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Pacific Forest Research Centre
Canadian Forestry Service
Environment Canada



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Service
des Forêts

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INTRODUCTION

This report on forest research and operations at the Pacific Forest Research Centre (PFRC), reflects the progress made during the fiscal year 1978/79 in achieving program objectives in British Columbia and the Yukon Region.

The major activity of the Centre is the conduct of forest research to gain improved knowledge and understanding of the forest estate. We are able to promote the management of forest resources for the benefit of all Canadians through the discovery and development of improved methods of measuring the resource and of growing, protecting and harvesting trees at competitive costs.

In pursuit of specified project objectives, the Pacific Forest Research Centre has proceeded on a program of purposeful, oriented research and development, survey and service which basically falls into four main program areas:

FIRE AND ENVIRONMENTAL FORESTRY research and operations include studies to improve the Canadian Forest Fire Danger Rating System for coniferous cover types in British Columbia and meteorological and hydrological influences on forest ecosystems. The environmental impact of harvesting methods in mountain terrain and the impact of major construction projects such as the Alaska Highway gas pipeline are assessed.

FOREST RESOURCES research and operations include studies in land classification, improving quality and production of seedlings, developing improved regeneration methods and silvicultural practices to enhance the productivity of coastal and interior forests. Federal responsibilities in seed certification and testing are carried out.

FOREST ECONOMICS includes the provision of policy advice on Canada's greatest forest region, as well as the operation of the region's program in energy from forest biomass.

FOREST PROTECTION research and operations include studies of insect and disease influences and forest depletion. Federal responsibilities in the Forest Insect and Disease Survey (FIDS), and plant quarantine are carried out in cooperation with other federal and provincial agencies.

These programs are more fully described in the following pages.



T.G. Honer, R.P.F.
Acting Director
March 31, 1979

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Fire and Environmental Forestry

PROJECT PC-25

Effects of Harvesting and Site Preparation Practices on Forest Resources and Values

Objective: To identify, measure and elucidate the effects of harvesting and site preparation practices on forest resources and values as a basis for rationalization of existing practices where appropriate, and for development of new practices where required.

Achievements: Continuous monitoring of water table levels and soil moisture was conducted on slopes of the Carnation Creek Experimental Watershed on the west coast of Vancouver Island. By the summer of 1980, two years of post-logging data will be available for the major study area. Analysis of this data and participation in joint analysis and reporting on hydrological data for the overall Carnation Creek project was initiated. An assessment of U.S.F.S. analysis procedures of water increase as a result of logging was carried out and a report prepared for distribution to prospective users of the program.

Methods were evolved to determine the overall effects of skidroads on tree growth by comparing adjacent roaded and unroaded portions of salvage-logged wildfires in interior B.C. Studies of growth of Douglas-fir on skidroads confirmed results of earlier studies with other species that significant reduction of height growth is experienced by trees growing on the inner, deeply gouged portion of the roads. A report on the earlier studies was circulated to interested parties and prepared for wider distribution. Presentations of the work were also made to the Steering Committee of the B.C. Interior Forest Harvesting Committee and to subcommittees in the Nelson and Cariboo Forest Regions.

PROJECT PC-30

Improved Prediction of Wildfire Behavior

Objective: To develop fire behavior prediction systems for major fuel types; to incorporate these systems along with the necessary informational elements on resources values, fuel quantifiers, topographic and risk ratings into the existing Fire Danger Rating System; and, to encourage implementation and use in fire management planning and operations.

Achievements: Fire hazard appraisal techniques and methodologies were developed for use in designing protection plans and standards for intensive silvicultural treatments. Juvenile spacing of stands were emphasized because of the large areas of high fire hazard fuels being produced in most B.C. regions under the provincial and federal-provincial intensive forestry programs. Several reports were prepared and presentations given at stand tending symposiums, workshops and protection meetings involving provincial and industrial forestry personnel throughout the province.

A national publication on weather observing standards and practices specific to the Canadian Forest Fire Danger Rating System was prepared in the region and distributed to all provinces and territories for users of the Fire Weather Index. This was a cooperative venture involving in-house staff, contract staff, the CFS National Fire Danger Group and received financial support from the Atmospheric Environment Service.

A problem analysis of fire management information requirements was carried out and proposals written for system design requirements, in conjunction with the provincial Ministry of Forests.

PROJECT PC-41

Use of Prescribed Fire for Wildland Management

Objective: To improve the application of prescribed fire for a variety of land management problems by prescribing guidelines to predict behavior and impact characteristics and to provide knowledge for application to specific areas.

Achievements: Research and demonstrations of the use of prescribed fire were conducted in the Chilcoten Plateau of interior B.C. Fire histories were determined and data on prescribed fire assembled. This information was used for a

field tour and workshop conducted for all B.C. Forest Service regions at Riske Creek where silviculture, protection and research staff were shown results of the 1977 and 1978 burns for mistletoe control and thinning. A number of old wildfires and their effects on stand structure and development were visited and discussed as possible models for prescribed fire programs.

Additional consultation on prescribed fire and forest protection policy and practice was provided to Mexico. Areas burned during the first visit the previous winter were re-evaluated in a spring 1978 visit and interest has been shown by the Mexicans in applying the Fire Weather Index, with some slight modification, as a fire danger rating system for Mexico. A Spanish translation of the index tables was requested and some changes in month designation made to suit the southern latitudes.

The PFRC Aerial Ignition System (Mark II) consisting of permanganate-glycol injection machine and dispenser for dropping incendiary spheres from helicopters continues to be a successfully marketed, commercially available, device. PFRC involvement with operational performance assessment of the machine on prescribed fire ignition continues.

PROJECT PC-43

Environmental Impact Assessment of Northern Pipelines

Objective: To fulfill federal responsibilities with regard to the Environmental Assessment Review Process (EARP), to provide protection, conservation, and wise resource management by ensuring that environmental effects are considered in planning, decision-making and implementation of federal projects.

Achievements: Major effort was expended on the Alaska Highway Gas Pipeline project in which the Environmental Impact Statement was reviewed. A review of alternate routes for gas pipelines was conducted, public hearings attended in Whitehorse and data gathered and assessed to determine vegetational communities and site sensitivity. In addition, the Environmental Impact Statement of the Shakwak (Alaska) Highway improvement project areas was reviewed. Two contracts dealing with data collection and analysis were supervised.

PROJECT PC-46

Improved Use of Meteorology in Forestry

Objective: To have acquired and applied meteorological knowledge to assist in the solution of forestry and environmental problems in the Pacific Region. In the shorter term, to have developed guidelines for the optimum siting of weather stations, to develop or adapt meteorological equipment to forestry situations and, to have tested one or more models which simulate climatic influences.

Achievements: Good progress was made in technology transfer through informal discussions, committee participation, meetings and seminars. Consultations included irrigation spraying of seed orchards, overwinter drought adjustments to fire weather danger rating, purchase and repair of instrumentation, interpretations of climate data, and spruce budworm studies.

A number of concepts for sub-components of instrument systems were completed and are being incorporated in instruments such as theodolite timers, anemometer counters, and data acquisition systems.

A wind model developed under contract with Atmospheric Dynamics Ltd., is now being used to analyze wind patterns in studies of insect dispersal and smoke management. Further modifications to the model are planned.

Forest Resources

PROJECT PC-23

Growth and Biology of Coastal Douglas-Fir Ecosystems in Relation to Management Practices

Objective: To investigate tree growth and biological processes of soil and trees in response to thinning and fertilization of a coastal Douglas-fir ecosystem,

and based thereon, to develop a comprehensive biological model for growth prediction.

Achievements: Data on the role of soil microflora and fauna in nutrient cycling, nitrogen transformation and uptake, change in photosynthesis as related to available nitrogen and resultant growth response in relation to nitrogen fertilization and thinning practices was analyzed and collated for reporting purposes. A biological model using these data is being developed so that the effect of these variables on growth can be predicted.

A report on a sensitive dendrometer band for measuring stem diameter growth was published. Three reports on soil fauna are in press. A study on stand treatment effect on biomass and nutrient content of understory was completed and a report prepared.

PROJECT PC-31

Landscape Interpretation and Management for Social Values

Objective: To assess the methodology of landform, soil and vegetation classification systems on lands in B.C. that are subject to population and resource use pressures; to relate the classification systems to proposed development schemes and assess their impact on the environment.

Achievements: The project is undertaken cooperatively with the Capital Regional District of Victoria and the Islands Trust. Draft reports and maps describing the landform, soils, and vegetation interrelationships for the Outer Gulf Islands and the shore zone from Sooke to Port Renfrew were completed. Several intergovernmental and public meetings were held. The English version of the ECOTOUR from Victoria to Hope was completed, ready for publication.

As a result of an A-Base budget review conducted by the Department, the project was terminated December 1, 1978.

PROJECT PC-35

Baseline Data for Resource Planning in the Yukon Territory

Objective: To categorize and map the resources of the Yukon Territory into ecologically sound units suitable for integrated resource planning and manage-

ment; develop and maintain an information storage and retrieval system that can incorporate all resource data.

Achievements: The field work for a pilot operation to demonstrate the technology for integrated resource planning was completed. A report is being prepared and maps on surficial deposits and landforms, existing vegetation, computer-assisted forest land classification, potential vegetation, forest cover type and forest capability were produced for over 25 000 km² of the Nisutlin Management Unit.

Work was initiated on mapping the terrain, vegetation and forest capability of the Lake Laberge Ecoregion (ER5) at a scale of 1:250 000. Most of the area between 60° and 61° N. latitude was covered, including that in the Nisutlin Test Area, for which 1:70 000 aerial photographs were available.

The information retrieval system, Yukon RRAMS, was updated to include fire history through 1977 and an information report on the system was issued.

A study of the land resource for settlement suitability of the Carcross Triangle was conducted by the Lands Directorate and PFRC for the Land Use Section of Dept. of Indian and Northern Affairs, Whitehorse. The terrain features were described and mapped and the vegetation was discussed in relation to the land resources.

A tour of the soil, permafrost and vegetative relationships in north-western Canada, as part of the international Society of Soil Science Congress in Edmonton, was held in June.

PROJECT PC-38

Land Inventory and Assessment in B.C.

Objective: To complete an ecological land inventory, interpretive and analytical studies for Northern Vancouver Island; to conduct detailed terrain, soils and vegetation studies providing baseline resource information for specific management interpretations and environmental impact assessments.

Achievements: The project is undertaken cooperatively with the B.C. Ministry of Environment. Twenty-one terrain maps were completed and the soils legend finalized. Approximately 25% of the soils mapping has been completed, and

all soil sampling and analysis was finished.

Two soil coordination tours were conducted to review classification standards.

PROJECT PC-39

Operations Research Techniques for Forest Management

Objective: To develop and test methodologies for simulating the growth of forest trees and stands; promote metric conversion and the development of forest standards; develop and evaluate remote sensing methodology and relationships with information storage mediums.

Achievements: The Compatible System of Growth Simulators, (CSGS), developed at PFRC is comprised of (a) a module to fit functional relationships, (b) a yield model which will calculate and project timber yield from volume/age relationships, (c) the individual tree model BUSH, which will simulate the growth of Douglas-fir and jack pine, and (d) the stand model. The function module and yield model are fully operational; BUSH is currently being validated for Douglas-fir, and the stand model is under development. An economic evaluation module was successfully integrated with CSGS and work is currently being undertaken to integrate a root rot model (ROTSIM) into the system.

"Scaling Roundwood, A National Standard of Canada", was published and distributed. A meeting of the Technical Committee on scaling of primary forest products was convened and a draft standard on the measurement of woodchips was reviewed.

PFRC, in cooperation with the Canada Centre for Remote Sensing and the Department of Supply and Services, supported the development of a low cost image analysis system by OVAAC8 International (Canada) Inc. The contract is 60% complete. Design targets were met and software development is ahead of schedule.

An investigatory study involving forest resource data from the Yukon Territory was undertaken to evaluate the application of digital image analysis techniques as a data base management system. At the request of the Forest Management Institute, the expansion and enhancement of the Canadian Forest Resource Data System was undertaken. This newest version called PASS, (Pacific Analysis Statistical System), met all requirements of Phase 1 of the pilot project

and is capable of presenting summarized data in any possible combination within 90 seconds. Some additional enhancements are underway.

Six manuscripts were accepted for publication in scientific journals and conference proceedings. A regional workshop on remote sensing was convened and PFRC was a co-host for the Fifth Canadian Symposium on Remote Sensing.

PROJECT PC-48

Regeneration and Silvicultural Systems; Pacific and Yukon Region

Objective: To develop, test and demonstrate new nursery systems and improved methods of stand establishment and tending in the Pacific and Yukon Region.

Achievements: Development, testing and implementation of the BC/CFS Styroblock Reforestation System was well advanced at an operational level. Input was concentrated in designing nursery facilities and providing guidelines for the Greater Victoria Water Board, and in further refining the basic container design concept to improve the root form of container stock. Consultations were made for the manufacture of a prototype.

In the associated mycorrhizal inoculation program, lodgepole pine field trials were established at Skimikin, Williams Lake and Riske Creek concurrently with laboratory investigations on (a) container size/nutrient level/mycorrhizal inoculation interactions on seedling growth, (b) influence of soil mix on mycorrhizal formation, and (c) variation in mycorrhizal formation across a range of 46 lodgepole pine seed sources.

The high elevation species and stock type trials were expanded to include a wider range of forest sites in the Coastal Forest Region and a greater variety of planting stock options, which included container, bareroot and container-transplant stock with eight tree species. A total of 18 000 trees were planted in 24 field plantations.

The stand establishment research program to demonstrate field performance of various stock types singly, and in combination with site preparation, continued in the Prince George Region. The capacity of different stock types to generate new roots was also demonstrated.

Field measurements were continued on the first phase of the Yukon regeneration research program in the Watson Lake area, where artificial regene-

ration techniques are being evaluated on white spruce on river flood plains.

A major achievement was the organization and co-sponsorships of the Symposium of the "Root Form of Planted Trees" held in Victoria in May, 1978, in which four study leaders contributed published papers.

Five manuscripts were accepted for publication in scientific journals and conference proceedings; nine file reports were also completed.

PROJECT PC-49

Tree and Seed Improvement, B.C. and Yukon Conifers

Objective: To enhance the quality and quantity of forest tree seed supply in B.C. and the Yukon, through improving methods for selection, breeding, production procurement, processing and utilization.

Achievements: In the genetic improvement area western hemlock was the principal species under study, and recent work focussed on flower enhancement. Results obtained in 1978 provide valuable guidelines for flower induction in rooted cuttings and young seedlings. These guidelines include times and methods of application of gibberellic acid ($GA_{4/7}$), the usefulness of other hormones, and stress treatments (water stress and girdling): the effectiveness of calcium nitrate as an additional enhancement factor was confirmed. Promising results were also obtained with extracts from good flowering trees of Douglas-fir applied to young seed orchard specimens of the same species. While effective activity could not be fractionated from the crude extract, the extract itself offers possibilities as an inexpensive flower promoter.

In the area of improving seed supply for domestic and export needs, a rated forecasting system for cone crops in B.C. and the Yukon was developed further, and a Bulletin was issued for the 1978 crop. A new study was initiated to establish morphological characteristics of reproductive buds, and to develop an identification manual and training workshops based on this knowledge.

Much of the forest tree seed exported from Canada must first be source-identified according to O.E.C.D. regulations. Through the certification service pioneered at PFRC, 120 separate certificates were issued for 20 seedlots collected for export by commercial seed dealers in 1978. Compulsory certification of lodgepole pine seed was invoked by the Swedish National Board of Forestry; in cooperation with PFRC, a scheme was devised for the authentication of

non-certified seed already in dealers' stocks when the new regulation came into effect. PFRC seed inspectors testified stocks totalling 769.3 Kg from 24 sources valued at about \$225,000.

Research continued in the development and testing of the aerial branch sampler and cone collector, the protection of seed crops from insect pests, and in the use of biochemical techniques for the identification or "fingerprinting" of seedlots of different geographical origin.

An important development in 1978 in the area of improvement and utilization of seed, was the establishment of the Official Seed Testing Laboratory accredited by the Zurich-based International Seed Testing Association. An important agreement with Canada Dept. of Agriculture now enables official Seed Testers to sample seedlots for the International Seed Testing Association, ISTA, and the Canadian Department of Agriculture phytosanitary tests. Over 700 tests were conducted on 65 different seedlots in 1978. PFRC now offers the full range of services needed by the Canadian seed export industry, in addition to research capability for solving associated problems.

A total of seven manuscripts were accepted for publication in scientific journals, conference proceedings or information reports. A further eight unpublished reports were completed. Study leaders were invited to participate actively in nine workshops and presented papers at four international conferences.

Economics

PROJECT PC-05

Development of Economic Guidelines for Allocating Resources for Forest Management and Research

Objective: To provide economics and policy advice to the Department, its cooperators, and the management and staff of PFRC; to improve the informa-

tion base in forest economics.

Achievements: A cooperative study was initiated with the U.S. Forest Service to evaluate regional flows of softwood lumber to various U.S. market areas. This study is not yet completed. Another study, which developed methodology for evaluating the economic feasibility of various intensive forestry practices in B.C. allows users to estimate maximum permissible expenditures on any given practice or combination of practices. A study funded by the ENFOR (ENergy for the FORest) Program concluded that it may be economically feasible to generate electricity from logging slash on Vancouver Island. A manual of procedures for accessing the PFRC economics data base was published, as well as a report on taxes, fees and royalties paid by the B.C. forest industry and its employees. This latter report indicated that an income of \$0.5 billion per year is generated for the federal and provincial governments.

Forest Protection

PROJECT PC-02

Forest Insect and Disease Survey

Objective: To annually monitor incidence of occurrence of insects and disease and appraise damage caused by them; improve and/or develop sampling procedures used to do the monitoring; and, evaluate remote sensing and aerial photography as a technique to facilitate the quantifying of forest losses caused by insects and diseases.

Achievements: The annual monitoring of incidence of occurrence of insects and disease was successfully completed and information regarding it was published. Mountain pine beetle continued as the most serious tree killer. Western spruce budworm populations declined and defoliation was much lighter and less widespread. Damage appraisal research augmented the radial growth reduction information obtained last year on Douglas-fir, with documentation that showed there were also height growth losses and stem deformity caused by the recent

spruce budworm outbreak. Improvements made in methods used to record, store and retrieve data collected on pest populations and tree damage assisted information retrieval procedures. Large scale aerial photos were useful in assessing frequency and severity of top-kill in Douglas-fir affected by spruce budworm. It was shown that LANDSAT imagery was not as accurate as aerial sketch mapping in recording defoliation caused by Douglas-fir tussock moth.

PROJECT PC-06

Reduction of Losses from Bark and Wood-boring Insects

Objective: To develop pest management guidelines that will allow forest managers to control damage caused to B.C. forests and forest products by mountain pine beetle, spruce beetle, Douglas-fir beetle and ambrosia beetle.

Achievements: Five PFRC scientists presented invitational papers on mountain pine beetle (m.p.b.) population biology and management at a symposium on "Theory and Practice of m.p.b. Management", Pullman, Washington. It was shown that nearly-mature m.p.b. could be effectively killed in trees when treated with the insecticide lindane. Trees baited with the attractant trans-verbenol and treated with the herbicide monosodium acid methanear sonite (MSMA) effectively killed m.p.b. The pathogenic fungus *Beauveria* spp. was field tested against m.p.b. and results indicate it has potential as a control agent. It was demonstrated that felled trap trees baited with the attractant frontalinal and the insecticide sevimol 4 were seven-fold more effective against Douglas-fir beetle than felled untreated trap trees. Experiments showed that spruce beetles do not respond to traps baited with ethanol but when ethanol was sprayed on the boles of green spruce trees, spruce beetle attack occurred in profusion. These results suggest that ethanol or similar chemicals play a major role in predisposing (signalling that the tree is ready for destruction) trees to bark beetle attack.

A mathematical model was prepared showing the relationship between temperature and gallery construction and egg-laying of spruce beetle. A bio-assay using reproductive rates of female spruce beetles was developed to measure population quality. The information may allow a one to two-year prediction of population trend.

It was demonstrated that both oleic acid and pine oil were highly effective for preventing attack on logs by ambrosia beetles. Pine oil afforded longer protection, a single application giving complete protection for over 30 days.

Two scientists and their support staff organized a series of seven highly successful workshops on ambrosia beetle problems and control at key centers on Vancouver Island and Lower Mainland. An outbreak hazard from the m.p.b. was appraised in the Akamina-Kishinena Park Reserve area and reported to the B.C. Forest Service.

PROJECT PC-07

Reduction of Losses from Balsam Woolly Aphid

Objective: To determine the scope of the balsam woolly aphid (b.w.a.) problem and to determine factors associated with tree susceptibility to b.w.a.

Achievements: The b.w.a. problem was shown to be small in scope. It was demonstrated that some factors associated with tree susceptibility to b.w.a. attack were water stress, elevation, rate of wound healing and tree nutrition. These findings were instrumental in the lifting of a quarantine on movement of logs in B.C. and the province-wide ban on growing *Abies* species. The project was terminated in 1978.

PROJECT PC-08

Reduction of Losses from Defoliating Insects

Objective: To develop pest management strategies for the major defoliating forest insects.

Achievements: A native virus and *Bacillus thuringiensis* were aerially tested in three different locations against western spruce budworm, (w.s.b.). A study on moth dispersal of w.s.b. was initiated by exploring the use of X-ray Energy Spectroscopy to identify dispersants and by building a wind model for mountainous conditions during the dispersal stage. Larval survival of w.s.b. in relation to topography, adventitious bud development and defoliation was quantified. Biological control programs on larch sawfly and larch casebearer were continued by importing and releasing parasitoids. A new initiative against winter moth was taken in cooperation with B.C. Agriculture, Agriculture Canada and a private contractor to collect, rear and release parasitoids against winter moth in Victoria, B.C. Pheromone trap development for detection and population assessment was continued for Douglas-fir tussock moth, two-year spruce budworm, western spruce budworm, European pine shoot moth and blackheaded budworm.

PROJECT PC-12

Reduction of Losses from Stem Diseases

Objective: To develop guidelines for the recognition, control and prediction of growth of stem diseases.

Achievements: Canker diseases and diebacks have been documented to meet the demands of silviculturalists. The information collected is forming the basis for control recommendations and planting guidelines. Taxonomic research in the microfungi associated with these diseases has led to compilation of a handbook describing the casual organisms and their associates. This project was amalgamated with Project 13 in 1978.

PROJECT PC-13

Reduction of Losses from Root and Stem Diseases in Second-growth Stands

Objective: To assess the significance of root and stem diseases as repletion factors in second-growth stands and, through biological and ecological studies of the fungi and hosts, prescribe sound control procedures.

Achievements: A statistically based sampling design was developed for *Phellinus weirii* root rot; computer programs and mapping techniques were completed. Three fungi were shown to have potential as biological control agents for the prevention of stump infections by *Fomes annosus* root rot, a major stem decay fungus in western hemlock sustaining logging injuries. Zinc chloride effectively prevented fungal infection of wounds but some phytotoxicity occurred in the host limiting its use. Zinc chloride was proven to be more effective than borax in preventing stump infection by *Fomes annosus*. *Armillaria mellea* was shown to be responsible for heavy losses in conifer stands of all ages in the interior of the province.

PROJECT PC-34

Cone and Seed Insects of North America

Objective: To prepare a comprehensive publication on the cone and seed destroying insects of Canada, United States and Mexico.

Achievements: A comprehensive publication on the cone and seed destroying insects of Canada, United States and Mexico was completed and is in press. The project was terminated in 1978.

PROJECT PC-40

Development of Pest Management Systems

Objective: To develop, by 1985, computer system applications to management of four major insect and four major disease pests of forest stands.

Achievements: A simulation model of dwarf mistletoe infection and spread in young western hemlock was completed and tested against field situations. Good agreement between field measurements and model predictions has been obtained. Analysis of the dispersion of dwarf mistletoe seeds from infections on western hemlock branches has provided basic information for incorporation into models of spread of this disease. A simulation model of *Phellinus* root rot of second growth coastal Douglas-fir stands can now incorporate the impacts on tree growth by the disease as a result of high correlation of diameter obtained between diameter growth and amount of root system rotted. A generalized submodel for root contact based on root angle, diameter and length has been developed for application to root rot and other problems involving root contact. A model of nursery disease of Douglas-fir seedlings has been used to develop guidelines for the management of root rot and damping-off. Systems analysis and simulation of western spruce budworm attack on Douglas-fir stands has identified critical host-pest relationships. A general simulator for tree growth reduction resulting from biotic or abiotic impacts on height and diameter growth has been developed from studies of budworm-attacked trees. A computer graphics system for display and analysis of spatial and temporal heterogeneity related to topography has been developed.

PROJECT PC-44

Reduction of Losses in Regeneration Forestry

Objective: To identify reforestation pest organisms or processes and determine the factors which enhance the pest and prescribe prophylactic measures; to define methods of maintaining reforestation losses to pests within economic tolerances; and, to predict incidence resulting from specific conditions, situations or treatments in nurseries, seed production areas, and recently reforested areas.

Achievements: Studies on moulding of stored seedlings showed that a pre-storage water spray was as effective as a fungicide spray, and pilot studies have been completed prior to implementing this treatment operationally. Studies in timing dosage, etc. of fungicide sprays for gray mould control of growing container stock have resulted in significant reductions in losses from this important disease. A survey was completed of all (less than 1500) conifer seedlots stored by user agencies and it showed that a seed-borne, pathogenic fungus (*Caloscypha fulgens*) occurs in about 30% of the *Picea* spp. seedlots and in up to 10% of the Douglas-fir and *Abies* spp. seedlots. These findings help clarify a major cause of pre-emergence losses in nurseries; controls have been implemented. Also it was found that the pathogen is most prevalent in seedlots originating from ground or squirrel-cache-collected cones; consequently cone collection procedures were altered so that all spruce seedlots collected in 1978 were pathogen free.

PROJECT PC-45

Evaluation of Natural Agents for Control of Forests Pests

Objective: To evaluate the potential of some natural enemies in combatting forest pests; to evaluate the potential of fatty acid salts (f.a.s.) as a control of some forest insects and fungal pathogens; and, to determine the impact of some parasitoids against specific forest defoliators.

Achievements: It was shown that the fungus *Beauveria* spp. has a promise as a control agent against mountain pine beetle. F.a.s. proved to be an excellent pesticide against algae, mosses and liverworts, three major pests of containerized nursery stock. It was demonstrated that f.a.s. combined with a commercial sticker has good potential as a controlling agent against root rot under field conditions. F.a.s. acted synergistically with methoxychlor against late instar larvae of winter moth giving excellent control results. It also allowed a significant decrease in the amount of methoxychlor needed to control this pest. The parasitoids *Agathis* sp. and *Diadegma* sp. were released in B.C. against the larch casebearer. *Olesicampe* sp. was released against larch sawfly. *Agrypon* sp. and *Cyzenis* sp. were released against winter moth.

PROJECT PC-47

Host-pathogen Relationships

Objective: To develop a whole-plant model of host-pathogen interaction and to identify conditions that weaken defense mechanisms.

Achievements: Collaborative studies with the U.S. Forest Service and the Connecticut Agricultural Experimental Station on beech bark disease and chestnut blight respectively have shown that new concepts of tree defense mechanisms in conifers developed at PFRC are applicable to two hardwood species viz *Fagus grandifolia* (American beech) and *Castanea dentata* (Sweet chestnut).

These two concepts are based on the idea that non-specific healing responses to any kind of injury in the bark, vascular cambium, and/or wood, comprise a major component of the host defensive capability, and that events in defense such as phytoalexin production are simply parts of the non-specific processes. Because these host processes are virtually universal, the effects of diverse pathogens can be studied from a unified point of view, which should permit both integration of data from diverse investigations and permit more streamlined investigations in the future.

Support Services

Objective: To provide efficient, specialized services to the research projects and other operations of the Centre.

Achievements: The PDP 11/45 computer and supporting staff were relocated into secure environmentally-controlled facilities on the penthouse floor of the building. Terminals grouped in adjacent offices resulted in much improved service to scientific staff. Microtechnique, programming and analytical chemistry services were maintained at normal levels in support of the research programs.

The Library continued to expand through the acquisition of 317 volumes of journals and approximately 250 monographs and symposia. It has, for several years, been the most complete forestry library on Vancouver Island with total holdings of 9 000 bound volumes and 38 000 reports, documents, reprints

etc., on all aspects of forestry as well as biology, economics, remote sensing and environmental subjects. During the year the Library actively promoted computerized searching of bibliographic literature. Its services are available not only to staff but to the scientific and technical forestry community and to the public.

Administration

Objective: To provide a system of financial control and accountability in accordance with statutory and regulatory requirements. To provide general administrative support services including materiel management, records management, secretarial services, vehicle fleet management and personnel services. To provide physical facilities for the total Centre and 11 field locations.

Achievements: Financial controls and budgetary systems were effectively maintained together with related support services as assistance to the Directorate and Managers in achieving their program goals.

The physical plant program continued to implement energy conservation measures and maintain building and grounds at a high standard. This involved the operation and maintenance function of 95 000 sq. ft. of laboratory, office, technical shops, greenhouse space comprising five buildings at 506 West Burnside and 11 field locations throughout the province. Physical plant fuel consumption for 1978/79 was down by 6.3% from the previous year; as well electrical consumption was also slightly less. These reductions indicated the Energy Conservation Program was successful and is being continued.

Information Services

Objective: To provide the Centre with editorial and graphic services. To act as the channel through which creative contact is maintained with the public, the forest community, national, regional and local news media, editors and printers. To produce booklets, news releases, exhibits and to handle telephone and written enquiries.

Achievements: During the year 20 releases were issued to the press; 50 reports were processed, and 55 scientific manuscripts and technical reports were edited for publication. Countless enquiries were received from the public and 80 000 pieces of literature were distributed in response. In addition 25 tours were conducted through the Centre and four exhibits were prepared and displayed at various locations.

An Open House was held to which more than 4 000 visitors attended, taking the opportunity to acquaint themselves with the research and operational activities of the Centre.

PACIFIC FOREST RESEARCH CENTRE
1978/79 EXPENDITURES

(\$'000')

PROGRAM AREA	PERSON YEARS	SALARIES	OPERATIONS & MAINTENANCE	CAPITAL	TOTAL
Fire & Environmental Forestry	12	\$293.9	\$ 38.2	\$ 7.9	\$340.0
Forest Resources	36	\$690.0	\$114.4	\$22.4	\$826.8
Economics	6	\$ 97.8	\$ 3.2	\$00.0	\$101.0
Forest Protection	72	\$1,430.9	\$138.3	\$18.0	\$1,587.0
Directorate (includes Information Services)	7	\$355.5	\$ 39.0	\$25.0	\$419.5
Support Services	14	\$279.3	\$ 68.6	\$ 4.1	\$352.0
Administration	25	\$403.9	\$337.3	\$71.4	\$812.6
TOTAL	172	\$3,551.3	\$739.0	\$148.8	\$4,439.1

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APPENDIX A

Contracts let or Supervised by
P.F.R.C. in fiscal year 1978-79

Contracts Name	Project Title	Amount
Reid Collins and Associates 1178 W. Pender St. Vancouver, B.C.	Reclamation of Accessible non-productive Forest Land	\$12,000
Douglas Ecological Consultants Ltd. 2049 Crescent Rd. Victoria, B.C.	Review of Vegetation Lists & Maps	\$ 1,200
Atmospheric Dynamics Corp. RR 1 Elmira Ontario	Development of Small Scale Wind Model suitable for Forestry Applications in B.C.	\$ 2,500
Vaartnou & Sons Enterprizes Ltd. 2950 Lansdowne, Victoria, B.C.	Mapping of vegetation types three kilometres on each side of the Alaska Highway pipeline Corridor over the full length of the Route in the Yukon	\$ 9,621
Paul H. Jones & Associates Ltd. 270-2025 West 42nd St. Vancouver, B.C.	Study on Energy from Forest Biomass - Forest Biomass location & volume: Extraction and Delivery Costs on Vancouver Island	\$58,000
Scada Associates Statistical Consultants & Data Analysts 14 Cottonwood Cres. London, Ont.	Collection and Evaluation of Vegetation Baseline data on the Right of way of the Proposed Alaska Highway Gas Pipeline	\$51,709
OVAAC8 International (Canada) Inc. 4800 Dufferin St. Downsview, Ontario	Development and implementation of LOCAS and LOCAS II--A Digital image classification and analysis system applicable to multispectral LANDSAT data	\$191,400

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APPENDIX B

APPENDIX C

PUBLICATIONS

- ALLEN, S.J. 1978. Forest Insect and Disease Conditions Cariboo Forest District, B.C., 1977. PFRC Rept. BC-X-175. 8 pp.
- ALLEN, S.J. 1979. Forest Insect and Disease Conditions, Cariboo Forest Region, British Columbia, 1978. PFRC Rept. BC-X-195. 7 pp.
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- DOIDGE, D.F. & H.P. KOOT. 1979. Forest Insect and Disease Conditions, Prince Rupert Forest District, B.C., 1978. PFRC Rept. BC-X-194. 15 pp.
- EDWARDS, D.G.W. 1979. An Improved Air Seed-Sorter for Laboratory Use. PFRC Rept. BC-X-188. 11 pp.
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APPENDIX D

**PACIFIC FOREST RESEARCH CENTRE
CANADIAN FORESTRY SERVICE
VICTORIA, B.C.**

ORGANIZATION AND PROJECT STAFF LISTING 1978/79

DIRECTOR	M.H. Drinkwater	(Sec. - R. Gale)
PROGRAM MANAGERS	C.E. Brown	(Sec. - K. Simpson)
	Dr. T.G. Honer	
	Dr. M.R.C. Massie	(Sec. - L. Michaud)
	Dr. C.D.F. Miller	(Sec. - J. Lawson)
ADMINISTRATIVE OFFICER	J.J. Ellis	(Sec. - K. Simpson)
INFORMATION OFFICER	T.C. Jones	(Sec. - B. Page)

PROJECTS

<u>Project No.</u>	<u>Title</u>	<u>Professional Staff</u>	<u>Technical Staff</u>
FIRE AND ENVIRONMENTAL FORESTRY (C.E. BROWN)			
PC-25	Effects of harvesting and site preparation practices of forest resources and values	Dr. R.B. Smith (Project Leader) Dr. E.D. Hetherington	E.F. Wass R.J. Roswell
PC-30	Improved prediction of wildfire behavior	B.D. Lawson (Project Leader)	G.A. Robertson
PC-41	Use of prescribed fire for wildland management	S.J. Muraro (Project Leader)	G.R. Lait
PC-43	Environmental impact assessment of northern pipelines	Dr. W.K. Stanek (Project Leader)	
PC-46	Improved use of meteorology in forestry	Dr. R.H. Silversides (Project Leader)	W.L. Cave

FOREST RESOURCES (DR. T.G. HONER)			
PC-23	Growth and biology of coastal Douglas-fir ecosystems in relation to management practices	Dr. H. Brix (Project Leader) Dr. T. Hall Dr. V.G. Marshall Dr. J.A. Dangerfield Dr. P.C. Pang	L.A. Bjerstedt K. McCullough C.R. Layton A. Mitchell J.J. Dennis
PC-31	Landscape interpretation and management for social value	Dr. S. Eis (Project Leader)	D. Craigdallie
PC-35	Baseline data for resource planning in the Yukon Territory	Dr. E.T. Oswald (Project Leader) Dr. Y.J. Lee	R.K. King
PC-38	Land inventory and assessment in B.C.	J.P. Senyk (Project Leader)	B.N. Brown
PC-39	Operations research techniques for forest management	Dr. R.V. Quenet (Project Leader) T. Van der Wereld Dr. J.W.E. Harris	D. Barwise

<u>Project No.</u>	<u>Title</u>	<u>Professional Staff</u>	<u>Technical Staff</u>
PC-48	Regeneration and silviculture systems: Pacific and Yukon	J.T. Arnott (Project Leader) J.M. Kinghorn Dr. R.G. McMinn	G.J. Goodmanson D. Beddows M.A. Grismer M.T. Hughes
PC-49	Tree and seed improvement: B.C. and Yukon conifers	Dr. D.F.W. Pollard (Project Leader) Dr. G.W. Edwards	J.F. Dronzek F.T. Portlock D.W. Taylor

ECONOMICS (DR. M.R.C. MASSIE)

PC-05	Development of economic guidelines for allocating resources for forest management and research	Dr. G.H. Manning (Project Leader) W.G. Howard	J. Rudd C. Macklin
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**FOREST PROTECTION
(DR. C.D.F. MILLER)**

PC-02	Forest insect and disease survey	H.A. Tripp (Project Leader) (sec. F. Douglas) Dr. D.A. Ross Dr. G.A. Van Sickle Dr. J.W.E. Harris Dr. R.S. Hunt D. Evans	R.L. Fiddick J.S. Monts R.J. Andrews H.P. Koot D.F. Doidge S.J. Allen L.S. Unger R.D. Erickson C.S. Wood R.O. Wood E.V. Morris C.B. Cottrell E. Wegwitz W. Adams N.G. Bauman A.F. Dawson R. Duncan E. Pass R.G. Brown D.P. Lowe D.G. Collis
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<u>Project No.</u>	<u>Title</u>	<u>Professional Staff</u>	<u>Technical Staff</u>
PC-06	Reduction of losses from bark and wood-boring insects	Dr. L. Safranyik (Project Leader) E.D.A. Dyer Dr. T.S. Sahota Dr. D.M. Shrimpton Dr. H. Moeck Dr. L.H. McMullen	D.A. Linton W.W. Nijholt A. Ibaraki L. Manning C.M. Lawko R.E. Betts
PC-07	Reduction of losses from balsam woolly aphids	Dr. G.S. Puritch (Project Leader)	M. Talmon de l'Armee
PC-08	Reduction of losses from defoliating insects	Dr. R.F. Shepherd (Project Leader)	T. Gray
PC-12	Reduction of losses from stem diseases	Dr. A. Funk (Project Leader)	D. Chu
PC-13	Reduction of losses from root and stem decays in second-growth stands	Dr. G.W. Wallis (Project Leader) Dr. D.J. Morrison	G. Reynolds H. Craig A.L.S. Johnson
PC-34	Cone and seed insects of North America	A.F. Hedlin (Project Leader)	D. Ruth
PC-40	Pest impacts on growth of managed stands	Dr. W.J. Bloomberg (Project Leader) Dr. A.J. Thomson	A. Hall
PC-44	Reduction of losses in regeneration forestry	Dr. J. Sutherland (Project Leader) Dr. J.C. Hopkins	W. Lock T.A.D. Woods
PC-45	Evaluation of natural agents for control of forest pests in B.C. and the Yukon	Dr. H.S. Whitney (Project Leader)	O.J. Spanier
PC-47	Host-pathogen relationships	Dr. D.B. Mullick (Project Leader)	G. Jensen

ADMINISTRATION (J.J. ELLIS)

Clerk/Typist/Receptionist	A. Noel
Typist	L.A. Johnson
Central Registry Supervisor	L.M. Donk
Financial and Materiel Officer	C.P. Sonders
Accounts Supervisor	D.L. Wherry
Jr. Accounting Clerk	J. Jickling
Purchasing Clerk	W.H. Gray
Jr. Purchasing Clerk	K.C. Vose
Storeman	J.R. Rafter
Assistant Storeman	D.A. Greenway
Chief Engineer	C.A. Phillips
Ass't Chief Engineer	E.K. Hopps
Sr. Maintenance Carpenter	W. Pearce
Maintenance Craftsman, Instrumentation	M. Buck
Maintenance Craftsman, Mechanical	R.H. Reid
Stationary Engineers	R. Semple G. Heard R.M. Richardson A. Couillard
Gardener	J.W. McCoy
Greenhouseman	B.J. Vander Heiden

SUPPORT SERVICES (C.E. BROWN)

Chief Photographer	A.R. Craigmyle
Ass't Photographer	E.J. Chatelle
Microtechnique Technician	S.H. Farris
Biochemist	E.E. McMullan
Chromatography Technician	W.W. Nijholt
Draftsman	J.C. Wiens
Scientific Editor	A. MacEwan (Sec. H. Matson)
Librarian	A. Solyma
Library Clerk	M.V. Mitchell
Head, Applications Programming	D. Hunt
Applications program analyst	R. Robertson
Computer Systems Programmer	G. Pellerin
Head, Operations & Systems Development	F.G. Heywood
Computer Operator	J.E. Foster
Keypunch Operator	C.E. Franzen
Applied Statistician	Dr. C.S. Simmons

VISITING SCIENTISTS

Dr. Owe Martinsson Royal College of Forestry Sweden (Forest Pathology)	Dr. John Hart University of Michigan U.S.A. (Disease Resistance)	Mrs. Augustina Gyimah Forest Products Research Institute Kumasi, Ghana (Seed Technology)
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Environment Canada
Canadian Forestry Service
Pacific Forest Research Centre
Victoria, B.C. V8Z 1M5
BC-X-199, September, 1979