Science Investments – Forestry Dividends

Canadian Forest Service – Pacific Forestry Centre
Program Highlights

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A Century of
Innovative Solutions
Cent ans de
solutions innovatrices

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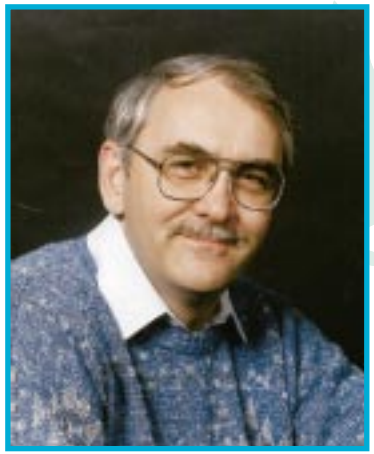
Introduction



Paul Addison, Director General
January 1999

Industrial and technological globalization is continuing at an increasing pace. While trade and investment remain as key drivers, the customers are making more and more of the resource management decisions. Regional and national economies are evolving into national and international economies.

Globalization has produced the impetus for international standards for performance and efficiency from both economic and environmental perspectives. In forestry, these standards are affecting both the management of forestlands and the forest products that are acceptable in certain export markets. Sustainability and stewardship of resources and species has become of greater interest in today's society.

World population growth (a net increase of about three people per second) will continue to produce substantial demands on global resources. Properly managed forests are renewable resource alternatives to meeting the demands for fuel, shelter and fibre. For example, to meet international commitments on climate change, it may be necessary for Canada to use forests as potential sinks of carbon and forest products as replacement for high energy consuming concrete and cement products.

In B.C., the forestry sector has been and remains a mainstay of the provincial economy and the financial source to underwrite future economic development. British Columbia's forests are a natural endowment with old-growth forest types comprising a greater proportion than any other jurisdiction in Canada. It is these characteristics that require the definition of acceptable levels of protected areas and sustainable forest management practices.

The Canadian Forest Service is dedicated to delivering the research base for a sustainable and competitive national forest sector. This mandate is delivered in partnership with the various sector stakeholders in an effort to ensure a timely, appropriate focus and the ready application of research findings. Located in Victoria, the Pacific Forestry Centre, part of the Canadian Forest Service, employs approximately 135 indeterminate and 30-50 seasonal scientific and development staff working in four major program areas: Forest Biology, Forest Resources, Marketing and Operations, and Industry, Trade and Economics.

Forest research and development activities at the Pacific Forestry Centre have a provincial, national and international scope. Both Science and Technology and Operational programs such as Model Forests and First Nations are part of national networks. As the Canadian Forest Service celebrates its 100th anniversary in 1999 under the theme of "A Century of Innovative Solutions," some of the current contributions of the Pacific Forestry Centre of the Canadian Forest Service are outlined in the following pages of this report. Hopefully, they will be both of interest and a stimulus for new opportunities to work together to contribute to the sustainable development and competitiveness of Canada's forests. The Canadian Forest Service is looking forward to the next century.

Innovation – in Partnerships

Integral to the research at the Pacific Forestry Centre are collaborative research programs with other B.C. stakeholders and international forest research organizations, and informal arrangements between scientists. Of the more than 100 ongoing research initiatives at the Pacific Forestry Centre, at least 80% involve collaboration with universities and other organizations such as the B.C. Ministry of Forests, industrial partners, the Forest Engineering Research Institute of Canada (FERIC), Forintek and Forest Renewal B.C.

the first nations forestry program

"Having a meaningful job and the potential to make a substantial amount of money has had some very positive results for these people and their families. They're not on social assistance and they don't have to move away (to get work). The grant money has made a huge difference."

These words from Pat Deakin, Special Projects Coordinator for the Uchucklesaht Band, typifies the ongoing success of the First Nations Forestry Program, a five-year program established in 1996 to enhance economic opportunities for First Nations both on and off reserves. The program, available to First Nation bands, tribal councils and organizations, helps to ensure that they have the tools and skills needed to operate and participate in forest-based businesses across the country.

The First Nations Forestry Program promotes joint ventures and business development.

"Opportunities are created so that there is more stability and enhancement with respect to forestry economic growth," said Nello Cataldo, Collaborative Forestry Program Manager at the Pacific Forestry Centre. "A major aim of the program is to encourage joint ventures with off-reserve business partners. The program supports activities that identify, encourage and develop partnership initiatives, capacity building, business and forest management skills."

Over the last three years the First Nations Forestry Program has funded skill development and training initiatives in operational forestry activities as well as market and mill feasibility studies, business plans, forest management plans, silviculture treatments, joint ventures and business development.

To participate as full partners in the forest sector, First Nations people are developing meaningful jobs, businesses and a sustainable future for communities and forests.

To the band-owned Sliammon Development Corporation, the First Nations Forestry Program meant help with four joint venture projects. One of these projects included band members clearing and replanting 120 hectares for conifer management. “It was a poorly producing forest,” says Chris Roddan, Forestry Coordinator for the corporation. “Now it will become a well managed and productive one.”

Another example of a project that received First Nations Forestry Program funding is a joint venture between the Upper Similkameen Band and Princeton Wood Preservers Ltd. “It’s a very good arrangement for us and I believe for Princeton Wood Preservers as well,” said Band Manager Philippe Batini. “They get the wood from our jointly held land to process and, in turn, are obligated to use our band members to do the logging and silviculture work.”

The First Nations Forestry Program is jointly funded by the Canadian Forest Service and the Department of Indian Affairs and Northern Development (DIAND). A national management committee consisting of the Canadian Forest Service, DIAND, and First Nations provides overall management and direction of the program across the country, exploring funding opportunities (trust funds, venture funding, capital pools) and establishing cooperative arrangements with other federal departments. Provincial or territorial management committees consist of individuals from the Canadian Forest Service, DIAND and First Nations and are responsible for the development and implementation of the First Nations Forestry Program in their respective province or territory. Provincial governments and members of the forest industry who can contribute to the objectives of the program are also encouraged to participate on the provincial or territorial committees.

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fire management planning and prediction tools

Every year in Canada, fires burn an average of 736,000 hectares of commercial forest (equivalent to 74 percent of the area harvested) resulting in a loss of 70 million cubic meters of wood valued at about $1 billion. Thus, every year, fire management information systems are vitally important. Based on over 60 years of research, the Canadian Forest Service, in cooperation with fire management agencies, has developed fire prediction tools that have been adapted and used by many countries worldwide.

One of the most popular tools developed by the Canadian Forest Service is the Canadian Forest Fire Danger Rating System (CFFDRS) which uses weather, fuel and topographic data to rate the potential for forest fire ignition and to predict forest fire behaviour. The Canadian Forest Fire Behaviour Prediction System (FBP) is a major component of the CFFDRS. It is used to predict fire characteristics such as rate of spread, fire intensity, and crowning potential. Now available as a field guide, the FBP is used regularly by management agencies throughout the country. The Pacific Forestry Centre developed the FBP field guide in response to the need for a user-friendly guide which fire managers and crews could use in the field.

“The Canadian Forest Service Fire Danger Rating System and its Fire Behaviour Prediction System component is extremely valuable in modern fire management for determining appropriate preparedness levels for fire suppression resources,” says Phil Taudin-Chabot, Team Leader, Training and Safety, Protection Branch, B.C. Ministry of Forests. “The development of the FBP field guide by staff at the Pacific Forestry Centre helps to get the needed information to the fire staff working on the fireline. Fire Research

Every year in Canada, fires burn an average of 736,000 hectares of commercial forest.

staff at the Pacific Forestry Centre continue to be key cooperators in documenting fire behaviour research and helping to transfer information for practical application."

Adds Eric Meyer, Fire Weather Specialist at the Protection Branch of the B.C. Ministry of Forests, "We used the prediction system directly on a number of the serious fires experienced in the (B.C.) interior this summer. In addition, it was used to generate fuel-type-based fire behaviour advisories for dissemination to fire crews throughout the fire centers."

In addition to the FBP field guide, the CFFDRS and FBP have been used to develop a fire management planning tool called a Wildfire Threat Rating System (WTRS). This system considers the four main components of wildfire threat: risk of fire ignition; values to be protected (e.g., the potential loss of life, property, timber supply, and aesthetic values); potential wildfire behaviour; and fire suppression capability. Coupled with a Geographic Information System (GIS), the WTRS allows resource managers to integrate and analyze the key factors that contribute to wildfire threat.

"With GIS and the analysis system, we are able to look at many variables at once and understand how they operate together," explains Dr. Brad Hawkes, Fire Research Officer at the Pacific Forestry Centre. "With such information resource managers can predict which factors would lead to, or avoid, a wildfire in the area."

A prototype of the WTRS has been developed for the McGregor Model Forest near Prince George, B.C. Forest inventory information about the McGregor Model Forest was coupled with silviculture information to create a fuel-type map for the area. This map was overlaid with digital terrain information to determine slope and aspect, which affect fire behaviour. Details such as rate of spread, fire intensity and potential for crowning were

Forest managers now have access to tools based on 60 years of experience that allow them to put resources where they are needed most, saving some of the $1 billion and millions of cubic meters of solid wood lost each year to fire.

combined into another map. The suppression capability was calculated by considering such factors as access to water supplies, road and initial attack base locations, and steepness of the terrain. Fire risk was determined using human-caused and lightning fire frequencies. Finally, the values at risk were added into the equation. Each of these components was weighed equally to come up with an overall wildfire threat. A world wide web version of the prototype model was developed by the McGregor Model Forest which allows fire managers to change the weightings of components and factors of the system.

"It was found that although the McGregor Model Forest as a whole has a moderate to high overall wildfire threat, there were many areas that rated a much lower threat," says Hawkes. "Knowing what part of the forest is under the greatest threat allows the fire manager to assess potential fires in a strategic manner. For example, before fire season begins, the fire manager could use the WTRS to assist in evaluating alternative locations for initial attack bases."

"The Wildfire Threat Rating System is a very useful diagnostic tool that helps resource managers assess the relative importance of the factors contributing to wildfire threat within a particular area," says Cordy Tymstra, Fire Ecology Officer, Forest Protection Division, Land and Forest Service, Alberta Department of Environmental Protection. "This system can also be used as a strategic tool to evaluate different 'what-if' planning scenarios."

The WTRS was first introduced in Australia but its application to the McGregor Model Forest was a collaborative effort between the Canadian Forest Service, the B.C. Ministry of Forests and the McGregor Model Forest.

Dr. Brad Hawkes can be reached at bhawkes@pfc.cfs.nrcan.gc.ca.

high spatial resolution digital imagery

Think of forest inventorying and computers and you may think of aerial photos and displays of interpretations in Geographic Information Systems. But technology in forestry has pushed beyond the traditional information-gathering methods. Now, high spatial resolution digital imagery may provide a quicker and more cost-effective means to survey the forest.

For three years, researchers at the Pacific Forestry Centre, in cooperation with MacMillan Bloedel Ltd. and a remote sensing company, with funding from Forest Renewal B.C., have been studying the feasibility of mapping forest parameters using data from the compact airborne spectrographic imager (CASI). CASI is a programmable imaging spectrometer that can acquire visible and near-infrared multispectral imagery of the forest. Analysis of imagery at resolutions of 50 cm to 1 m permits automated interpretation on a single tree basis. Research results on CASI have been promising.

"Our studies indicate that CASI is able to apply high spatial resolution digital imagery data to various B.C. forestry management activities such as regeneration assessment, gap mapping, stream platform mapping and, to a lesser extent, root rot detection," says Dr. Don Leckie, a research scientist at the Pacific Forestry Centre. "It's a quicker and less expensive means of obtaining forest management parameters than using ground-based methods. For example, traditional ground-based root rot surveys on the west coast cost $40-$70 per hectare. A high resolution remote sensing survey would be in the order of 1/3-1/4 those costs."

In its application to forestry, CASI is installed in light aircraft and flown over a forested area. Its optics project a line perpendicular to the flight path onto one axis of a two-dimensional CCD (charged coupled device). The image is dispersed spectrally along a different axis of the CCD and a com-

Alternative harvesting and regeneration can be better planned to save time and money - using remote sensing technologies. Through this program, collecting and processing up-to-date information for forest managers helps avoid costly mistakes.

plete spectrum is obtained. This process is repeated as the aircraft moves over the forest, creating a two-dimensional scene at high spectral resolution.

"We are looking at the use of CASI for some phases (tree counts, gaps and possible speciation) concerning inventory updating and habitat supply," says Nick Smith, Senior Resource Analyst, Corporate Forestry, at MacMillan Bloedel in Nanaimo, B.C. He's been working with Leckie and Dr. François Gougeon (also at the Pacific Forestry Centre) on the research. "The project is presently in the research proof-of-concept phase."

Another partner in the research is ITRES Research Limited in Calgary, Alberta. "We design and build airborne remote sensing instruments (such as CASI) and provide information products based on those instruments," says Cliff Anger, president of the company. "We've been working in forestry for the last couple of years and now we're seeing serious operational use being made of the technology."

In an effort to share and discuss the advances in high spatial resolution digital forestry data with other researchers and potential users, the Pacific Forestry Centre, the B.C. Ministry of Forests, and MacMillan Bloedel hosted an international forum. Called "Automated Interpretation of High Spatial Resolution Digital Imagery for Forestry," the meeting was held in February 1998.

"True digital image processing of high resolution data for forestry is in its infancy, with most developments being less than five years old," notes Leckie. "But judging by the participation at the forum, automated interpretation of high spatial resolution digital data for forestry is alive, well, and growing."

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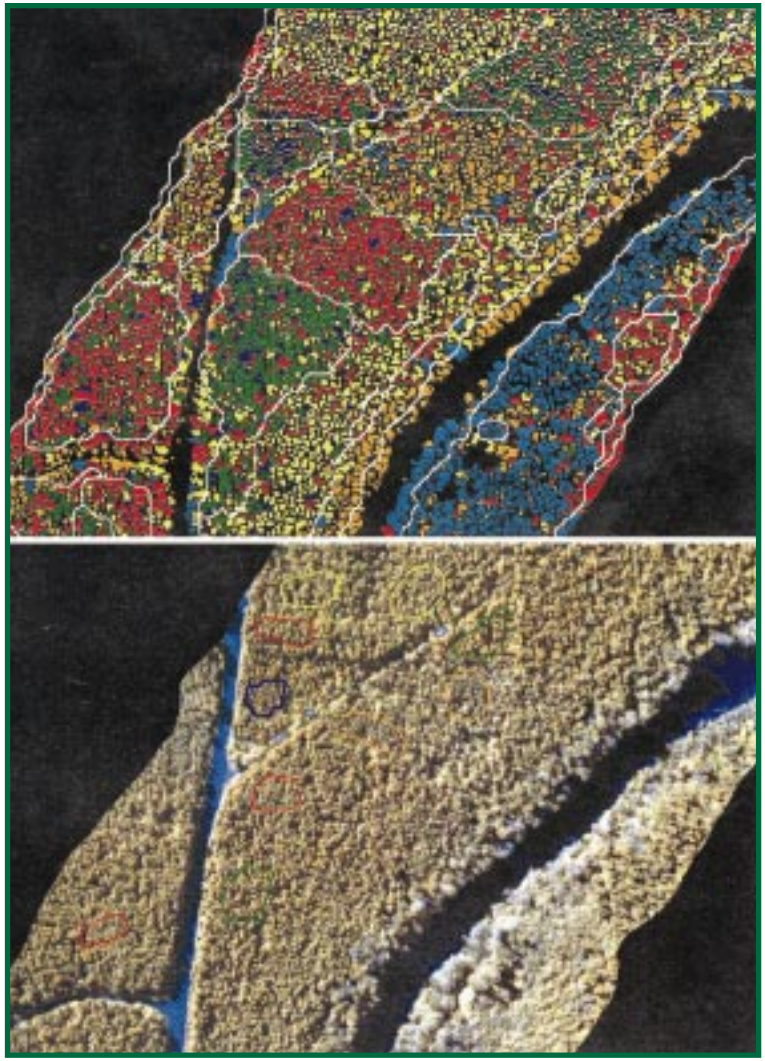

Pseudo-color infrared rendition of a 60 cm/pixel CASI image taken over central Vancouver Island and its computer analysis. Species composition on a stand basis was estimated on average to within 10-15% for the main species of the stands.

salal cedar hemlock integrated research program (SCHIRP)

The SCHIRP project was established in 1986 by an interdisciplinary team of scientists working in a wet biogeoclimatic subzone on northern Vancouver Island. Over a decade of research has been conducted to address poor conifer regeneration in this area. Results will help researchers to recommend the most effective silvicultural methods to improve tree growth on potentially productive forest land. The research could result in better regrowth in this area, which could contribute about $35 million a year to the forestry industry.

The research aimed to determine the causes of poor conifer regeneration in sites where there has been extensive reoccupation by salal, a dense, leafy shrub, which can overtake an area and compete with newly planted seedlings. The problem occurred on sites formerly occupied by old-growth cedar-hemlock forests, five to eight years after clearcutting and slashburning.

"Part of SCHIRP involves planting seedlings on clearcut and slashburned sites that had previously been occupied by an old-growth cedar-hemlock forest and a younger hemlock-amabilis forest," says Dr. Caroline Preston, a research scientist at the Pacific Forestry Centre.

Long-term research showed that the seedlings planted in the old-growth cedar-hemlock forest type experienced a growth check, while the seedlings in the hemlock-amabilis forest type were healthy. A series of fertilization trials identified deficiencies of the nutrients nitrogen and phosphorus as the cause of the growth check of conifers in the cedar-hemlock forest type.

SCHIRP nitrogen sampling.

Once the problem with the cedar-hemlock forests was identified, scientists concentrated on determining the reasons for deficiencies of the nutrients and the best silvicultural practices for alleviating the growth problem. Three reasons for poor growth were identified.

First, cedar plant litter (leaves, twigs and other matter decaying on the forest floor) contains less nitrogen and more decay-resistant material than other species. Second, the floors in cedar-hemlock forests are wetter and have less soil fauna than in hemlock-amabilis forests. This leads to incomplete decomposition and mineralization of nitrogen. Third, competition from salal in cedar-hemlock forests makes the problem worse by interfering with mineralization of nitrogen.

By investing in nitrogen rich fertilizer for specific conifer sites, forest managers can solve regeneration problems and increase productivity by some $35 million per year.

"Salal can take away nutrients with its widespread rootmass," says Preston. "Salal is high in tannins, which may inhibit decomposition. It can also adversely affect the mycorrihizal fungi that help seedlings take up nutrients."

The SCHIRP team found they could help relieve the growth check in cedar-hemlock forests by using different types of organic and inorganic fertilizers. The fertilizers add nutrients, which help the trees grow faster. When the trees grow high enough to attain crown closure, enough shade is provided to slow down the salal's growth.

These results will greatly help forest managers. "A key to the success of SCHIRP has been the recent development of a data management system which will allow data from the many SCHIRP trials to be quickly analyzed, summarized and sent out to help forest managers," says Cindy Prescott, SCHIRP coordinator at the University of British Columbia.

SCHIRP is an integrated research program conducted by scientists from the University of British Columbia, the University of Victoria, the Canadian Forest Service, the B.C. Ministry of Forests, and Western Forest Products Ltd. Funding was provided by these groups and Forest Renewal B.C., NSERC, Timberwest Ltd., MacMillan Bloedel Ltd., the Science Council of B.C., and the South Moresby Replacement Fund.

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Innovation – in Technology

The Pacific Forestry Centre is a leader in the technological advancement of forestry research.

dna research means $$$ saved

Every year illegal logging costs B.C. between $10 and $20 million in terms of lost revenue — $100 to $300 million when criminal prosecutions and legal fees are considered. Trees are stolen not only from Crown land but private land and ecological reserves. But, like other criminals, tree thieves will soon be subject to forensic applications of DNA analysis.

The Canadian Forest Service, in partnership with the B.C. Ministry of Forests, has been developing an investigation method for apprehending tree thieves and ultimately curbing the crime. It is the first time DNA matching in trees has been applied to tree theft in North America and possibly the world.

"The results from our feasibility studies have been very encouraging," explains Dr. Eleanor White, a molecular biologist with the Pacific Forestry Centre. "We have extracted DNA from needles, inner bark, and wood of cedar. The plan is to have law enforcement officials sample DNA from seized wood and match it with DNA from illegally harvested tree stumps."

Dr. Eleanor White working in the DNA lab.

Convictions in the past have been secured through matching the shape and annular rings of a cut log with its stump. But thieves now remove a section from the butt of the stolen log to make the technique ineffective. Without

Giving authorities new technology to fight the theft of $10-20 million in valuable B.C. trees each year protects this resource. Saving some $100-300 million in legal expenses also contributes significantly to our economy.

that technique, "catching them in the act" is virtually the only evidence that can stand up in court against an accused individual or company. With DNA analysis, however, a tree thief could be convicted even if there were no witnesses to the crime.

"Nothing's going to completely stamp out tree thefts," says Jerry Hunter of the Compliance and Enforcement Branch in the B.C. Ministry of Forests. "But DNA testing will discourage it because potential thieves will know there's a much greater chance of getting caught."

Initial tests were limited to DNA matching in yellow cedar only. "But since the research was so successful with yellow cedar," adds White, "we applied it to red cedar, some of which was 257 years old. That was a bit more challenging as at that age the heartwood is full of contaminants that kill the enzymes used to analyze DNA. But we found that extracting the DNA from a block of an old tree was possible, which means that this forensic technique may be applied to forest products like cedar shakes well after the tree has been stolen and the wood processed."

Adds Corporal Colin Worth of the R.C.M.P.'s Forest Crimes Investigation Unit, "The work of Dr. White and her team is essential in moving current DNA research as it relates to western red cedar from the laboratory to the courtroom. The ability to conclusively match wood will greatly enhance our investigation capability and increase the likelihood of a conviction."

This innovative application of DNA research will curb the crime quickly and inexpensively, decreasing substantial losses to both B.C. and the private landowner.

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disease, knowledge and diagnostic tools

Tree diseases can degrade lumber and cause tree mortality, yet are essential to forest ecological processes and biodiversity. Therefore, understanding forest disease-host relationships is fundamental to sustainable management plans. Now it takes only a few simple keystrokes to access disease-related information and diagnostic tools developed at the Pacific Forestry Centre.

"Accessibility and ease of use has been dramatically increased by making disease knowledge and diagnostic tools available on the World Wide Web," explains Dr. Alan Thomson, research scientist and developer of the new tools. "Just like we can have several books on a subject, we have a range of web-based disease information systems."

A diagnostic tool based on the book *Common Tree Diseases of British Columbia* by Pacific Forestry Centre researchers Eric Allen, Duncan Morrison and Gordon Wallis is available on our World Wide Web site (http://www.pfc.cfs.nrcan.gc.ca/health/td_web). At this site, information on specific pathogens can be searched by scientific or common name, by host, or by symptom. A diagnosis is attained by listing the signs and symptoms of the host and then submitting the query. The result is a list of possible diseases affecting the host, with the most likely diseases at the top of the list. The reasons why a particular disease is ranked further down in the list are also provided.

The B.C. Host/Fungus index database is also available on the web (http://www.pfc.cfs.nrcan.gc.ca/biodiversity/herbarium). It has been designed to assist in the identification and formal documentation of fungi occurring on native plants in B.C. (except for most agricultural crops and horticultural or ornamental plant species). The host-fungus database was compiled from 60 years of Canadian Forest Service records as well as pub-

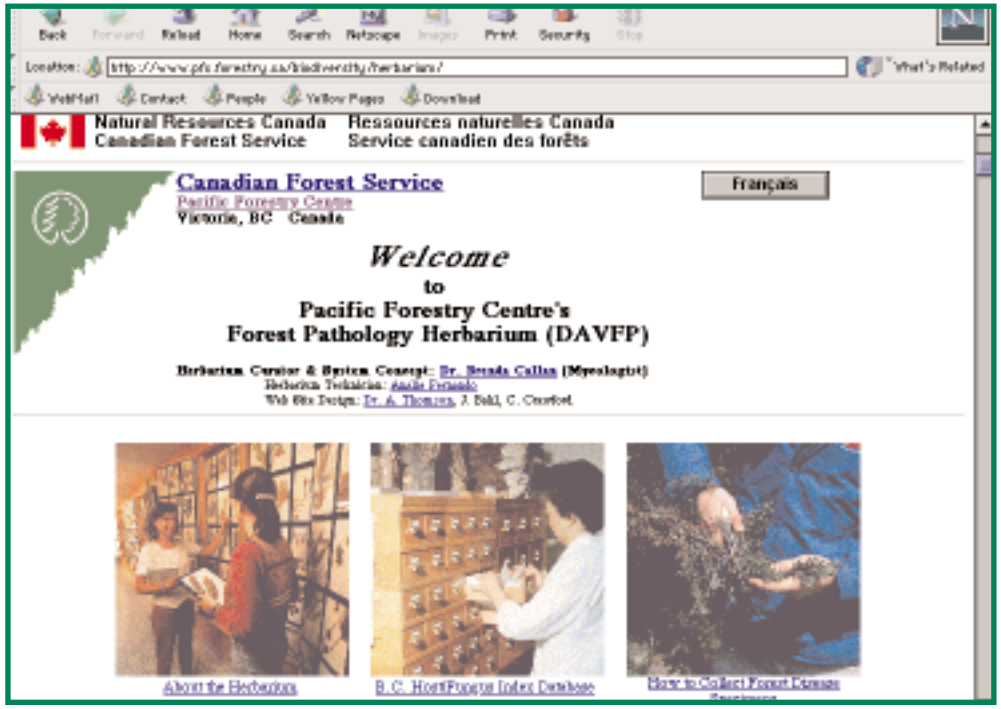
Harnessing the diagnostic and delivery powers of the World Wide Web is saving forest managers, researchers and others time and money. We're continuing to place close to 100 years of research where others can find and use it – quickly, accurately and efficiently.

lished literature and data provided by Agriculture and Agri-food Canada. This section can be searched by genus or specific epithet of both host plants and fungi, and includes a smaller list of fungi associated with other substrates including non-plant hosts.

"I just visited the herbarium site and was very impressed by its thoroughness," says Jerry Carlson of Phero Tech Inc., a resource management company in Delta, B.C. "(It's) an excellent and interesting presentation. We should be regular visitors and will benefit substantially from its availability."

Adds Thomson, "These diagnostic tools draw from previous work on forest insect and disease diagnosis and management using expert system-guided hypermedia. The combination of hypermedia and expert systems overcomes many of the limitations of using an expert system alone."

Dr. Alan Thomson can be reached at athomson@pfc.cfs.nrcan.gc.ca



Accessibility and ease of use has been dramatically increased by making disease knowledge and diagnostic tools available on the World Wide Web

Innovation – in Adaptation and Understanding

The Pacific Forestry Centre is known internationally for its success at adapting existing techniques to new applications to provide a greater understanding of our forests.

global warming heats up litter

Canadian forests release billions of metric tonnes of carbon every year through fire, photosynthesis and the decaying leaves, twigs and other organic debris that make up plant litter. However, the natural forest carbon cycle can be altered by even the smallest disturbances, and global warming could accelerate it. Twenty researchers from the Canadian Forest Service, universities and provincial governments across Canada have been participating in the Canadian Intersite Decomposition Experiment (CIDET), a long-term climate change study that examines litter decomposition and nutrient mineralization in Canada's forests.

In 1992, CIDET was initiated to examine the rate at which decaying plant litter releases carbon into the atmosphere. Carbon is a component of carbon dioxide, which is directly related to global warming. If global warming increases the decomposition rate of plant litter, carbon will be released into the atmosphere faster, in turn prompting more global warming.

"Canadian and other boreal and temperate forests contain over half of the world's litter," says Tim Moore, Professor and Chair of the Department of Geography at McGill University. "Models of climate under elevated atmospheric carbon dioxide concentrations suggest that these forests will experience major changes in climate during the next century."

Dr. Tony Trofymow in a CIDET plot.

In 1992, researchers began to examine litter collected from sites throughout Canada. This data is used to study the relationship between decay rates, soil quality and climate change in regions with different stand structures and climates.

"Despite the importance of litter to the carbon cycle of the forests, our knowledge of litter decomposition is deficient," says project leader Dr. Tony Trofymow, a research scientist in soil ecology at the Pacific Forestry Centre.

Research on the interaction of forests and global warming assists in planning for sustainable forests.

"CIDET will provide data for 10 years in 21 forested sites across Canada, covering a broad range of ecoclimatic regions."

The rate at which litter decomposes depends on stand structure, site characteristics and climate. Forest management practices such as harvesting and silviculture can influence the carbon cycle through altering the uptake and storage of carbon, releasing more carbon into the atmosphere, which in turn could increase global warming.

"A long-term study such as CIDET allows the Canadian Forest Service to look at the effects of temperature and moisture on the more resistant fractions of organic matter," says Trofymow.

Looking at the decomposition rate of plant litter is just the beginning of a long process to assess the possible effects of global warming on forests. Other studies look at how global warming may affect tree growth, fire activity and insects. The results of these studies will help forest managers in the long-term planning of sustainable forests.

Dr. Tony Trofymow can be reached at ttrofymow@pfc.cfs.nrcan.gc.ca

utilizing sortyard fines

Disposing of residue from log handling is a major expense to most forest companies. It also raises environmental concerns. In B.C., a single year's worth of coarse wood residue could fill 3,680 barges, a line 185 kilometers long. The Pacific Forestry Centre in cooperation with the Forest Engineering Institute of Canada (FERIC) is researching the organic make-up of sortyard residues as a first step in turning them into higher-value environmentally-friendly commodities.

Historically, much of the residue was burned or dumped in landfills. New rules and regulations restrict burning and there are concerns about toxic leachate in landfills. While much of the residue generated in sortyards is currently reclaimed for materials such as wood chips, the fines (wood, bark, leaves, needles, gravel, and soil) present a challenge. Being approximately five centimeters or less, the fines are often high in ash and moisture content, and are thus unsuitable for adding to pulp or fibreboard.

"Possible alternative uses for sortyard fines include landscaping products (mulches and topsoil mixes), land rehabilitation (logging roads and landings), composting material, or as fuel," says Dr. Caroline Preston, research scientist in soil chemistry at the Pacific Forestry Centre. "But it is first essential to determine that the material is environmentally benign. Determining ash and elemental concentrations is a relatively simple chem-

Sorting sortyard fines.

Finding environmentally safe uses for the sortyard leftovers increases the added value obtained from our forest products. There may be 'gold' in recycling what others have been leaving behind.

istry procedure, but understanding the organic makeup of the fines in terms of its carbon-containing building blocks is more challenging."

Once material is reduced to small particle size, mixed with dirt and exposed to the elements, traditional means of chemical analysis become almost impossible. However, a technique developed at the Pacific Forestry Centre provides a quick fingerprint of the carbon structures in woody residues. Using nuclear magnetic resonance spectroscopy (NMR), Dr. Preston can generate a fingerprint of the carbon structures in residue samples. The NMR technique can be used for many elements including hydrogen, nitrogen, phosphorous, silicon, aluminium and carbon.

"The research undertaken by the Pacific Forestry Centre and FERIC into the physical and chemical properties of sortyard fines is key to developing alternative uses for this material," says Patrick Forrester, researcher in Harvesting Operations at FERIC. "Dr. Preston's work has indicated … that the chemical makeup of the fines is similar to that of woody soils which occur naturally in most forest systems."

Adds Preston, "So far we've sampled sortyard fines from sites on Vancouver Island, in the interior of B.C., and in Washington State. Our research shows that sortyard residue can be used directly or in combination with supplements for roadways, forest land additives, rehabilitation and perhaps urban landscaping. Sortyards can be rehabilitated easily for other uses without environmental concerns if there are no additional pollutants on the site."

Although further research is required, returning the material to the forest ecosystem as a soil amendment appears to be an option compatible with its origin and chemical properties. Research results from this study are currently being applied to a B.C. Ministry of Forests study on road rehabilitation.

"Understanding the organic makeup ... will result in new opportunities for utilizing this material that are cost effective for the forest industry," says Tony Sauder, Group Supervisor of Harvesting Operations at FERIC.

It may be possible to turn a disposal problem into a resource for sustainable forestry.

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exotic pests pose economic threat

People tend to think of insects as small and insignificant, but in Canada insects pose a real threat to forests. Native bark beetles and ambrosia beetles kill trees and degrade the cut timber of B.C. coastal forests, and the arrival of exotic pests from other countries could result in even greater problems.

In the past three years, researchers at the Pacific Forestry Centre have discovered five non-native wood-boring ambrosia beetles that are already established in lower mainland forests. In addition to direct damage, some exotic pests can indirectly affect forest health by acting as carriers of plant disease organisms such as Dutch elm disease.

"This year we found the first evidence that at least two of these species have already moved into working forests, and one of them is attacking conifers," says Dr. Lee Humble, an entomologist at the Pacific Forestry Centre.

It's impossible to measure the impact exotic species could have on forests as a whole, but the economic impact is obvious.

"Non-indigenous species impact the industry in a couple of different ways," says Dr. Eric Allen, head of the Forest Health unit at the Pacific Forestry Centre. "First, they take the resource away by killing the trees. Second, there

Pests often arrive in Canada in the untreated wooden packaging of imports.

are trade implications. If the species are shown to be established in Canada, then other countries could put trade embargoes on us."

Pests often arrive in Canada in the untreated wooden packaging of imports. The U.S. Department of Agriculture has amended its regulations by adding treatment requirements for wood packing material imported from China.

The amendments are largely due to recent infestations of the Asian long-horned beetle (*Anoplophora glabripennis*), which arrived in the U.S. in wooden packaging from China and has established in Chicago and New York. While not yet known to be established in Canada, the Asian long-horned beetle, which infests and kills trees, poses a serious threat that may result in devastating ecological and economic consequences. The United States estimates a $41 million loss if the beetle establishes further, and losses to the Canadian economy could be even greater.

"We need an economic analysis of the threat exotics pose to the industry," says Allen. "Imposing restrictions on poor quality wood packaging will close the door on one of the main pathways, but there are still a lot of obvious gaps in our knowledge of these species."

The North American Plant Protection Agency (NAPPO) Forest Panel has proposed new standards that will require all wood packing materials entering Canada, the United States or Mexico to be treated to eliminate pests.

"The *Anoplophora* has raised everyone's concerns " says Jon Bell, a biologist from the western area office of the Canadian Food Inspection Agency. "The standards are going to come into effect very quickly, and they will impact $100 billion worth of Chinese trade. We recognize we have a problem, and implementing the standards will help, but it's really only the first inch of a very long climb."

Though the standards may greatly reduce the number of exotic pests coming into North America, there are likely many undetected exotics already established in Canada.

"We need to establish a better public understanding of what the impacts of these introductions are," says Humble. "Most people think that insects are insignificant, but there are some very small insects that kill trees."

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Exotic pests pose a serious threat to Canadian forests and their future. Preventative action now, by closely monitoring foreign shipments, will prevent serious economic and environmental damage.

Innovation – in Forest Practices

Putting forest research to the test – the Pacific Forestry Centre applies its science to the forest in a variety of ways.

a MASSive partnership

The high elevation montane forests on central Vancouver Island supply a significant part of the coastal timber harvest. Clearcutting originally seemed like the best method to harvest these forests because of its cost effectiveness, but growth stagnation in some large clearcuts suggests that regeneration may not be meeting expectations. Growth problems may be related to environmental conditions on clearcuts that create unfavorable microclimates, affecting forest regeneration and inhibiting sustainable development.

The long-term Montane Alternative Silvicultural Systems (MASS) project is a multi-agency cooperative that researches new approaches to harvesting and regeneration in these forests. Early results of this research show that there are alternative silvicultural systems that may be more suitable for this kind of forest.

"Basically, the MASS project, located near Campbell River, B.C., is a study of four silvicultural treatments and their comparison to an unharvested, old-growth area," says Jim Arnott , a Canadian Forest Service senior research scientist at the Pacific Forestry Centre. "Future timber harvesting will depend heavily on montane forests, creating a need to better understand these ecosystems. The predominantly old-growth montane to subalpine forests (those over 700 meters in elevation) where MASS is located contain a significant part of the coastal timber harvest."

Technology transfer at the MASS site.

Shelterwood (retaining 30 percent of the basal area of the original stand – approximately 200 stems per hectare) is one of the alternative silvicultural treatments at the MASS site. The other treatments include: Patch Cut (harvesting a 1.5-hectare patch at a time, with the adjacent patch remaining until regeneration reaches ten meters high); and Green Tree Retention (reserving at least 25 trees per hectare). These systems are compared to each other, as well as to a 69-hectare clearcut (cutting all trees) and a 20-hectare old-growth reserve.

Learning more about regeneration and growth of the montane forest offers new harvesting and silviculture techniques to sustain the future ecology and productivity of a major portion of B.C.'s coastal forest.

MacMillan Bloedel Ltd. is the principal industrial partner in this multi-agency cooperative. “MASS gave us valuable experience with new approaches, and data on the incremental costs of alternative systems,” says Bill Beese, MacMillan Bloedel forest ecologist. “We need the results from MASS to help foresters determine the best management techniques to sustain the productivity of high elevation forests.”

Besides being a study in the operational costs and feasibility of alternative silvicultural methods, there are 21 integrated long-term, multi-disciplinary research studies underway at the MASS site. Researchers are conducting studies on forest structure, ecological processes, regeneration, seedling stress, vegetation competition, and bird and insect diversity.

This research and operations partnership between industry, universities, and provincial and federal governments is a model of new forestry practices regionally, nationally and internationally. Besides the Canadian Forest Service and MacMillan Bloedel Limited, partners include the Forest Engineering Research Institute of Canada (FERIC), the University of British Columbia, the University of Victoria, and the B.C. Ministry of Forests.

Many of the studies will be monitored for at least 20 years to provide more definitive answers on the implications of alternative silvicultural systems on montane ecosystems in coastal B.C.

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working towards sustainable forests

In B.C., the long-term effects of forestry operations on ecosystems are a serious concern. Studies show that from 1976 to 1985, soil degradation reduced annual wood yield by 400 000 cubic meters, and that this was increasing by 50 000 cubic meters each year.

Skid roads and trails cause soil degradation that can harm ecosystems.

John Senyk, a research officer at the Pacific Forestry Centre, has been studying the effects of soil degradation in B.C.’s interior and the coastal montane forests of Vancouver Island for a number of years. Senyk’s studies and other similar projects may help preserve ecosystems and ensure sustainability of future timber supplies.

Reducing soil disturbance during harvesting can add thousands of cubic meters to future forest productivity and preserve ecosystems – ensuring sustainability of future timber supplies.

"Years ago we recognized we were losing 25-30 percent of the cutblock land in the interior to soil erosion and mass wasting caused by ground-based operations, skid roads, trails haul roads, landings and associates" says Senyk. "It became apparent that these disturbances were having an effect on long-term forest productivity."

Sustainability of forests is threatened when ground-based operations cause compaction, displacement and a loss of nutrients in the soil. The harvesting operations can affect the soil's bulk density, porosity and chemistry, leading to inhibited root development and productivity. Soil disturbance can also lead to landslides, which can affect entire ecosystems, leading to a loss of many different resources.

"In the interior of B.C. there has been a considerable change in forestry practices over the past ten years, but there are still ground-based operations going on," says Senyk.

In the mid-eighties, Senyk participated in a study in the Golden Forest District that focused on determining the effects of soil disturbance on long-term tree growth. Four clearcut blocks were chosen, and seedlings were planted on skidroad running surfaces, tracks, and adjacent undisturbed soil. While some trees were more sensitive to disturbances than others, the study confirmed that seedling growth is strongly related to soil disturbance. In general, the running surface and tracks had low soil porosity, high bulk density and a high susceptibility to water erosion, all of which contribute to reduced productivity.

Forest managers are aware of the problem, and they're using the Forest Practices Code soil conservation guidelines, to which Canadian Forest Service research contributed.

"We have one specialist with an M.Sc. in Forestry who works specifically on this problem in order to maintain forest productivity," says Dennis Rounsville, Chief Forester at Crestbrook Forest Industries in Cranbrook. "At this point we do 100 percent skidtrail rehabilitation, and the trials we put out there are getting the growth we've anticipated."

In 1992, Senyk began to conduct research as a part of the MASS project (Montane Alternative Silvicultural Systems) in the high elevations of a coastal montane ecosystem south of Campbell River. In this study, soil disturbances from yarding and skidtrail rehabilitation were studied in four silvicultural systems, and 920 of both western hemlock and amabilis fir seedlings were planted on the disturbed soil. After three growing seasons, the survival of amabilis fir was better than western hemlock in all the disturbance types. Growth of both species was poorest on tracks and rehabilitation skidtrails. These results, combined with the work of other studies, are helping forest managers work towards building sustainable forests.

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root rot research

It is one of the most damaging root diseases affecting Douglas-fir in the forests of northwestern North America, reducing timber volume and growth by millions of cubic meters annually. It's known as *Phellinus weirii*, or laminated root rot (LRR), a fungus that causes wood to decay and separate along annual rings as laminations (hence the term, "laminated root rot").

"There are a number of fungi that cause root diseases in B.C. but *Phellinus weirii* is the major root pathogen on the coast," explains Rona Sturrock, researcher at the Pacific Forestry Centre. "While LRR has been a natural

Douglas-fir affected by *Phellinus weirii*.

component of coastal ecosystems for thousands of years, its incidence in our forests, particularly in management stands, has been increased by several factors. These include practices such as the restocking of infected sites with only Douglas-fir, and in the loss of a native LRR-tolerant conifer, white pine, to white pine blister rust."

Like many root diseases, LRR spreads via root contact and can survive in stumps and roots for decades, acting as inoculum for subsequent rotations. There are several management strategies for LRR, most of which are best conducted at the time of stand regeneration when inoculum can be reduced, or when tree species which are immune (or have a low susceptibility to the fungus) can be planted.

"Forest managers on both private and Crown land have known for decades of the losses incurred from *Phellinus weirii*," says John Phillips, Management Forester for Timber West, the largest private forest landowner in western Canada. "(Last fall, Rona) worked with our foresters, planners and production managers, recommending strategies to manage root diseases. We now have a clearer understanding on where to focus our treatments and how to protect our forest investments."

The goals of root disease management are to regenerate harvested areas, improve timber production and reduce losses to root disease during the rotation. Inoculum reduction – the removal of infected stumps and roots — has proven to be one of the best ways to ensure these goals are met. Stump removal or push-falling of diseased trees with excavators significantly reduces the amount of root disease in the regenerating forest. But soil and topographic constraints often limit stump removal. And stump removal may be considered expensive, averaging $1000 per hectare in coastal B.C. So other strategies to reduce losses to LRR are being evaluated in operational and research trials.

"The ideal for the industry would be the availability of Douglas-fir that is tolerant to *Phellinus weirii* infection," adds Sturrock. "Given that the fungus has been associated with the species for thousands of years, it is expected that there must be some Douglas-fir families that have developed a tolerance to the disease.

Knowing more about one of the most damaging forest fungi allows forest managers to improve the regeneration of Douglas-fir forests and timber production, and to reduce the costly loss of millions of cubic meters of timber.

Currently, with funding from Forest Renewal B.C., Sturrock has discovered evidence of genetically based tolerance to *Phellinus weirii*. "Now we need to identify the mechanisms of Douglas-fir tolerance to the fungus. In the future we'll need to identify how this information can be incorporated into industrial and provincial breeding programs or to the genetic engineering of Douglas-fir."

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models predict future fire potential in BC forests

In 1998, wildfires in B.C. destroyed over 78,000 hectares of forest and cost over $140 million to fight. While the combination of high temperatures and dry conditions were partly to blame, researchers at the Pacific Forestry Centre believe forest fire potential may have been increased by the impacts of today's forest management practices.

Steve Taylor, a researcher at the Pacific Forestry Centre, has spent the past three years examining the effects of forest management practices such as fire suppression. His research currently involves models designed to forecast the long-term effects of forest management practices on forests, as well as studying the historic rate of change in forest cover and composition.

"There has been substantial changes in forest cover and composition in many southern interior forests in the past 40 years," says Taylor. "Forest in-growth is occurring due to a number of factors including fire suppression, cattle grazing, and selective logging."

Forest in-growth refers to an increase in the numbers of trees in the lower canopy, leading to dense stands. In-growth can result in a reduction of forage production for forest grazing, a reduction in habitat for wildlife species, a decrease in forest health, and an increased risk of catastrophic wildfires.

"Understanding the issue of forest in-growth as a result of fire suppression is vitally important," says Don Gayton, a range ecologist with the B.C. Ministry of Forests in the Nelson Forest Region. "This project is valuable in establishing baseline information that we need, like the loss of wood value from a fire, or the impact of fires on forage production for elk, sheep and deer."

Historically, southern interior ponderosa pine and Douglas-fir forests were maintained by naturally occurring surface fires, which would keep the stands open while maintaining grasslands.

"The risk of a crown fire is much less in open stands, but because of in-growth we've got closed stands with a lower and more continuous canopy, and the crown fire potential is higher," says Taylor. "There's a concern that more severe fires are happening, so we're developing models to quantify and project changes in fire behaviour potential resulting from changes in forest composition and management practices."

The ideas behind the project began in 1992, when Taylor began working with the BC Ministry of Forests on a pilot project called Ecosystem Maintenance Burning Evaluation and Research (EMBER).

"When we were working on EMBER, it became apparent that models were needed to help plan stand treatments and restoration programs," says Taylor.

With funding from Forest Renewal B.C, Taylor began working with the U.S. Forest Service and ESSA Technologies to develop a metric version of their Forest Vegetation Simulator (FVS) Fuel Dynamics and Fire Effects Model (FEDEM), a model used to predict regeneration, growth and natural mortality between fire events. To incorporate specific B.C. data, the metric

Suppressing natural fires in today's forests may be disturbing the natural fire cycle and causing wildfires - which cost over $140 million to fight this year and destroyed over 78,000 hectares of forest.

version was later integrated with the B.C. variant of the FVS growth model (SimProg) developed by the B.C. Ministry of Forests. Once completed, a Windows interface was built to control the model's functions in a user-friendly way.

The project also examined changes in forest composition and fire potential in four study areas in southern interior B.C. By incorporating base maps, air photos, tree list data and historical weather records, Taylor and his team were able to develop techniques to predict fire potential.

By using Taylor's research to determine wildfire behaviour potential, resource managers will be able to put ecosystem restoration and maintenance programs into place, which will decrease the risk to timber supply and other resources.

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Forest managers lighting ground fires for prescribed burning of a stand.

Innovation – in Global Competitiveness

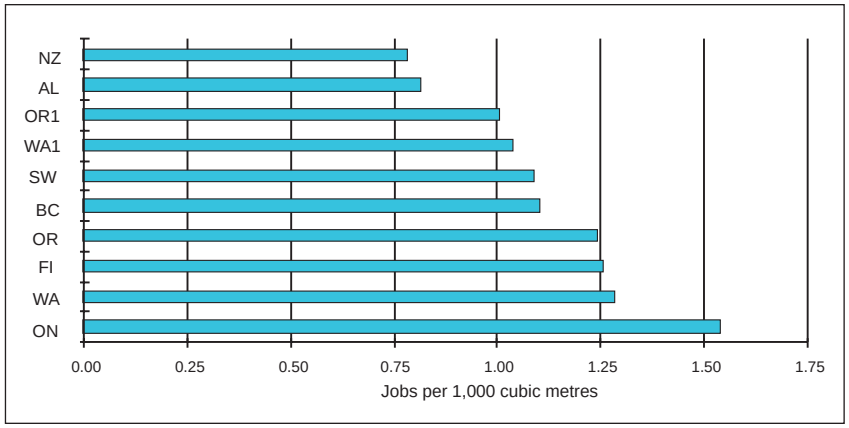
The Industry, Trade and Economics division at the Pacific Forestry Centre identifies economic opportunities for the Canadian forest sector in the Asia Pacific, U.S., and South American regions. The division analyzes the structure and significance, financial performance, competitiveness, and market opportunities of secondary manufacturing in forestry. It also examines forest policies related to land use, timber supply and silviculture practices, and reviews strategic options for the forest sector.

an international comparison of forest sector direct employment

The integration and linkage of global institutions and markets has served to create an international standard for performance and efficiency. This in turn has reinforced the signals which draw capital investment, manufacturing activity and consequently, employment. Many developed economies are experiencing significant labour displacement and underemployment as industry shifts in response to investment opportunities and technological change.

"In response to pronounced and prolonged structural unemployment, many developed economies are examining options to stimulate direct employment through public intervention," explains Dr. Bill Wilson, Director of Industry, Trade and Economics at the Canadian Forest Service, Pacific Forestry Centre in Victoria. "Forestry has a broad history of such policy intervention. In forestry such interventions include enhanced resource access, trade restrictions, capital and factor subsidies, market development aid, funding for research and development, and labour training support."

A comprehensive examination of a selection of forestry jurisdictions was completed in an effort to identify any differences in the level of direct employment in forestry. This information was necessary in order to identify which jurisdictions were relatively more successful in securing higher employment levels in forestry and warranted further work to study the factors and policies which contributed to this improved employment.



Standardized estimates of jobs per thousand cubic meters harvested, adjusted for differences in wage rates, 1993.

BC = British Columbia, AL = Alberta, ON = Ontario, WA = Washington, OR = Oregon, SW = Sweden, FI = Finland, and NZ = New Zealand. OR1 and WA1 are alternative estimates based on the reported volume of timber used in lumber production. Source: Delcourt, G.; Wilson, W. 1998. Forest industry employment: a jurisdictional comparison. Canadian Public Policy. Vol. XXIV.

Employment and harvest levels were developed for B.C., Alberta, Ontario, Washington, Oregon, Sweden, Finland, and New Zealand. Each of these jurisdictions generate significant economic activity, employment and export earnings from forestry.

A coefficient of direct employment per thousand cubic meters of timber harvested was estimated for each of these jurisdictions. In order to develop an accurate comparable estimate, adjustments were made for imported fibre, recycled fibre, intra-state fibre flows, exchange rates, direct employment estimates and differences in salary structures.

"To create a valid comparison of forest sector employment requires a standardized measure for direct employment, adjusting for differences in the definitions of forest sector employment and timber harvest volumes," adds Wilson. "Once we determined the measurement by which we could make an accurate comparison, we found there was very little statistical difference in the amount of employment resulting from an equivalent amount of timber harvest."

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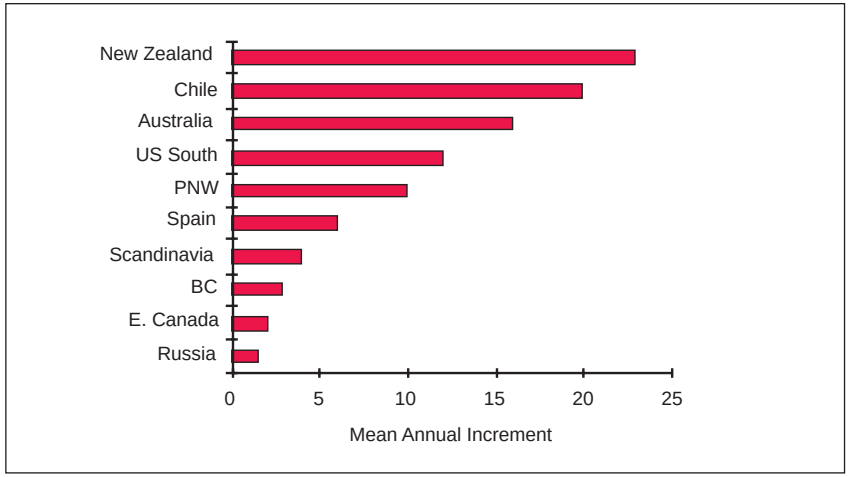
forest policy: international case studies

Forest policy involves a complex balance of governmental, social and industrial objectives in an environment where the forests and the institutions are also constantly changing. Across the various forestry jurisdictions there are a wide variety of policy models that have evolved in response to specific societal demands, institutional structures and forest environments.



A summary of timber growth rates.

Source: Wilson et al., eds., 1998. Forest Policy: International Case Studies (CABI Publishing).

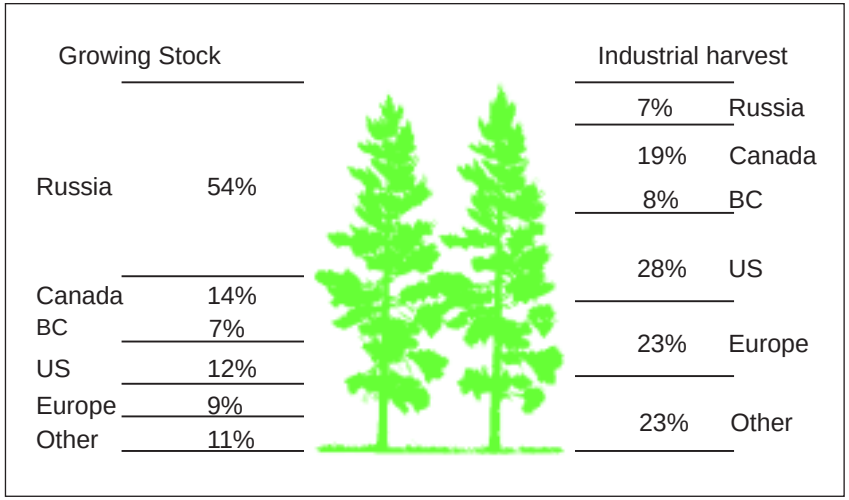
A new book entitled *Forest Policy: International Case Studies* (1998, CABI Publishing, UK) examines forest policy in a selection of major forestry jurisdictions, primarily the major competitors in world softwood markets. These include the British Columbia, Alberta, the US Pacific Northwest and Southeast, New Zealand, Sweden, Finland, Chile and Russia. These regions represent systems operating with natural forests, plantation forests, initial forest endowments, second/third generation forests, public forest land ownership, private forest land ownership, open markets, highly structured markets, and various responses to sustainability.

"For each jurisdiction, a brief overview to the economy, the contribution of forestry, the resource base, the composition of the forest industry and the major stakeholders is provided," says Dr. Bill Wilson, Director of Industry, Trade and Economics at the Pacific Forestry Centre and one of the authors

and editors of the book. “The policy discussions include forest management, timber pricing and export policy, environmental standards, land ownership and use, and the institutional setting relating to government agencies, taxation, labour and capital.”

Comment is provided on the evolution of the existing policy structure and the chapters finish with an evaluation and prognosis for the jurisdiction. The book is intended as a reference source for forest policy practitioners, students of forestry and political economy and industrial decision-makers seeking to position their business in global forestry.

In addition to Dr. Wilson, *Forest Policy: International Case Studies* is edited by Dr. Casey van Kooten, Dr. Ian Vertinsky and Dr. Louise Arthur, all at the University of British Columbia. The book is available from CABI Publishing (Oxford, UK).



World softwood growing stock and harvest.

Source: Wilson, et al., eds., 1998. Forest Policy: International Case Studies (CABI Publishing).

Innovation – in Communication

Of what use is research if no one has access to the results? The Pacific Forestry Centre has developed numerous vehicles of communication.

canadian forest researchers directory

The Canadian Forest Researchers Directory is an information tool linking forestry researchers across Canada and providing the forestry community with the capability to locate and contact them. The directory can be searched by discipline, location, activities, as well as scientific name of species. Maintained by the Pacific Forestry Centre, the Canadian Forest Researchers Directory is open to all Canadian forestry researchers including graduate students. Signing onto the directory is done through an input form available at www.pfc.cfs.nrcan.gc.ca/cfrd/.

forest ecosystem research network of sites

The Forest Ecosystem Research Network of Sites (FERNS) is the framework for a national suite of research sites focused on the development of innovative forest management practices and the understanding of ecosystem processes at the stand level. By providing opportunities for comparative and collaborative research, FERNS fosters partnerships between governments, universities, and industry, and serves as a national communication tool between researchers and with forest managers. FERNS promotes long-term forest management research sites nationally and internationally. More information is available at: www.pfc.cfs.nrcan.gc.ca/practices/ferns.htm

bark beetle decision support systems

Bark beetles are highly damaging insects in mature forests of western Canada. Periodic outbreaks can cause tree mortality on a catastrophic scale, and have major impacts on stand structure and composition, fire hazard, recreation and aesthetic values, as well as management plans. In B.C. the most damaging species are the mountain pine beetle, the spruce beetle, the Douglas-fir beetle, and the western balsam bark beetle. The major host species are lodgepole pine, white and Engelmann spruce, and subalpine fir. The bark beetle decision support systems are composed of several software products that are designed to assist in managing forests where the bark beetle is present. The entire suite of software is available at http://www.pfc.cfs. nrcan.gc.ca/landscape/beetle/mpbdss/current.html#dss or by requesting a 3.5” floppy disk.

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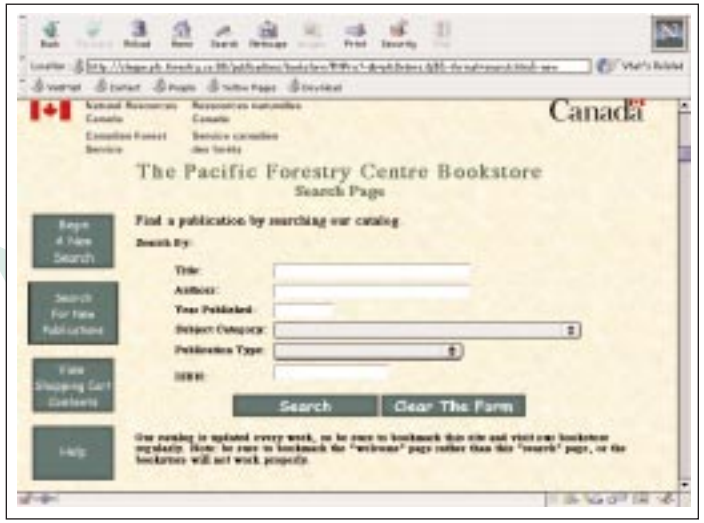
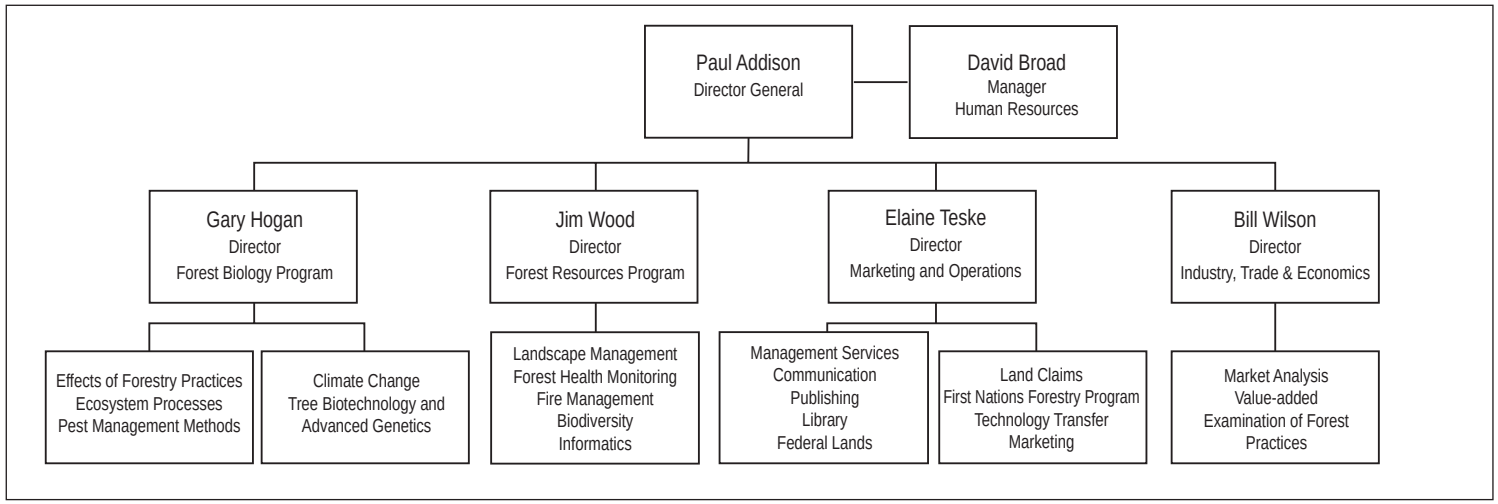


Visitors to our website can download and order publications electronically.

about the pacific forestry centre

Although forest management is the responsibility of each province, science is the foundation of forestry policies across the country. The Pacific Forestry Centre, under the Canadian Forest Service, Natural Resources Canada, employs approximately 135 research and development staff working in four major program areas: Forest Biology; Forest Systems; Marketing and Operations; and Industry, Trade and Economics. Forest research and development activities at the Pacific Forestry Centre are not limited to B.C., but have a national and international scope.

For further information (including requests for publications), please contact the Pacific Forestry Centre at (250) 363-0600, fax (250) 363-0775, or visit our website at: www.pfc.cfs.nrcan.gc.ca



Canadian Forest Service Victoria Organization Chart.

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