yukon describes a reconnaissance level biophysical survey of the Yukon Territory. The primary feature used to segregate and describe the ecoregions was the vegetation on different landforms under a regional climate. ■







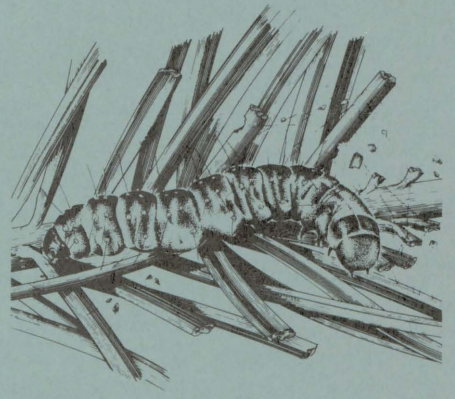


Protection

New Solutions – Old Problems

Fire, insect and disease play a major role in the cycle of growth depletion and rejuvenation of Canada's forests, and controlled fires are often used as a forest management tool. Outbreaks of these major forest influences threaten our regional and (particularly with respect to British Columbia) our national forest economy by a loss estimated at about over 3.5 million cubic feet annually. Protection problems are more acute in softwood forests, our major commercial species. A strong interrelationship exists between these forest influences, in that forests that succumb to insect and disease attack also contribute to high fire hazard.

The Canadian Forestry Service takes a major role in the protection research, considering that outbreaks and control measures, whether against fire, insects or disease, are frequently interprovincial, national or international in extent. ■



Spruce budworm

Field Surveys

The detection, evaluation and prediction of forest losses in British Columbia relative to insects, diseases, climate, and air pollutants is a continuous service as part of a national Canadian Forestry Service program. Early detection and appraisal of outbreaks enables forest protection agencies to take quicker preventive measures to reduce losses.

The survey team is supported by an insectary and a herbarium where specialists identify insect and disease samples sent in from the field. In one year these specialists will process over 3000 collections and respond to about 1500 enquiries. ■

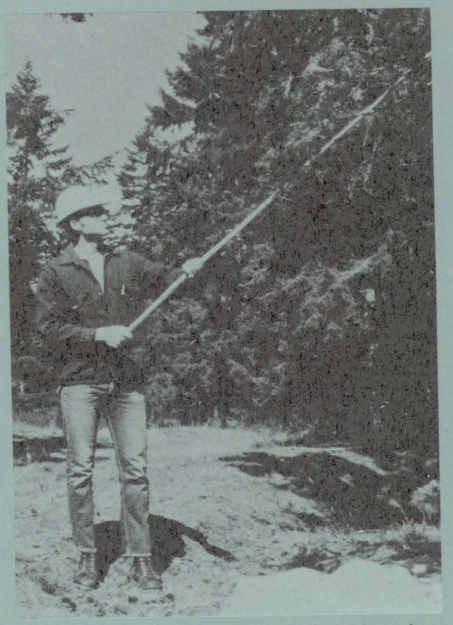
LOOKING FOR THE PROBLEM

Forest Insect and Disease Survey

Detection, evaluation and prediction of forest losses in British Columbia and Yukon Territory relative to diseases, insects, weather and air pollutants is a continuous service, part of a nationwide Canadian Forestry Service program. Skilled technicians assigned to the Forest Districts monitor the forests, and survey research officers develop methodology and damage appraisal techniques, and provide coordination, diagnosis and assessments.

Root rots, dwarf mistletoes, bark beetles in pine and spruce, budworm in Douglas-fir are the most damaging pests of British Columbia's forests. Of less importance are the extensive infestations of sawflies in lodgepole pine. Several major defoliator epidemics have collapsed, notably the Douglas-fir tussock moth in 1976 and the western hemlock looper in 1977.

The destructive spruce beetle and Douglas-fir beetle increased to levels where preventive and salvage measures were given greater consideration. The mountain pine beetle persists in lodgepole pine stands as the current major tree-killing insect in British Columbia. Noteworthy expansions of the pest occurred in Cariboo, Kamloops and Nelson Forest districts. The insect is also very destructive to the white pine component of the forests in the Blue River and Adams - Barriere lakes region of Kamloops Forest District. However, the massive infestation in a lodgepole pine stand in the Klinaklini Valley, Cariboo Forest District, appeared to be on the decline, owing to lack of living host trees.

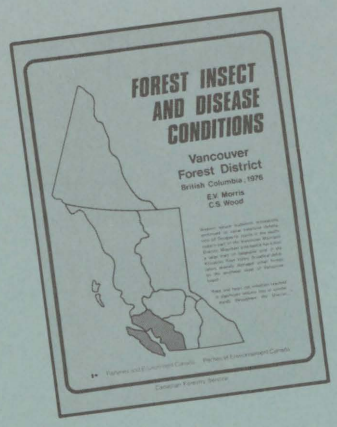


△ Beating a tree to see if it is harbouring insects.

The total area of spruce budworm defoliation of Douglas-fir in southern British Columbia jumped from 190 000 hectares (580,000 acres) in 1976 to 240 000 hectares in 1977, according to aerial surveys by the Detection and Reporting group of the Forest Insect and Disease Survey.

An unusually extensive infestation of sawflies developed on lodgepole pine in the valleys of the North Thompson and Clearwater rivers, Kamloops Forest District. A previously unknown debilitating disease of lodgepole pine plantations on the Coast was caused by a mite and a die-back fungus.

Survey staff assisted in a proposed spruce budworm control program, undertaken by the Provincial Forest Service, by supervising an egg and larval sampling project, and keeping track of populations and some effects of parasitism over an infested area of half a million acres. Early indications are that the epidemic will continue into 1978.



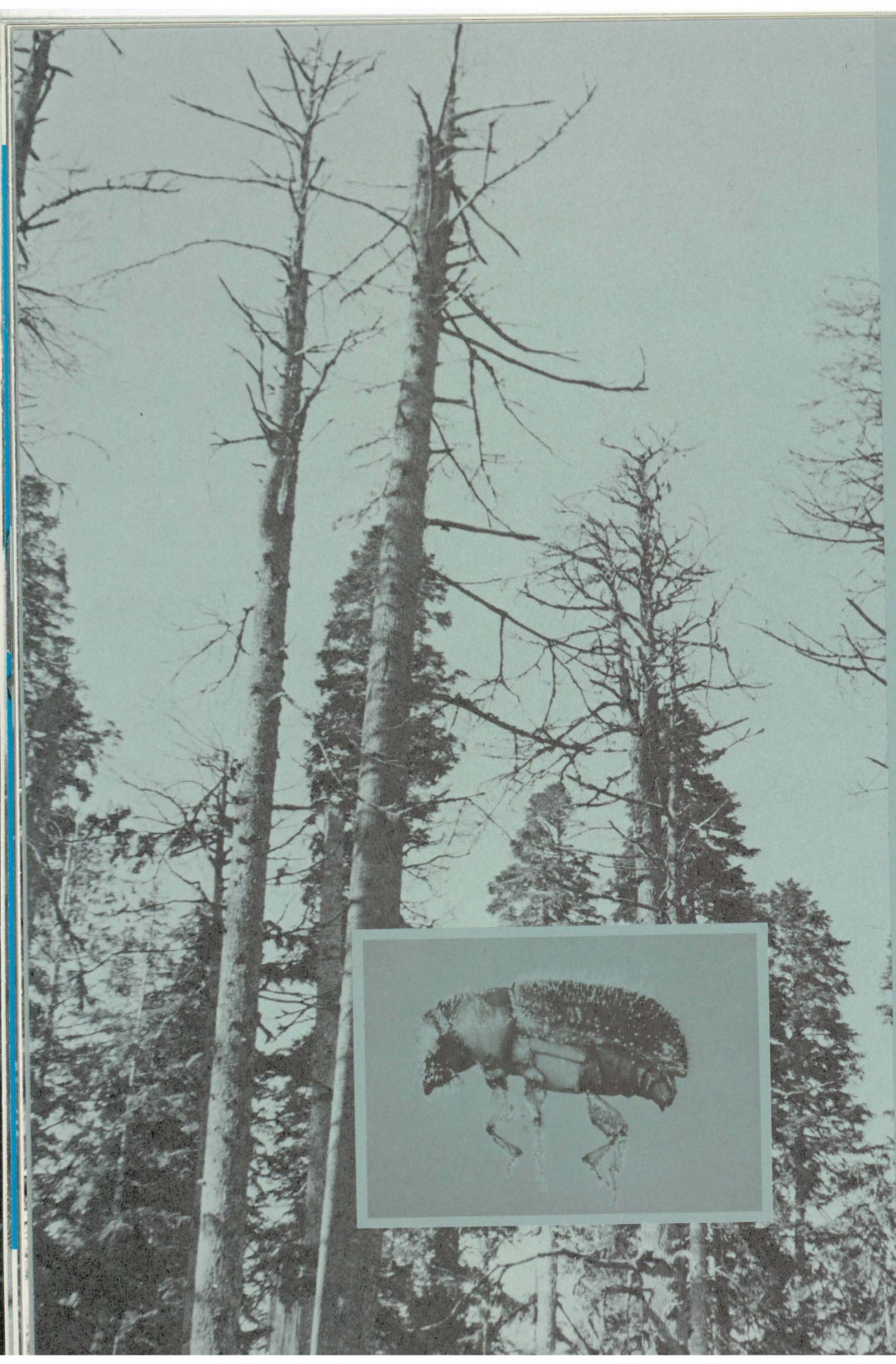
The current pioneering study by the damage appraisal group of the Forest Insect and Disease Survey on top-kill and increment loss on individual trees, as well as assessment of the amount of tree-kill by spruce budworm on Douglas-fir, will provide an invaluable basis for management of defoliated stands. Preliminary conclusions are that failure of trees to produce height and radial growth during an epidemic are probably the most serious impacts from budworm feeding. Top-killing and forking are important but appear to vary considerably. Recent Douglas-fir tree mortality, attributable to feeding budworms, was absent in stands examined in 1977.

△ Annual monitoring of pest problems is a cooperative effort with industry and the B.C. Forest Service.

Four agencies united to prevent establishment of the European pine shoot moth in native pine stands in the interior of the Province: the British Columbia Forest Service supplied manpower for an intensive survey, in 1977, of planted ornamental pine in the Okanagan - Kamloops area; Forest Insect and Disease Survey of C.F.S. provided instruction, advice and insect traps; Federal Plant Protection personnel inspected pine transplants in nurseries, and staff of the B.C. Ministry of Agriculture treated pine in localities where the shoot moth was discovered. A similar program is planned for next year.

Members of the British Columbia and Yukon forest services and forest industry increasingly rely on the "third opinion" supplied verbally and in technical reports by Forest Insect and Disease Survey personnel. Field instruction and demonstrations of survey methods by F.I.D.S. personnel, notably on mountain pine beetle and dwarf mistletoe, have further encouraged forest managers to assess and, manage their pest problems. ■

△ Early detection of outbreaks is vital to implimenting controls.



MAJOR EFFORT COMBATING THE SPRUCE BEETLE

"The spruce beetle is one of the most destructive insect pests of mature spruce forests in British Columbia and the Yukon."

Over ½ billion cu ft of spruce was destroyed by this beetle between 1956 and 1965. The beetle infests windfalls, logging slash and injured trees. During epidemics, large numbers of apparently healthy trees will be killed over thousands of square miles; usually the largest diameter component of stands suffer the most severe mortality. Outbreaks usually develop during periods of hot, dry growing seasons preceded by severe windthrow or excessive accumulation of slash suitable for attack by the beetles.

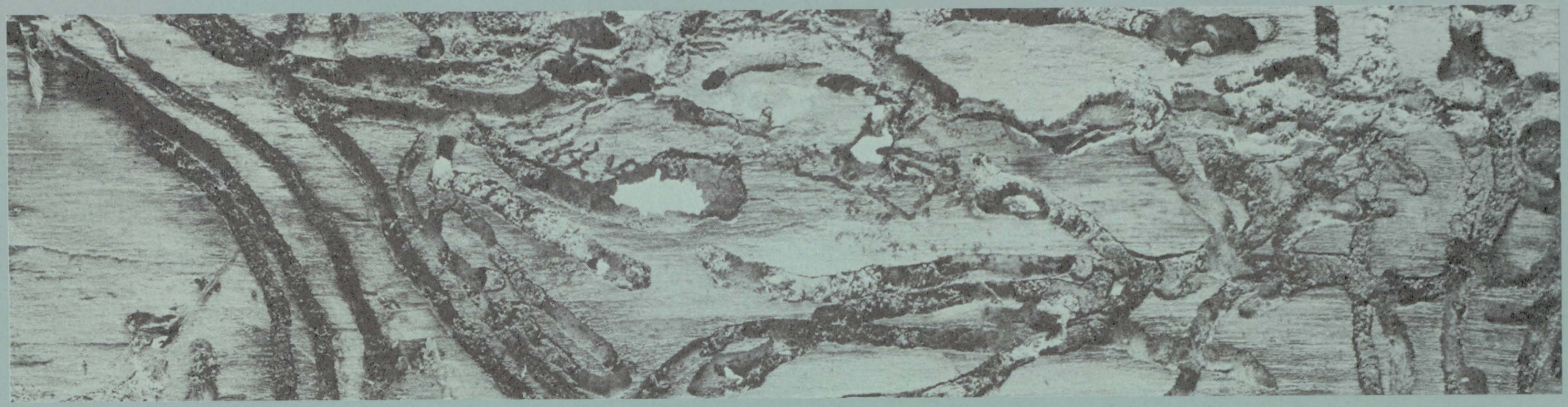
FEMALE AGGRESSORS

The female beetles initiate the attack by chewing through the bark on stumps and the main boles of trees or windfalls, and constructing egg galleries in the inner bark. During initial stages of gallery construction, the female beetles release chemical attractants, called pheromones, causing both sexes to aggregate at, and mass-attack, these host materials. Beetles of both sexes carry associated blue stain fungi and other microorganisms into the tree. In susceptible trees, the fungi quickly penetrate and kill living cells in the inner bark and sapwood. When the killing of living cells is extensive around the entire circumference of the lower bole, the tree will die and beetle broods become established. Normally, trees resist the establishment of beetles and blue stain fungi by killing or repelling the beetles with an extensive flow of resin. There is a dynamic interaction between trees and stands on the one hand, and beetles with their associated blue stain fungi on the other. Understanding this interaction is fundamental for forecasting outbreaks and initiating forest management practices to reduce losses.

◁ The spruce beetle is one of many destructive bark beetles.

IT'S A MULTI-DISCIPLINE PROJECT

The spruce beetle program, a coordinated, multi-discipline research project, was established in 1972 following a series of beetle outbreaks in southern British Columbia. Objectives of this project are to discover, develop and promote environmentally acceptable control and protection techniques and forestry procedures that will enable forest managers to reduce losses from the spruce beetle and to preserve mature spruce stands for harvesting, and amenity values.



△ Insect galleries that harbour the young.

The project is comprised of seven studies and involves a team of six scientists whose expertise ranges from tree and insect physiology through plant and insect pathology to insect population biology. The field work is carried out in the Naver Forest, about 35 miles southeast of Prince George. Many spruce stands in this forest suffered heavy mortality during the last major epidemic of 1959-64.

COMPUTER MODEL

A conceptual computer model of spruce beetle population dynamics was developed, based on the collective experiences and hypotheses of the research team, to aid in evaluating the spruce beelte problem and to identify research needs and priorities. Computer simulation, using this model, indicated that stand susceptibility to attack by spruce beetles generally increases with stand age and stand diameter, site quality, and the per cent spruce component. However, the results also suggested that, depending on weather conditions, high incidence of windthrow or slash may or may not be a precursor of outbreaks; outbreaks may develop in stands during periods of dry years, with very low densities of windfall being present. Another important suggestion from the simulation work was that even relatively moderate killing of the emerging beetles during the year preceding an outbreak may result in substantial reduction in stand depletion.

RESISTANCE TO SPRUCE BEETLE

It has been demonstrated that white spruce trees of all ages are actively resistant to spruce beetle attack in most years. The process of resistance culminates in the formation of a resinous tissue by the vascular cambium and inner bark. Secretion of resins by these tissues cleanses the wound and seals the damaged surface. Recently, the study of this process of tree resistance has progressed from a study of chemical and cellular changes to a study of the energy balance of the trees under attack by beetles. Through this approach, the capacity of trees to survive attacks, and the effect on future growth, can be assessed.

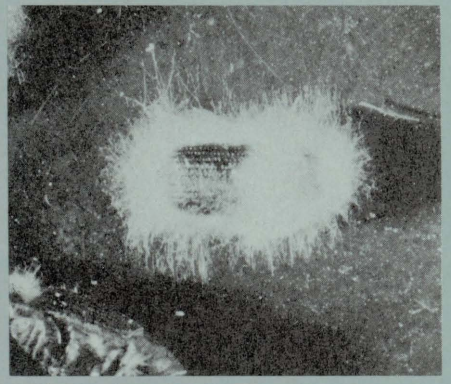
LOGGING SLASH

Spruce logging slash is invariably infested by spruce beetles. However, brood survival is generally low, except below the duff, and above the duff near the duff-line, on the north and east sides of stumps and on the undersides of logs which are in contact with the ground. Mortality is generally greater in stumps cut with mechanical sheers, where much of the stump is shattered and the bark is missing or disturbed, than in stumps cut with a chainsaw. During hot, dry summers, beetle broods in slash will develop on a 1-year-cycle. These 1-year beetles, added to the 2-year cycle beetles that normally develop in windfall inside stands, can considerably increase the size of the attacking beetle population; hence, the outbreak hazard to the stand. Slash burning is generally ineffective in killing beetles unless the burn is hot enough to scorch the bark and burn away the duff from the bases of stumps.

△ Traps are placed in strategic locations

PHEROMONE BAITING

An experimental control trial of the spruce beetle with the synthetically produced pheromone, frontalin, was evaluated in a 2000-acre spruce forest. The objective was to bait beetles into standing trees where the trees natural resistance could kill their broods. One hundred randomly selected spruce trees were selected in the experimental area and baited with a mixture of frontalin and a spruce resin component prior to beetle flight. Following beetle flight and attack, the densities/acre of spruce beetles were estimated in the baited trees, adjacent bait-influenced trees and windfalls. Only 3.6% of the beetles attacked the baited trees, while about 95% of the beetles attacked wind-thrown trees. The remainder of the beetles attacked unbaited trees. These results show that the presence of windfall suitable for attack will seriously reduce the efficiency of the pheromone baiting control technique. Since, on average, a wind-throw absorbed about four times as many beetles as a baited tree, the effectiveness of pheromone baiting to reduce a spruce beetle population over large areas will depend directly on wind-fall density.



△ Insect destroyed by virus.

BIOLOGICAL CONTROL

Under controlled laboratory conditions, a pathogenic fungus killed all the spruce beetle in the test. Under field conditions, mortality was only moderate and it took considerably longer for inoculated beetles to die than under controlled laboratory conditions. In spite of the moderate success of field experiments, we believe that with more efficient formulations, better dissemination techniques and timing, this naturally occurring beetle pathogen can be used effectively to prevent these insects from building up to high numbers.

WINDFALL SURVEYS

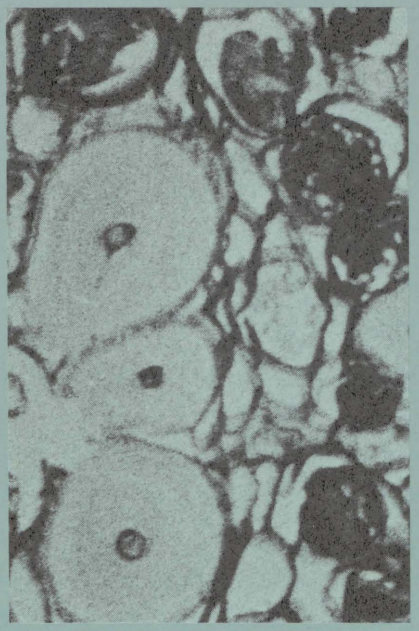
Windfall surveys on two Timber Harvesting Licenses indicated that windfall incidence can be high in mature spruce stands even during "normal" windthrow years. During the past 5 years, the density per acre of windfall of these two areas ranged from about one-fifth to over 1.5 trees. Inside the stands, many windfalls resulted from windbreak, often because of advanced stem or root decay while, on the stand edges, most windfalls had root pan. The most heavily affected stand edges were those facing the direction of the local storm-force winds. These edges did not stabilize, even 5 years after logging. The bulk of the windfalls became infested by spruce beetles each year during the study period but very few standing infested trees were observed; usually more than 95% of the beetle population emerged from windfall or slash. Beetle attacks on standing trees were often confined to a strip of bark surrounding an area of injury on the lower bole. High endemic populations of beetles were maintained in windfall; with enough beetles produced to infest 1-2 trees/acre/year uniformly throughout the stands. However, this did not happen for two reasons: (a) there was ample windthrow and slash each year to

△ Trees felled by wind provide an excellent breeding ground for beetles.

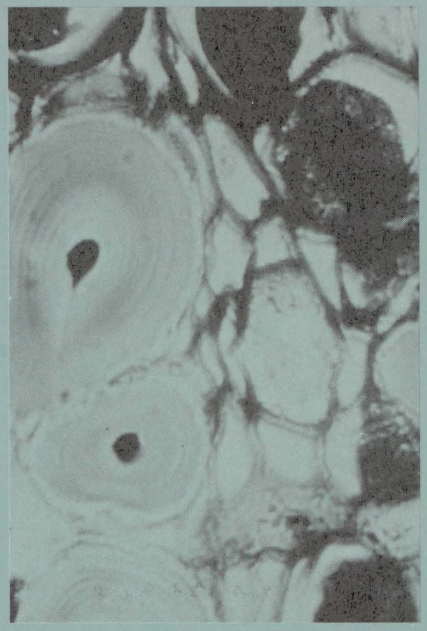
absorb the emerging beetles, and (b) the trees were apparently not susceptible to attack. When trees were baited with synthetic chemical attractants, they became attacked but invariably resisted the establishment of the beetles and blue stain, except during the 1977 growing season. In 1977, some of the attacked baited trees were successfully colonized by spruce beetles, indicating perhaps a decline in tree and stand resistance.

USE OF MICROPHOTOMETRY

Computer-assisted microphotometry, developed at the Pacific Forest Research Centre, has been adopted for assessing qualitative changes in spruce beetle populations that translate into quantitative differences in reproductive capacity and survival in a given environment. The equipment consists of a microscope whose stage movement is controlled by a computer. Readings of up to 200/second are taken by a microphotometer and these readings are analyzed by the computer, utilizing techniques similar to those used for digital images from satellites. This technique should develop into a powerful tool in microbiology, tree physiology and related disciplines. ■

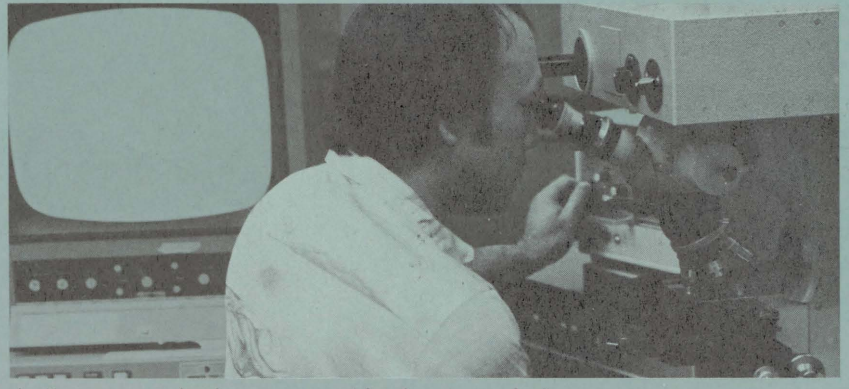


△ Picture from microscope.



△ Computer assisted photo of same scene showing greater detail.

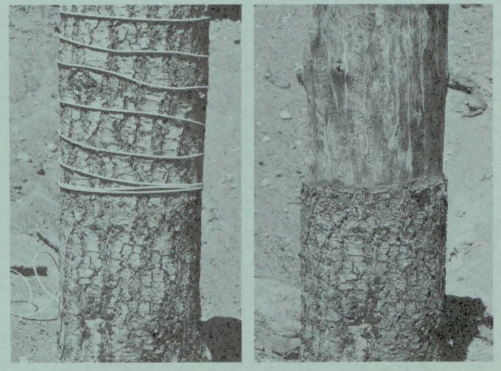
The first phase of this bark beetle project is nearing completion. Future work will emphasize the development of preventive and curative forest management guidelines based on existing knowledge, further experiments into aspects of host attraction, stand resistance and predisposition, techniques of direct control and beetle survival in standing trees.



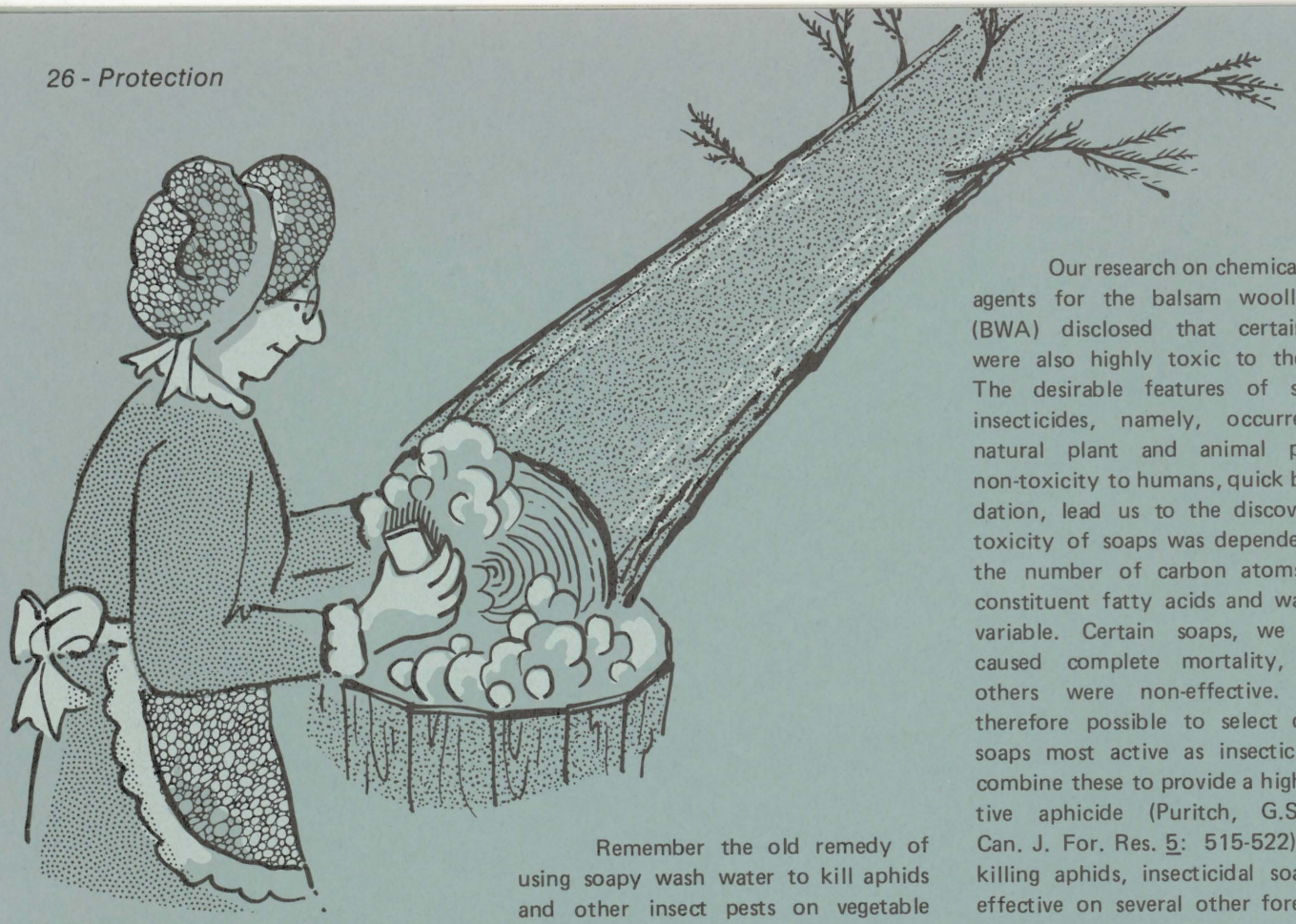
△ Computer and microscope combine for a better look.

SOMETHING DIFFERENT

Experiments were carried out on the possibility of removing bark from boles of infested trees and logs with explosives, in collaboration with the Fleet Diving Unit of the Department of National Defence, advice and services from CIL, and in cooperation with the British Columbia Forest Service. Preliminary results indicated that at least on thinner bark tree species (e.g., pines, spruces), the bark can be blasted off and/or mangled to destroy or curtail



development of most of the brood. These experiments indicated that the effectiveness and efficiency of this type of treatment vary considerably with its timing relative to beetle attack, the type of explosive used and the deployment of the explosive material. Further tests will be made to evaluate the potential of this technique for treating individual infested trees in localized 'hot-spots' with a view to preventing population build-up. ■

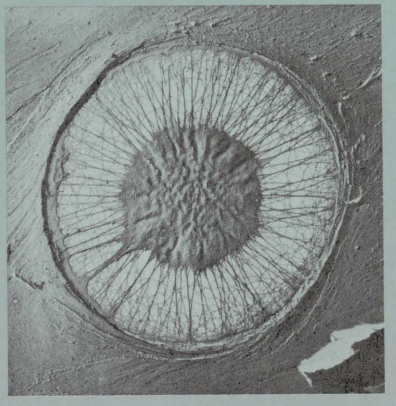


Remember Grandma's Lye Soap?

Remember the old remedy of using soapy wash water to kill aphids and other insect pests on vegetable plants? Well it's back in vogue.

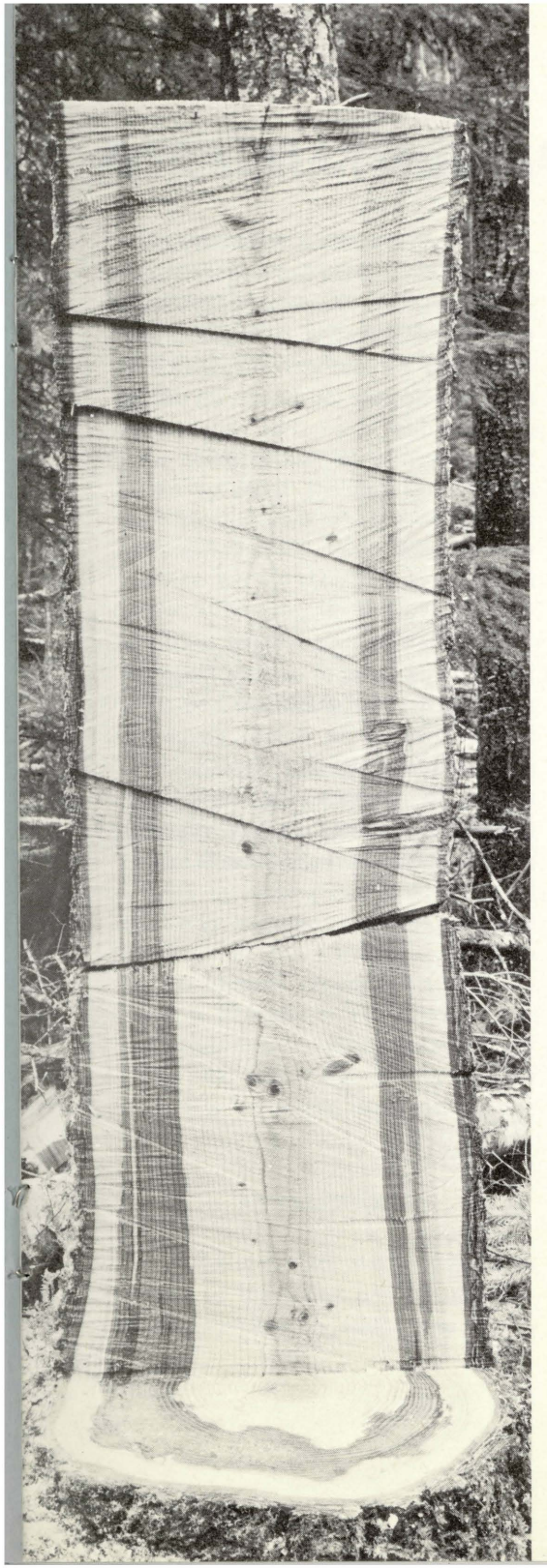
Soaps (technically salts of fatty acids) have been used for centuries for insect control. In the 1920s and 30s, various scientific studies showed that insecticidal activity varied with the type of soap used and that soaps with a high proportion of low chain saturated fatty acids or unsaturated 18-carbon fatty acids were the most toxic. Unfortunately, the insecticidal use of soap declined after the late 1930s and has been ignored in recent years.

Our research on chemical control agents for the balsam woolly aphid (BWA) disclosed that certain soaps were also highly toxic to the aphid. The desirable features of soaps as insecticides, namely, occurrence as natural plant and animal products, non-toxicity to humans, quick biodegradation, lead us to the discovery that toxicity of soaps was dependent upon the number of carbon atoms in the constituent fatty acids and was highly variable. Certain soaps, we learned, caused complete mortality, whereas others were non-effective. It was therefore possible to select only the soaps most active as insecticides and combine these to provide a highly effective aphicide (Puritch, G.S. 1975. Can. J. For. Res. 5: 515-522). Besides killing aphids, insecticidal soaps were effective on several other forest pests, including spruce gall aphids, black headed budworm, tussock moth and spruce budworm. Major field trials showed that BWA can be entirely eliminated from stem attack pockets, using soap solutions, with no undesirable side effects. Tests on BWA infested seedlings were also successful. This information was utilized by the B.C. Department of Agriculture in preparing the regulations for growing Abies seedlings. Soaps have also been used successfully for treating a seed insect in a commercial seed orchard. ■



What is it?

This is a tree cell membrane magnified 8000 times by an electron microscope. This technique assists scientists to identify the minute actions of trees and insects. Such a photo enabled scientists to discover how the balsam woolly aphid, a tiny sucking insect, interfered with feeding mechanism of the tree.



ROOT ROTS KILLING TREES

The impact of root rots on young coniferous forests has been extensively invesitgated by PFRC research pathologists Dr. Gordon Wallis and Dr. Duncan Morrison. Root rots literally rob British Columbia of over $35 million annually because of damage to young stands of Douglas-fir, hemlock and other conifers.

Three types of fungi cause the most damage, and control is difficult and costly because the root rot is hidden beneath the soil surface and survives for decades in old stumps and roots.

HOW IT DESTROYS

The disease penetrates through the bark of roots and decays the wood. Spread to the young timber stands occurs when the roots make contact with mycelium in the old roots and stumps. When diseased and healthy roots entangle, the disease spreads to healthy trees. The trees die from the girdling of the stem at the root collar or from gradual decaying of the roots. Some trees are killed quickly while still standing; others may be wind-thrown following extensive decay of the root system.

◁ Root rots work from the bottom up.

IS THERE A SOLUTION?

Scientists discovered that some species are immune to the disease and have recommended that alternate species be planted on infected sites. Western red cedar and a variety of deciduous species are resistant to infection. On good growing sites, scientists recommend the removal of infected stumps and roots by root raking. In some cases, stumps can be chemically treated, using borax, to prevent infection by spores. Studies are underway to find a chemical suitable for protecting basal wounds against wood decay fungi.

Control of root rots in coastal forests will best be achieved by maintaining the forest in a vigorously growing state. Methods of controlling the disease in heavily infected stands in the Interior are under investigation. ■

△ Without roots trees cannot stand tall. Young plantations are very susceptible to root rot.

△ Sprays were applied by aircraft.

Tussock Moth Control

One of the many defoliators, the Douglas-fir tussock moth, has been under the microscope as part of research and development of pest management systems by the Canadian Forestry Service.

The tussock moth outbreak at Kamloops was part of the outbreak in Oregon, Washington and B.C. that started in 1970. Defoliation occurred in the Okanagan Valley on both sides of the border and collapsed in the southern part of B.C. at the same time as it did in Oregon and Washington, but it intensified around Kamloops.

Larval densities in many stands were extremely high and control action had to be timed precisely to the beginning of feeding. Heavy defoliation occurred if spraying was delayed. However, 'Orthene', the chemical used in the control operation, is so short-lived that applications of it a few days before feeding resulted in only partial control. In areas where control was not sufficient the first year, trees were severely defoliated but still bore viable buds. The next year it was essential to save the new flush developing from those buds in order to save the trees; thus, the need for critical timing. Orthene was most effective in preserving current foliage because of its fast action.

△ Douglas fir tussock moth.

Dimilin, a material more specific in its action, was tested and found to be more effective in reducing populations, but it was slower acting and allowed greater defoliation of current growth. Less expensive than Orthene, it has a long residual life.

Of the microbials, the specific virus proved most effective in controlling populations. A year after application, the population was reduced to endemic levels. Foliage preservation was sufficient to keep the trees alive. Cost was relatively high but is compensated for by the continued protection obtained from a single application. Bacillus thuringiensis produced neither sufficient population control nor adequate foliage protection even at high application rates. Stands treated with B.t. in 1975 had to be retreated the following year. Costs were relatively high.

Little effect was found on bird census numbers, but Orthene may harm ants which are incidental predators of the tussock moth. Results on aquatics are not available. Toxicity studies indicate a gradation in specificity from Orthene through Dimilin and B.t. to the virus. ■

MOUNTAIN PINE

In cooperation with the British Columbia Forest Service in the Cariboo Forest District, trials are being conducted to determine how a synthetic pheromone may be used and what chemicals may be effective for destroying beetles on individual trees. The objective of the research is to find effective ways of treating incipient spots of beetle infestation before they spread into large infestations which cannot be economically controlled.

The mountain pine beetle is killing large areas of mature lodgepole pine forests in the Cariboo and other Forest Districts in British Columbia. The problem has no easy solution except to increase the amount of logging in infested stands wherever possible. This, however, disrupts longer-

BEETLE CONTROL

term management plans and may not suit milling or market requirements. In areas that are not salvage logged, the dead timber deteriorates and after several years is of little commercial value.

The pine beetle infests the larger trees in mature stands and continues to spread each year, provided there are suitable host trees and that the weather, particularly mild winters and warm summers, is suitable to the beetle's survival in large numbers.

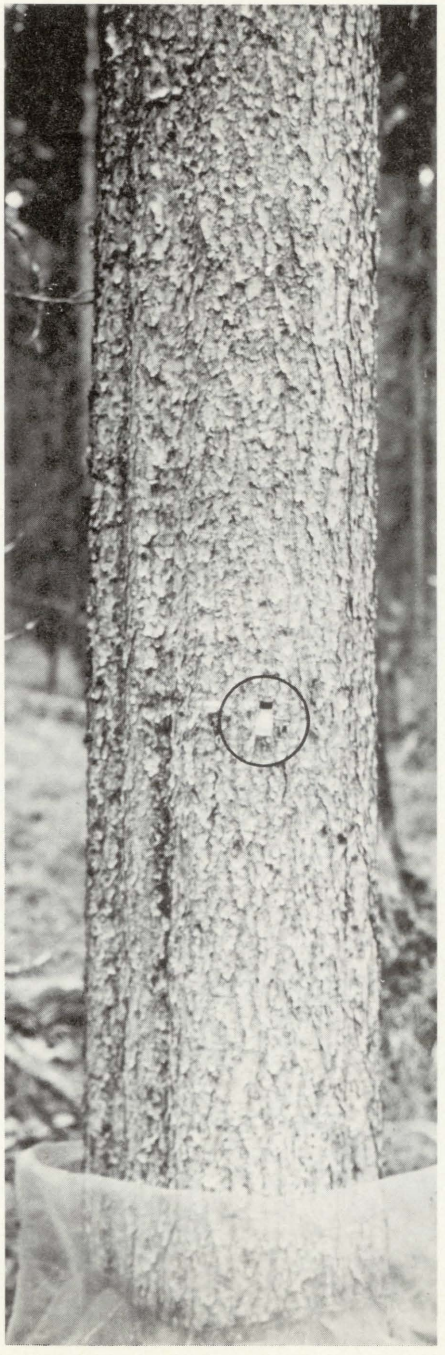
FEMALE FIRST

These beetles use chemical "odors" or pheromones to attract and aggregate both sexes at suitable host trees. The females always initiate attacks by boring into the bark and tunneling between the bark and the sapwood in the cambium. As soon as the female begins an attack she emits a pheromone that brings males and more females which help to overcome the resin flow of the tree by mass attacks on the lower part of the bole.

ATTRACTANTS

An attractant pheromone, which is part of the group of naturally produced chemicals to which these beetles aggregate, has been synthesized. This, with a component of pine resin, can be placed in small capsules on living pine trees to induce the first attacks when the beetles are searching for host trees. It apparently does not attract beetles from a distance but induces them, when they fly nearby, to first attack the baited trees. If baited trees are resistant to beetle attacks, they may kill the beetles with pitch flow. Usually this cannot be predetermined, so the baited trees may be treated with insecticides or other chemicals to become lethal traps where the beetles either die or cannot reproduce.

Uninfested trees, near dying pines which were infested the previous year, were sprayed with insecticide on the basal 3 meters of the bole and the attractant or pheromone, trans-verbenol, was attached in a capsule to the trunks at breast height. When the beetles emerged from the dying trees, they were attracted first to the pheromone-baited trees and many thousands were killed by the insecticide as they tried to bore into the bark. Many also successfully infested adjacent trees, spreading some attacks further into the uninfested forest. Some of the infested trees were immediately treated with a sylvicide which was taken up by the sap-stream when injected into shallow oxe-cuts in the bark around the tree bases. This treatment killed both adult and young beetles under the bark, although these trees also died. Other infested trees were left until early the following summer, when the boles were sprayed with a mixture of insecticide and diesel oil to kill the nearly mature brood before they emerged to infest green trees. These treatments kept the spread of infestation in the treated 40-acre plot to about 300 trees compared to the adjacent untreated 40-acre plot where 1787 trees were infested in 1977.



MUST BE MANAGED

Experience in the past 2 years confirms the infestations of bark beetles in lodgepole pine stands must be managed as you would fight a forest fire. When the first few pines are found to have beetle attack, immediate predetermined control action should be initiated to prevent spread. By all methods at our disposal, the beetles should be killed or removed before the infestation becomes large. Large infestations, like large fires, can rarely be stopped by the efforts of man; they must be thoroughly extinguished when very small. ■

◁ Baited trees draw the insects away from more valuable trees.

New Technology

New Problems

Disease plays a crucial role in the quality and quantity of forest nursery seedlings, as it triggers a solid jolt to two vital areas: reforestation costs and scheduling. The eventual hope of PFRC researchers is to reduce or eradicate seedling losses.

Several recent changes in nursery production technology and reforestation practices have influenced the incidence and severity of seedling diseases. For example, growing seedlings in container nurseries has greatly increased the importance of grey mould caused by the fungus Botrytis cinera. This disease, of minor importance in bare root nurseries, severely damages shoots of container-grown western hemlock and Douglas-fir. Container nurseries provide ideal conditions for grey mould because large numbers of succulent seedlings are grown under crowded, humid conditions. Some disease control can be achieved by reducing seedling densities and relative humidity, e.g. by regulating watering and improving aeration. Grey mould control, however, still depends upon the use of

◁ Containers developed by research have enabled foresters to grow more seedlings in a shorter period of time.

fungicides. Research at this Centre has helped develop better spray schedules, application methods and fungicide recommendations. Consequently, disease control has improved markedly, while fungicide usage has been reduced. Research now underway is directed at replacing fungicides with cultural and biological controls.

IN REFORESTATION

Reforestation of high elevation sites is another example of technological change that has indirectly caused an increase in seedling disease losses, because it has necessitated storing seedlings for longer periods, until spring snow melting allows outplanting. Lengthening the seedling storage period has resulted in a drastic increase in storage moulding. Researchers found that moulding of most interior seedling species can be prevented by storing the seedlings at temperatures slightly below freezing. This is a practical solution for controlling moulding of these seedlings, but coastal seedling species cannot withstand frozen storage. Research results indicate that post-storage treatment with systemic fungicides may prevent storage moulding of coastal species.

Some changes in nursery practices have decreased disease losses. For example, increased numbers and size of both bare root and container nurseries have allowed bare root nurserymen to implement a policy of fallowing fields between crops. Fallowing has eliminated losses from corky root disease, and reduced severity of root rot of Douglas-fir. In conjunction with fallowing, soil samples are collected during early summer from fallow fields and assayed for plant pathogenic fungi and nematodes. Thus pathogen populations, which could damage the next seedling crop, are detected early enough to allow implementation of preventive measures during the remainder of summer and fall. One control measure that has worked well is frequent disking of pathogen-infested soils during the hot, dry summer period. This measure reduces pathogen population to innocuous levels. In conjunction with a service study within the nursery disease project, reconnaissance surveys, and assays of nursery water supplies and soil amendments for pathogens are also made to detect and prevent disease occurrence. The service study receives about 75 requests each year for disease diagnosis and control recommendations.

A study was begun to determine the effect of seed-borne microorganisms on seed viability. To date, about one-third of all BCFS spruce (Sitka, white and Engelmann) seedlots assayed are infested with a pathogenic fungus. Within seedlots, incidence of diseased seeds varies from 0.2 to 26%. These findings are important because the fungus can spread and kill seeds during stratification or in cool, moist seedbeds. Our studies demonstrated that the fungus occurs only in seeds that have been extracted from cones collected from the ground beneath trees or from squirrel caches. Thus, the disease could be controlled by using only cones that have been picked from trees. However, since this is not always practical, studies are now being made to determine how long cones can remain on the ground, or in caches, before a significant number of seeds become diseased. Also, experiments are planned to find out how the length of the cone storage period, i.e., time between cone collection and seed extraction, affects incidence of the seed fungus. ■

The plug seedling.

FIRE

DOING A BETTER JOB

PFRC fire researchers prove that thermal infrared imagery can be a valuable tool in detecting hang-over fires in logging debris.

SLASH BURNING PROBLEM

Every fall, in the B.C. Interior, several hundred logging operations burn logging waste to reduce the fire hazard. The debris accumulates at the "landings", or points on the logging operation where the trees are yarded before being cut into logs and loaded on trucks. They are generally ignited in October and November to eliminate the hazardous fuels before the heat of the next summer, and to enable the areas taken up by the logging landings to become productive forest again by planting or natural regeneration.

◁ The drip torch is quicker and safer.

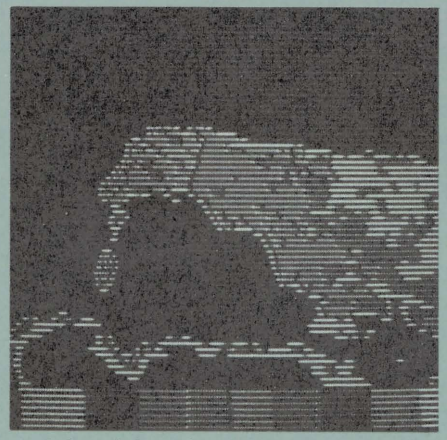
The slash fires sometimes "hang over" or smolder all winter under the snow and sometimes in the dry, windy spring days of May and June the smoldering fires come to life and escape into surrounding slash, new plantations and standing timber.

Often the smoldering fires emit little or no smoke and are virtually undetectable. The solution to this problem seemed to be providing the air observer with an aid that would enable him to see the heat from the smoldering fire and not have to depend on smoke for detection.

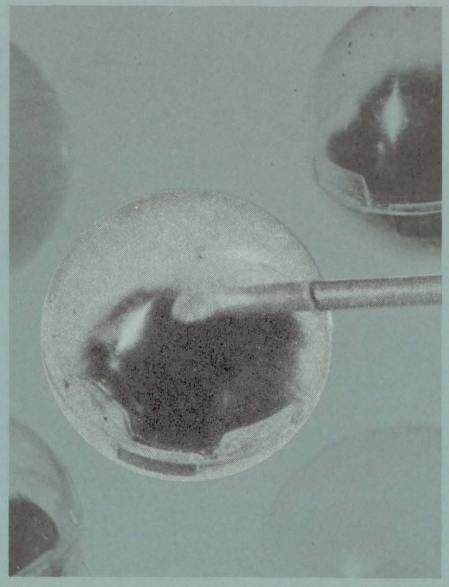
RESEARCH PROVIDES AN ANSWER

At PFRC, fire researchers had been using a thermal infrared imaging system for fire behavior mapping on spreading wildfires and research fires. It seemed logical that equipment capable of detecting and displaying the invisible heat energy from a spreading fire could do the same job for the fire control organization concerned with detecting hang-over landing fires before they became spreading fires.

△ The aerial drip torch.



△ Infrared detection



△ The AID fire ball

REDUCING FIRE COSTS

Infrared equipment was mounted in a helicopter and several hundred burned landings were scanned during May, in the Cariboo and Kamloops Forest Districts. Of these potential fire sources, only a dozen were hot, and men and equipment were dispatched to extinguish the smouldering material before the fire became a major source of cost and damage to the industry and the B.C. Forest Service.

Following these successful demonstrations of infrared imagery capability for fire detection, the B.C. Forest Service purchased a small, inexpensive infrared unit for each of the six Forest Districts. These units will be used in routine fire detection patrols and also on the ground to aid suppression crews in "mopping up" fire lines where hot spots are often difficult to detect.

Adding heat-detecting "eyes" to fire control, people's detection capability will cut down on high costs of landing fire hang-overs (over $200,000 suppression costs for this type of fire in Kamloops district in one year).

This is an example of useful spinoff from research that results from maintaining close liaison between researchers and operational staff in client agencies. ■

Single tree burning is effective for destroying insect populations. ▷

THE TREE DEFENDS ITSELF

MULTIMILLION DOLLAR IMPACT OF BALSAM WOOLLY APHID RESEARCH

Drastic attacks by the balsam woolly aphid (BWA) on true firs (Abies species in Washington and Oregon states, in the late 50s, resulted in strict enforcement of forestry regulations in British Columbia. All stock of Abies seedlings was destroyed and a ban was imposed on growing or planting the species for reforestation or nursery purposes until adequate control measures were developed.

THREE-WAY RESEARCH

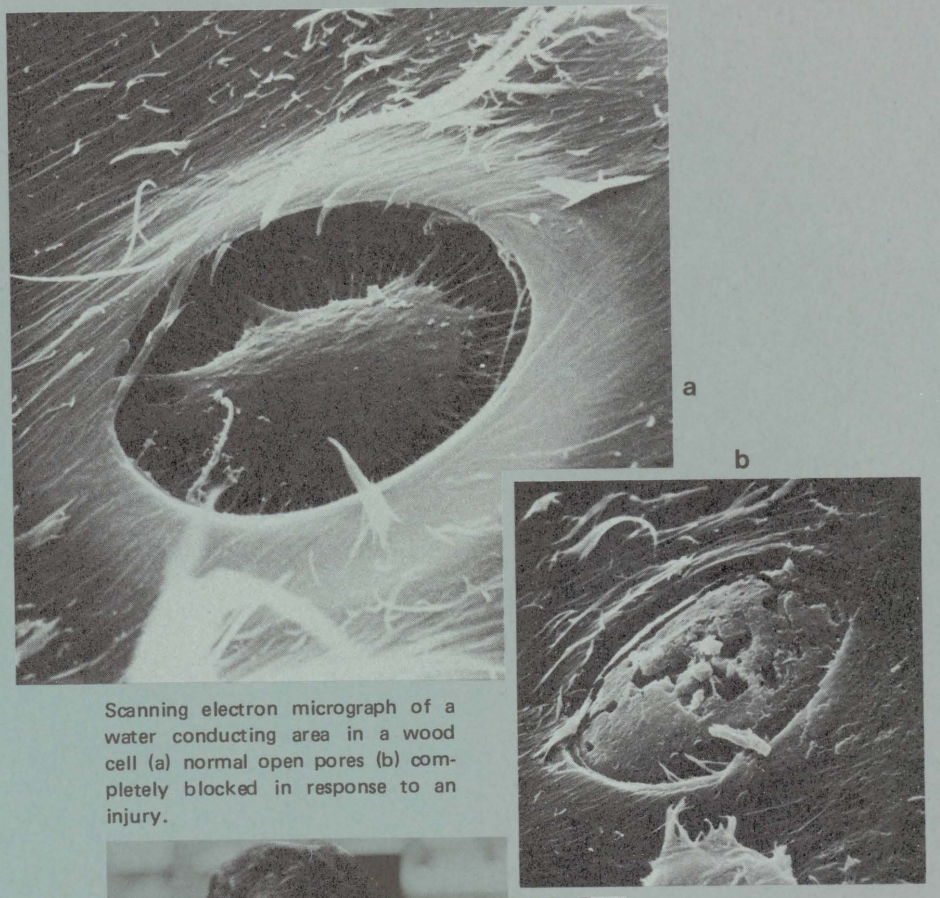
The Pacific Forest Research Centre is overcoming the deficiency of knowledge through research in three major areas. Extensive surveys, carried out regularly since the aphid was discovered, have shown that the boundary of the infested zone has remained virtually static and that the aphid population has collapsed in some areas. The second phase led to development of mild, environmentally compatible chemical control measures, using selected soaps, which effectively control the aphid in isolated pockets.

TREE DEFENSE

The last area of research centered on tree defense mechanisms in b.w.a. interactions and showed that trees have active defense capabilities and do not serve simply as a food source for this insect. Thus, the presence of the aphid does not automatically mean significant losses. The defence responses are non-specific, i.e., a wide variety of diseases trigger the same basic response(s) in the tree, making it easier to sort out the specific effect of individual disease organisms and develop specific control measures for individual diseases. Environmental factors, long associated with disease outbreaks, also affect these defense processes. For instance, drought conditions, which have been correlated with disease outbreaks, adversely affect the defense processes.

COMPLEX REGULATIONS

During the period of the foregoing research, it became increasingly evident that the ban on growing Abies was causing an ecological imbalance, which produced a negative impact. It was particularly costly for forest companies reforesting high elevation logging sites. Attempts to substitute Douglas-fir for Abies amabilis met with failure, resulting in a direct multimillion dollar loss to the companies in lost seedlings, planting costs and lost years of production on these sites.



Scanning electron micrograph of a water conducting area in a wood cell (a) normal open pores (b) completely blocked in response to an injury.

Scientists use a variety of ▷ specialized equipment.

The understanding of the trees' defense mechanisms, the results of the surveys, and the development of mild chemical control measures formed the basis for recommendations that resulted in revised regulations to control the BWA problem that now permit, among other things, the growing of Abies for reforestation and for nursery use, subject to constraints on movement of stock from the infestation zone.

The issuance of the original ban, necessitated by lack of adequate understanding and the urgent need to protect the resources, and the results of our studies clearly show the real monetary contribution of long-term essential basic research in resource management and pest control.

A NEW IMAGE

The research at PFRC into the BWA problem produced a model of host-pathogen interactions that is applicable to a wide range of disease problems. The fundamental understanding of host responses that occur or should occur under attack by any of a wide range of disease agents, such as fungi, parasitic plants and many insects, under a wide range of environmental conditions, provides a new perspective and opens new approaches to integrating the diverse factors involved in disease. Exploitation of tree defense offers the opportunity for developing, from a sound knowledge base, biological control procedures that are specific to a given disease problem, de-emphasizing non-specific, environmentally damaging pesticide approaches to control. Further, such knowledge will provide parameters for selection of resistant stock for reforestation and for predicting the performance of this stock under adverse environmental conditions. Continuing essential research will provide information that is a valuable input to models of diverse diseases in understanding variability in host susceptibility - a necessity if meaningful predictions of disease behavior are to be obtained. In addition, this information is a stepping stone in the development of means through remote sensing for forecasting disease outbreaks and the state of our forest inventories.

◇

Dr. Bir Mullick, PFRC scientist, has issued a comprehensive review on this subject in "Recent Advances in Phytochemistry" Vol. 11. Plenum Press, New York 1977). ■

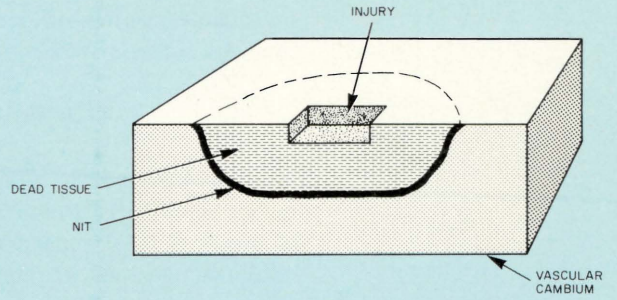


Fig. 1. Loss of the outermost living bark cell triggers the non-specific process of phellogen restoration which through a sequence of alterations in the surviving bark restores a functional skin.

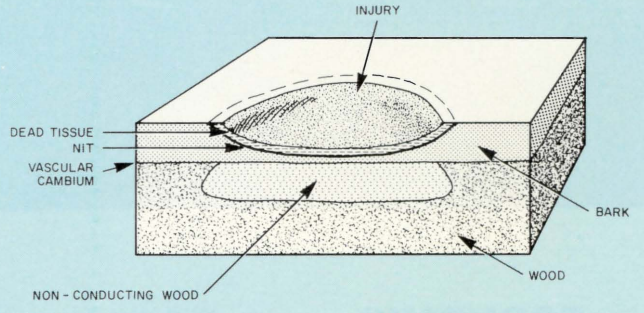
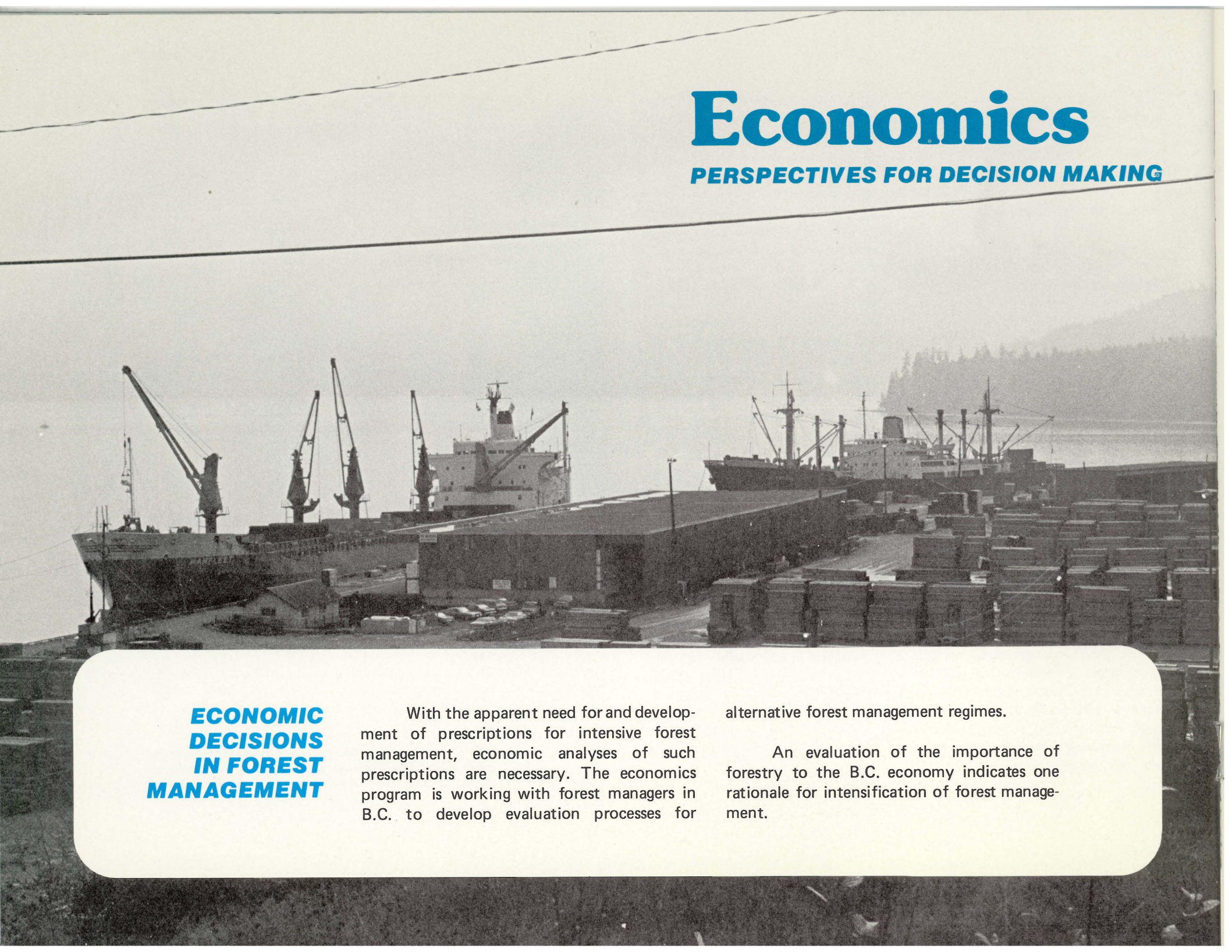


Fig. 2. Injury to close to the conducting sapwood also triggers another non-specific defense process, that of blacking conductive sapwood. If successful, this "quarantines" the affected area.

Economics

PERSPECTIVES FOR DECISION MAKING



ECONOMIC DECISIONS IN FOREST MANAGEMENT

With the apparent need for and development of prescriptions for intensive forest management, economic analyses of such prescriptions are necessary. The economics program is working with forest managers in B.C. to develop evaluation processes for alternative forest management regimes.

An evaluation of the importance of forestry to the B.C. economy indicates one rationale for intensification of forest management.

ENVIRONMENTAL PROTECTION COSTS

It is possible to vary road design and construction practices to a large degree to comply with environmental constraints. To establish a basis for sound multiple-use forest management, public natural resource agencies and private firms need information about the relationships among timber harvesting damage, protective measures and damage prevention costs.

A case study of the Wilson Creek Forest Road in the Nelson Forest District, shows that the magnitude and distribution among design and construction tasks of the costs incurred, to comply with a set of environmental constraints, can be recorded. The relationships between constraints and corresponding design and construction cost increases were determined using a modified and expanded cost accounting system. However, it was not possible to determine relationships between road cost increases and environmental quality indicators, such as stream sedimentation.

A second study, the Carnation Creek Watershed Project, afforded an opportunity to investigate the relationship among environmental damage-prevention costs and design and construction modifications, and resulting environmental quality. The study road, comprised of the Ritherdon Road extension with branch roads, is located in the western part on the carnation Creek watershed. The watershed is located on Barkley Sound on the west coast of Vancouver Island and within Tree Farm Licence No. 21 of MacMillan Bloedel Ltd.

Samples of water quality and construction activity were taken in an attempt to relate stream sedimentation to road construction tasks. However, there were too few samples to determine a relationship between sediment levels and tasks by flow or precipitation. Had this been possible, the probability of significant sediment levels occurring as a result of road condition, hydrological factors, tasks performed and segment characteristics could have been estimated. From this relationship, the damage prevention cost could have been estimated. In lieu of such relationships, the information available from this study was used to illustrate how to estimate the least cost preventive prescription to achieve a stream quality standard.

ECONOMIC IMPACTS

A study of the importance of the woodpulp industry to B.C. has shown that world demands have increased at an annual rate of 6% over the past. Once the present slump in woodpulp demand ends, this growth is expected to resume. The industry provides 15% of provincial value-added, and is a major employer. Trends of demand and allowable cut indicate that wood may not be available to supply anticipated growth. ■

◁ B.C. forest products are exported to many parts of the world.

Serving the Forest Community

ROOT ROTS

To ensure that the results of research into the control of root rots are made available to the practicing forester, a series of one-day workshops were held throughout the province. Designed for foresters, land managers and woods supervisors, the workshops explained the consequences and life cycles of the three root rot fungi and gave a first-hand look at identifying the cause of the damage and what could be done to reduce losses.

Surprisingly, the workshops were the first opportunity that many foresters had of having a first-hand look at a disease that was causing major concern to agencies who wished to initiate intensive forest management practices. ■

MOUNTAIN PINE BEETLE

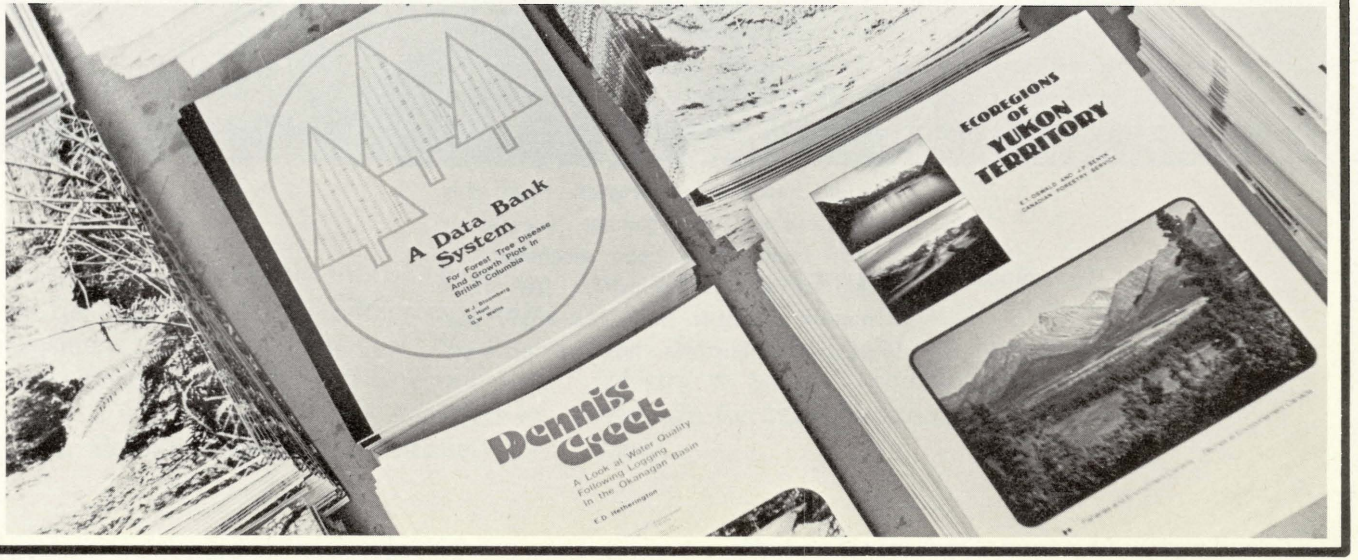
Workshops on the mountain pine beetle, held throughout British Columbia, were presented by illustrated talks, displays and, wherever possible, field trips. The talks stressed: symptoms as they are seen; how to evaluate damage and forecast trends; what to do in the face of damage; the effects of the beetle on stands and risk evaluation, and recommendations for management. Forestry procedures were emphasized throughout. Dual projectors were used to emphasize synchrony or similarity of events. The display was designed to augment field trips by showing symptoms not evident at the time of the workshops and to highlight aspects not stressed in the talks. Field trip sites were chosen to show the symptoms used in cruising and to illustrate the role of the beetle in stand dynamics.

More than 300 industrial and government foresters, government agencies, educationalists, concerned citizens and the news media attended the workshops. ■

PUBLICATIONS

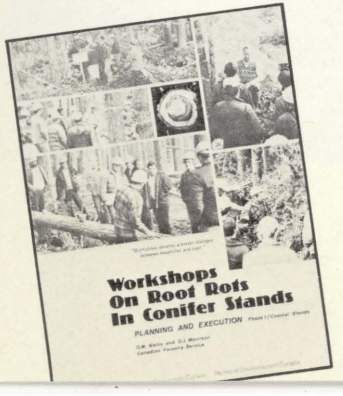
Publications are one of the major communication tools utilized by researchers to ensure the use of the results of their research. More than 80,000 reports and publications, dealing with a wide variety of subjects, are distributed annually to foresters, resource managers and the general public.

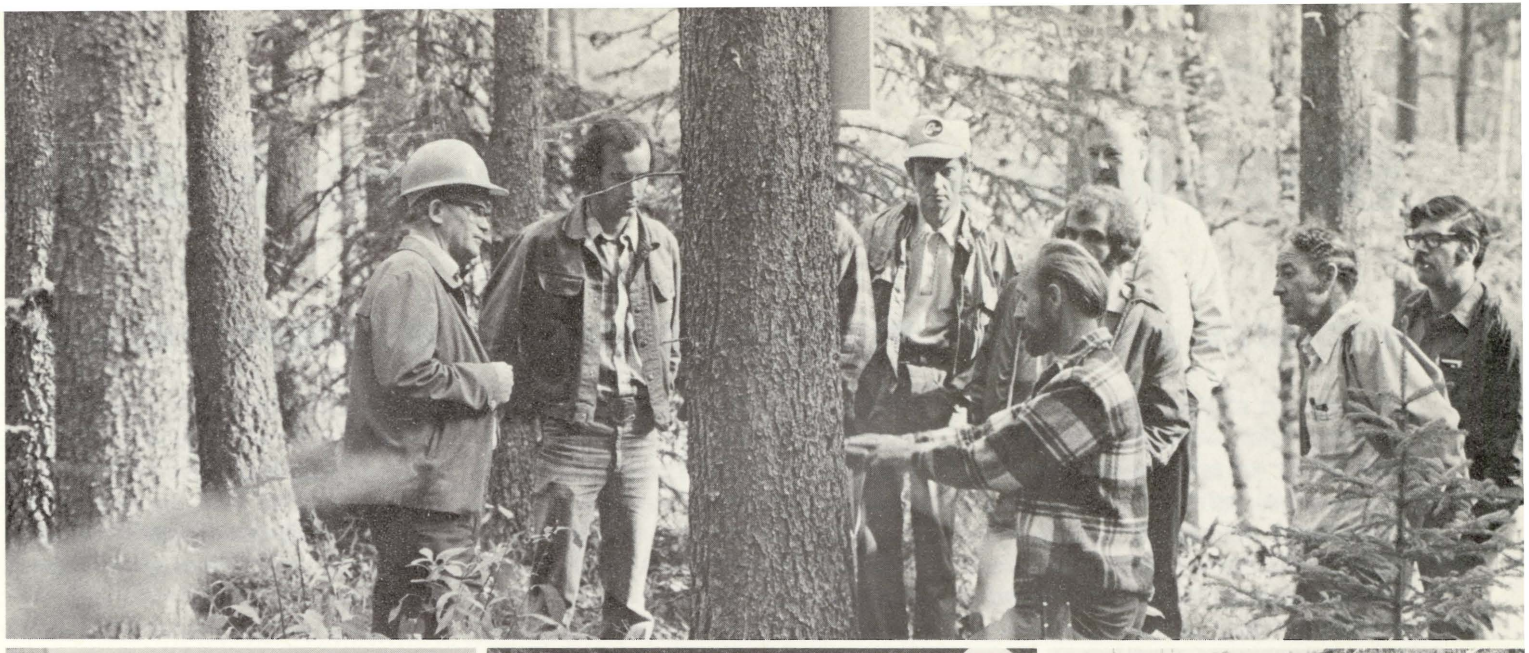
Anyone may obtain copies by requesting to have their names added to the PFRC regional mailing list.

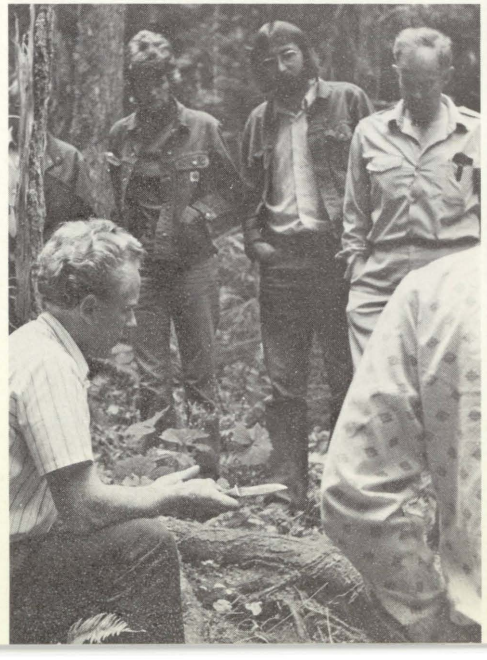


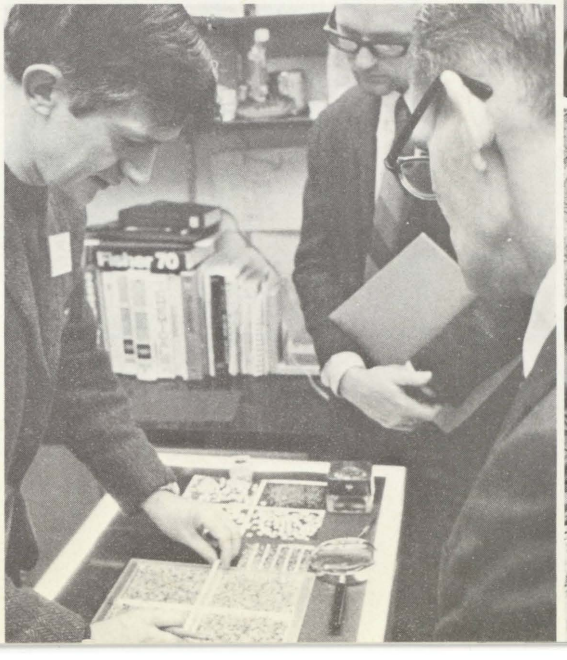
SITE PREPARATION

PFRC staff participated in a series of BCFS seminars, dealing with site preparation and planting studies in North Central Interior B.C. Another topic of interest involved techniques now under study that seek to circumvent the effects of brush growth by improving growth potential of the site and planting stock, which is contrary to the traditional technique of removal of competing vegetation by "scalping" to mineral soil. Incorporation of organic matter into mineral soil by "mixing" (rototilling), "inversion" of sod (turning), and "mulching" by clipping of minor vegetation, were shown to result in improved seedling growth in comparison to scalping. Also detailed were the effects of initial seedling size and stock type on outplant performance, which showed that relatively minor increases in seedling size and use of thrifty container-grown stock may result in vastly improved growth rates, thus precluding the need for site preparation. These findings have been confirmed and are available in a recent PFRC Report (BC-X-149). On balance, the seminars provided an excellent forum for emphasizing to forest managers the need to consider potential trade-offs in alternative techniques. ■









Serving the Canadian Public

EXHIBITS

Displays in shopping malls, conventions and workshops enable the public to take advantage of knowledge and new ideas that have been developed by scientists of the Pacific Forest Research Centre. Information is displayed that may help you identify a tree species or explain why action is required to save a forest against a destructive pest.

PUBLICATIONS

If you have termites in your garage, aphids in your fir tree or wish general forestry information, the Centre has a number of popular publications suitable for teachers, students and the general public.

Fact sheets, pest leaflets, newsletters and general brochures are available upon request.

MUSHROOM CLINIC

The Centre operates a mushroom clinic for local enthusiasts who have difficulty identifying the edible species. The Service also assists the Poison Control Centre whenever mushroom eaters are brought in.

Mushrooms are members of the fungus family. The study of fungi, particularly microscopic growths that attack trees, is undertaken by specialists at the Centre.

If there is a single rule to eating mushrooms, PFRC mycologists suggest: When in doubt — don't eat it".

NEWS MEDIA

We must improve communications with all segments of society if we are to retain a viable forestry community. Radio, television and newspaper help in the communication process by broadcasting the results of research. News releases are issued on a regular basis and scientists are always available for interviews.

TOURS

The Centre sponsors tours in order that teachers and students, as well as members of the public, can benefit from the knowledge developed by researchers. Tours usually consist of a briefing session explaining the Centre's objectives followed by a look at some of the projects in progress.

SCHOOLS

Dear Sir: A friend and I are seriously considering a career in forestry. We would like some information - - - - - - - - - - - - - - - -
Dear Sir: I am currently enrolled in the fourth semester of Renewable Resources and need - - - - - -
Dear Sir: I am a second year forestry student and want to get information - - - - - - - - - - - - - - - -
Dear Sir: My Mom said you would give forestry information for a school essay on - - - - - - - - - - - - -
Dear Sir: May I bring my students for a tour on - - - - - - - - - - - - - - -

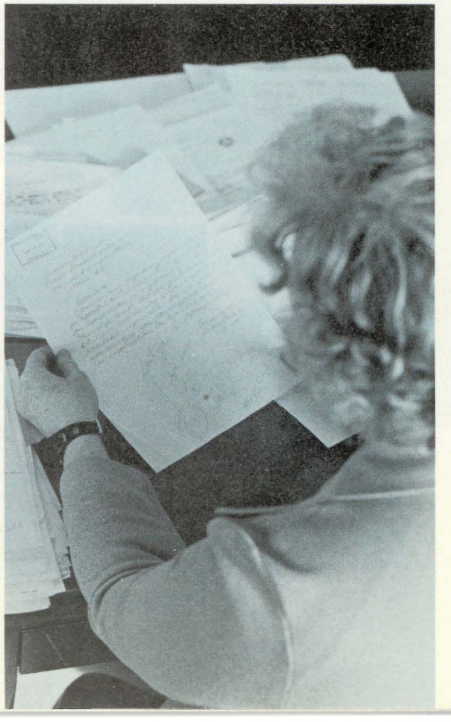
Special attention is given to the needs of students and teachers who wish forestry information.

URBAN FORESTRY

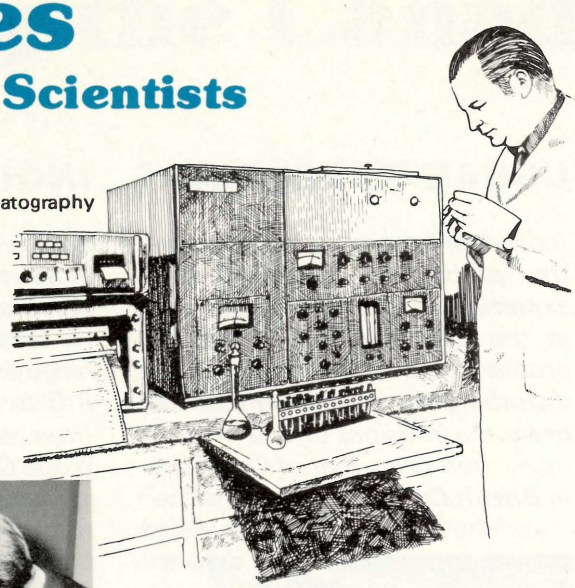
Individual homeowners who have tree problems often use the expertise of specialists employed at the Centre. Urban forestry problems are usually caused by disturbing the tree's environment or by the invasions of one of the many tree pests that afflict trees in British Columbia.

INQUIRIES

Each year the Centre receives more than 10,000 individual inquiries for information. Requests via letter telephone or in person, range from a student in Nelson, B.C. to a scientist in the Phillipines; from an industrial forester in Woss Camp, Van Island to a government official in Washington; from a BC Forest Service resource manager in Victoria to a United Nation's official in North Africa. All seek the knowledge developed by scientists of the Pacific Forest Research Centre.



Services
In Support of Scientists



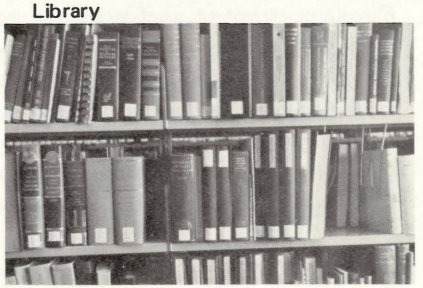
Gas chromatography

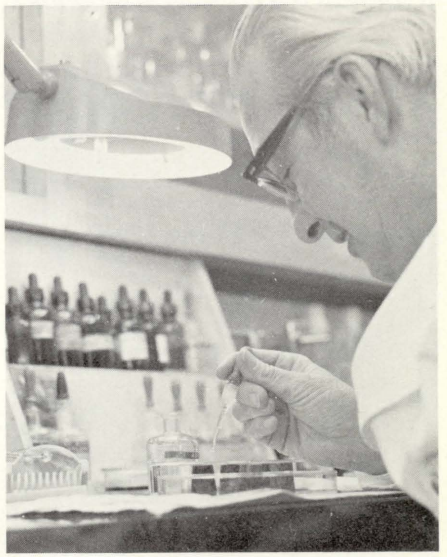
Library

Editorial

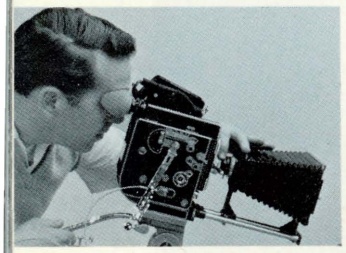
Graphics
Photography

Scientists are supported by highly trained technicians in addition to specialists in microtechnique, chemistry, computer services, chromatography, library services, photography and graphic services, as well as an editor of scientific publications.

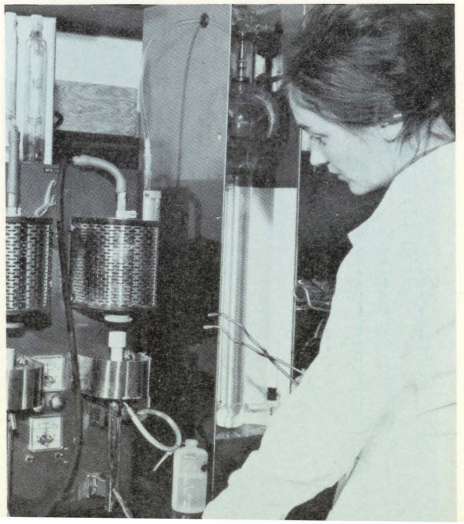




Microtechnique



Computer sciences



Chemistry

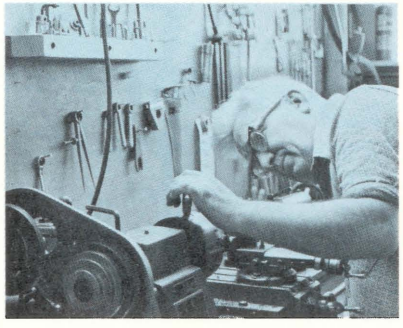
Administration

Administration services also play a vital role in the day to day operation of the Centre. Laboratories, special environmental chambers, growth rooms, greenhouses and other research facilities require trade specialists such as engineers and carpenters. Office personnel include an administrative manager, secretaries, stenographers and financial specialists.

Switchboard

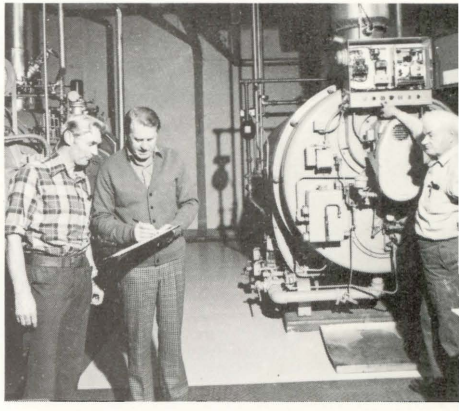
Secretarial

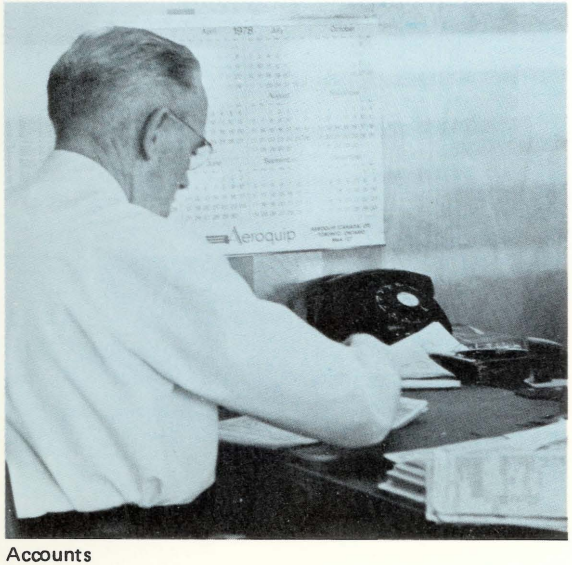
Clerical



Machinist

Engineering

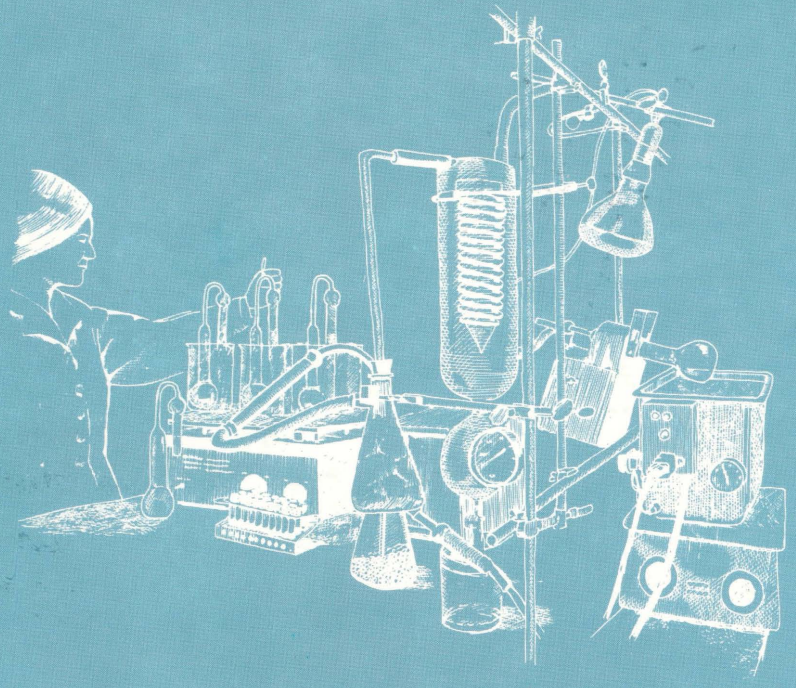




Accounts

Carpentry

Greenhouse specialties



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