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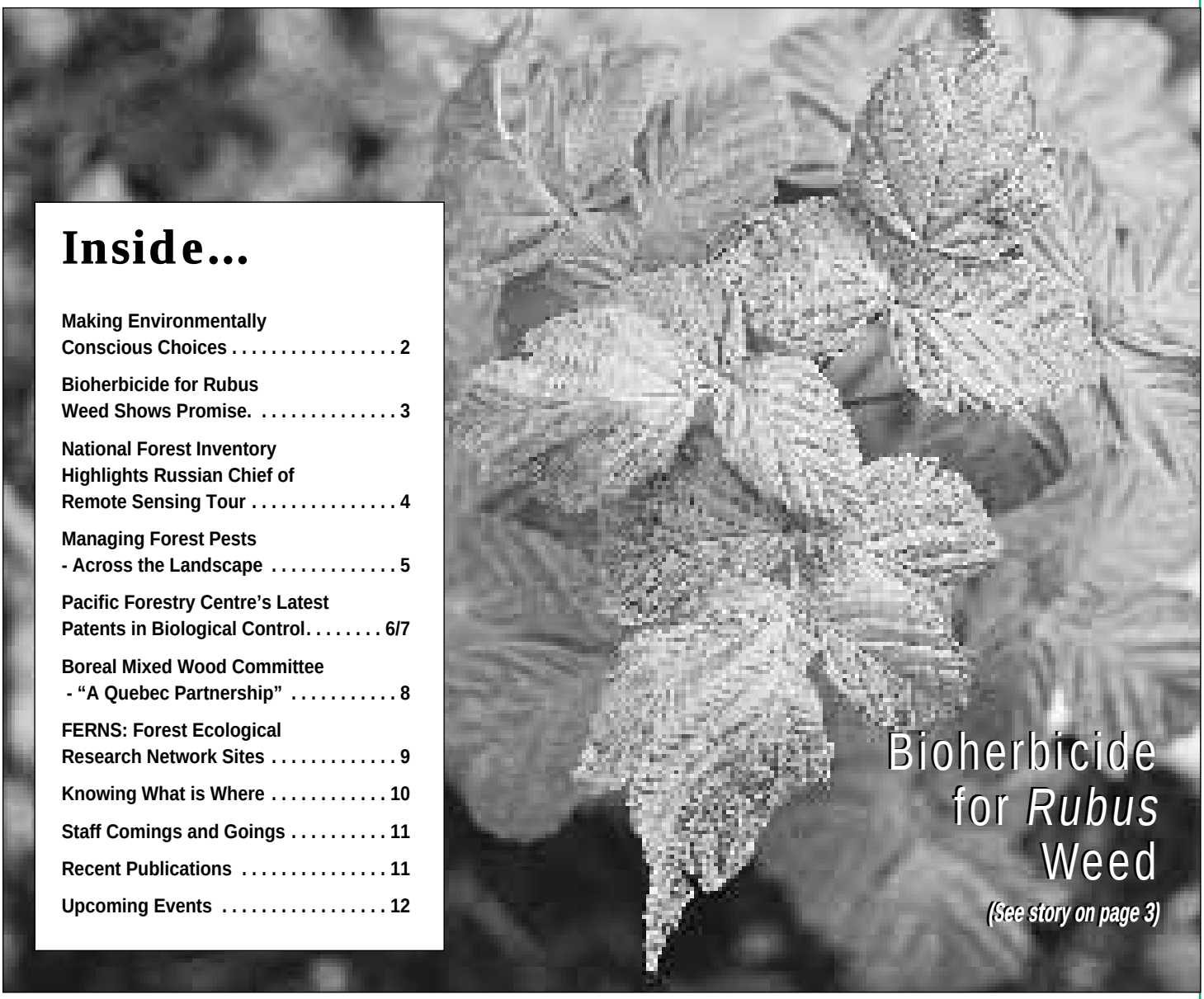
INFORMATION FORESTRY

Pacific Forestry Centre



Inside...

Bioherbicide for *Rubus* Weed

(See story on page 3)

Natural Resources Canada
Canadian Forest Service

Ressources naturelles Canada
Service canadien des forêts

Canada

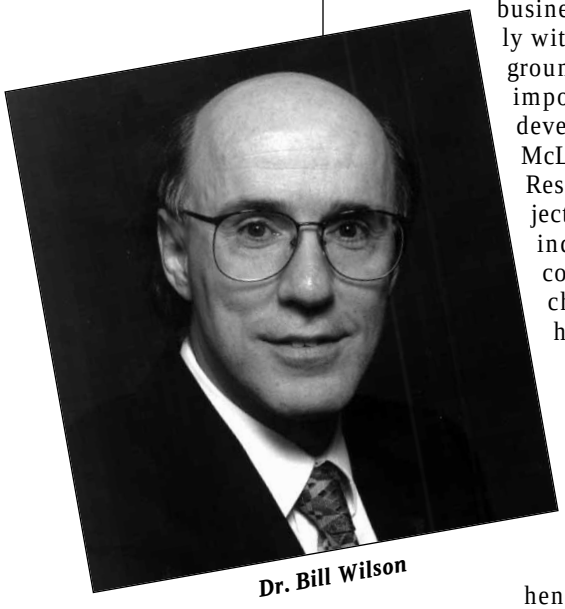
Making Environmentally Conscious Choices

"Athena allows both industry and consumers to make informed choices and contribute to a healthier environment."

The three little pigs may tell you to build with bricks, but you'd be better off consulting the Greek goddess of wisdom, Athena. Or at least the project named after the goddess....

ATHENA™ is a breakthrough in environmental technology, putting Canada among the world leaders in the development and application of life cycle analysis for building materials. It is a computer-based, decision-support tool that demonstrates the environmental consequences of producing, transporting, using and disposing construction materials such as wood, concrete and steel.

"ATHENA™ is an excellent example of government's new way of doing business by working cooperatively with partners in breaking new ground in applied research, an important aspect of sustainable development," said Anne McLellan, Minister of Natural Resources Canada. "(The project) allows both building industry stakeholders and consumers to make informed choices and contribute to a healthier environment."



Dr. Bill Wilson

ATHENA™ is based on life cycle analysis, a widely accepted method for evaluating the environmental impact of a product at each stage of its life cycle. The comprehensive, up-to-date information of ATHENA™ is available to consumers, designers, builders, public policy makers and others wanting to make design and construction decisions with improved environmental legacy.

ATHENA™, is the result of a three-year research program coordinated by Forintek Canada Corp., a national non-profit wood products institute with research facilities in Vancouver, B.C. and Quebec City, Quebec. The project is cost-shared by NRCan primarily through the Canadian Forest Service and the Canada Centre for Mineral and Energy Technology (CANMET), as well as private sector wood, concrete and steel companies.

Wood: an Environment-Friendly Choice

Although not intended to encourage the use of one building product over another, ATHENA™ illustrates the relative environmental advantages of wood construction.

"Looking at the environmental issue from a global perspective, one can see the significance of making environmentally-conscious construction choices," explains Dr. Bill Wilson, Manager of Industry, Trade and Economics at the Pacific Forestry Centre. "Every second, three people are added to the global population with consequent demands on the resource endowment for shelter, food and energy. Products to meet this demand will increasingly be measured against their environmental legacy. It is a choice among alternatives, none of which is optimal.... (although) wood has some very attractive characteristics."

Unlike many other construction materials, wood is reusable, recyclable, and biodegradable. In terms of energy efficiency, wood products are a greater insulator than concrete or steel and require less energy to produce. And wood is the only building material that is derived from a renewable resource.

Forintek Canada, in its research for ATHENA™, discovered that compared to wood, a steel wall produces three times more carbon dioxide emissions, significantly higher emissions of carbon monoxide, sulfur dioxide, nitrous oxides, methane, and particulate and volatile organic compounds. It requires three times more energy than a wood wall, and 25 times more water.

Similarly, aluminum and concrete manufacturing have an environmental legacy. Aluminum production generates eight times more polluting emissions in the air and 300 times more in water than wood product manufacturing. Concrete produces two to three times more carbon dioxide, carbon monoxide and hydrocarbons than timber production, and results in five times the volume of solid waste compared to wood.

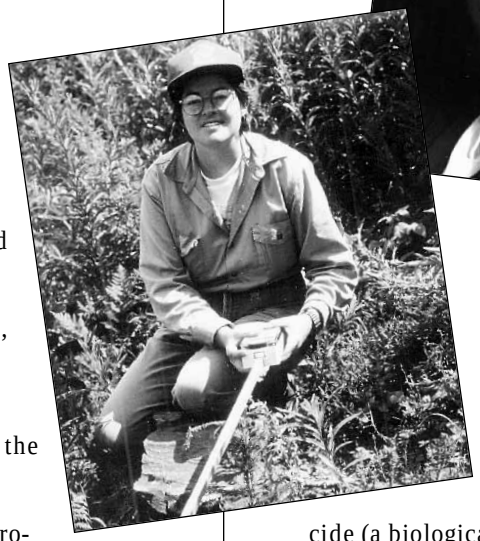
To secure the earth's renewable resources for future generations, the environmental impact of construction products must be considered. Wood conforms to the concept of sustainable development, and is an environmentally-responsible option.

Bioherbicide for *Rubus* Weeds Shows Promise

"Rather than introducing something new into the ecosystem, we're giving the course of nature a bit of a push in the right direction."

Thimbleberries, salmonberries, and wild red raspberries don't quite sound like threatening vegetation, but in a forest renewal site it's a horror movie called "Return of the *Rubus parviflorus, Rubus spectabilis,* and *Rubus strigosus.*" Dr. Simon Shamoun, scientist at the Pacific Forestry Centre and the Canadian Forest Service (CFS) Pest Management Network, is developing a bioherbicide to combat this weed in forest renewal sites.

Rubus plants cause greater conifer mortality than any other brush species and often dominate replanted clearcut and burned forest sites, competing with young seedlings for nutrients, moisture, space and light. Shamoun's breakthrough study is based on the fungus, *Fusarium avenaceum*, a natural enemy of the *Rubus* weed.



Dr. Simon Shamoun (top) and Carmen Oleskevich (left)

"It's a native pathogen of the plant; a naturally-occurring organism," explained Dr. Shamoun. "So rather than introducing something new into the ecosystem, we're just giving the course of nature a bit of a push in the right direction."

An application of a fungus simply increases the proportion of the native pathogen, raising it from naturally low or "endemic" levels to "epidemic" levels among the weeds. Many fungi are host-specific, so they target the weeds and leave surrounding conifer species unharmed, tapering down to its natural, endemic level when the target weed dies. Having less impact on the environment results in lower handling and application costs compared with chemical herbicides, and it is less expensive to commercialize a biological herbicide. The search for non-toxic alternatives to traditional herbicides also stems from public concern over the use of chemicals in our forests.

"We have to come up with alternative methods of weed control — alternatives that are environmentally acceptable, economically feasible and effective," Shamoun said. "Manually removing *Rubus* weeds is time consuming and labour intensive, as it only causes them to resprout more vigorously. However, this fungus is showing a lot of promise as a mycoherbicide (a biological agent made of indigenous fungal plant pathogens)."

Dr. Shamoun has confirmed the identity of the fungus and isolated it on dying red raspberry bushes. It was proven to be an effective bioherbicide in the interior region of British Columbia, taking care of the *Rubus*, without harming conifer seedlings.

Besides the B.C. interior, the weed is evident on the coast. But different ecosystems respond differently to applications. Therefore, Shamoun and his research team are applying *Fusarium avenaceum* fungus to a site on the coastal region and comparing results. "We want to see how the fungus will behave in different ecosystems, on different species of *Rubus*," Shamoun explained. Eventually, the fungus formulation could be applied to other areas, as the need to control the weed is not just a regional, but national concern for forest sites in Canada.

Dr. Shamoun and Carmen Oleskevich, microbial control technician at the Pacific

Continued on page 12

National Forest Inventory Highlights Russian Chief of Remote Sensing Tour

"I find Canada's commitment to sustainable forest management commendable."

Contrary to the image that the word inventory may evoke, Canada's National Forest Inventory (CanFI) is not the result of some poor soul counting every tree, bush and seedling in the country. It is a collection of maps and associated data of the forested parts of Canada. And it was what sparked the interest of a Russian scientist and reform leader.

The Canadian Forest Service Landscape Management Network led by the Pacific Forestry Centre was the B.C. host to Dr. Natalia Malysheva, Chief of the Remote Sensing Methods Department, Federal Forestry Service of Russia. Although Malysheva's tour covered many of the research areas within the Pacific Forestry Centre, the emphasis was on the research in remote sensing and CanFI.

Dr. Natalia Malysheva

"I find Canada's commitment to sustainable forest management commendable and CanFI most interesting," said Dr. Malysheva. "Forest inventory and other database information are the operational basis for landscape management in Russia and it's interesting to compare inventories of both countries."

CanFI is a cross-Canada compilation of provincial and territorial forest inventories, including information such as age, maturity, forest type, volume, area and species. It is used for data and support, reporting of criteria indicators, the National Forest Account and the State of Forests report. It is also used to provide resource information at the landscape level. The Canadian Forest Service updates its forest resources information every five years. The data, which is typically derived from aerial photos with scales of about 1:20,000, is condensed to a cell level - grain-sized map sheets - of about 10 by 10 km. It takes 49,000 sheets to map all of Canada.

"It is currently the best place for forest resource information at the ecozone and ecoregional levels," explained Dr. Steen Magnussen, research scientist and head of the Forest Inventory and Analysis Project. "A national inventory is essential for providing resource information at the landscape level."

Malysheva agreed, "In my country, as in yours, we can understand our forests only by knowing their characteristics, such as dominate tree species, age and density. Forest inventories in Russia are based on air photos that are in the same scale as in Canada, but you use black and white photos and we use infrared. Nor do we use digital cartographic database methods to the extent that you do," she said. "Another difference is that the economic situation in Russia limits the level of sophistication in terms of technical support. But the basic objectives of scientific research are the same."

Besides the Pacific Forestry Centre, Malysheva was escorted by Dean Mills (Marketing and Operations Division) to the B.C. Ministry of Forests, forest and computer companies, and the Long Beach Model Forest on the west coast of Vancouver Island. It was at Long Beach that Malysheva commented on how Russia uses their forest maps for purposes other than forest inventories.

"We use the new technology such as visualizing images, topographical and thematic maps, and special databases to communicate with those in remote communities. We have found that a visual means to communicate is an effective way to talk through cultural and political differences."

Dr. Malysheva's trip was part of a Yeltsin Democracy Fellowship Program between Canada and the Russian Federation to implement democratic reforms through providing short term training for Russian reform leaders. In Canada it is managed by the University of Saskatchewan under the terms of a contract.

Managing Forest Pests - Across the Landscape

"Because forest pests don't recognize borders, there is a need for decision-making tools to be shared with forest managers across the country."

Every year, about 80 to 100 million cubic meters of timber in Canada are lost to insects or diseases - that's equal to roughly half the annual harvest and is four times greater than timber lost in wildfires.

To predict outbreaks and their effect on the forest, pest managers are looking to Decision Support Systems (DSS), computer-based models and interpretation systems linked to a Geographic Information System (GIS). These systems help the user predict "alternative futures," such as the effects of pest outbreaks on forest structure, wood production or wildlife habitat.

"Essentially, a DSS is a 'what if' tool that explores the effects of different management regimes if they are carried out," says Dr. Dave MacLean, research scientist with the Canadian Forest Service in Fredericton. MacLean is the principal developer of the Spruce Budworm DSS, a system that helps forest managers predict the effects of budworm outbreak and create scenarios of insecticide use or management effects on the forest inventory at user-specified times in the future. A stand-level growth and yield model predicts responses to defoliation patterns and a timber supply model and inventory projection system helps managers apply their results to actual stands.

Computerized decision support systems are being developed to assist forest managers in reducing damage from pests such as the spruce budworm.

"A pest-oriented decision support system can help forest management planning in many ways from growth and yield forecasting, to timber supply analysis," explains MacLean. "Or for sustainable harvest calculations, harvest scheduling, and forest inventories."

The models help managers evaluate alternatives to stop the budworm's onslaught such as different silviculture approaches or the use of biological insecticides. Forest planners can then use these models to adapt long-term forest management plans and reduce the severity of future outbreaks.

MacLean is also the coordinator of a national DSS research group which started in 1992 under the Green Plan. The group's five-year goal is to integrate models and systems to better manage four of Canada's worst pests: the spruce budworm, jack pine budworm, hemlock looper and the mountain pine beetle.

Because forest pests don't recognize borders, there is a need for these decision-making tools to be shared with forest managers across the country. The four DSS development projects are led by CFS scientists across Canada and rely on cooperators in provincial government agencies, the forest industry and academia. The research falls under the Landscape Management Network in the new CFS research network framework, which will help ensure that DSS technology reaches an audience across the country.

Dr. Rene Alfaro, research scientist with the Pacific Forestry Centre, is heading up a project on the spruce weevil, with the participation of the University of British Columbia, Simon Fraser University and the University of Northern B.C. This weevil is a significant pest in the McGregor Model Forest. Dr. Alfaro and his team of researchers are looking into the history of the weevil in the forest and the various forest management methods that have been used in the past. They have determined that the spruce weevil has been a natural part of the ecology of the McGregor Model Forest. This information will help them model natural changes in the landscape, predict the effects of logging and fire, and determine whether the weevils change the course of natural succession. Using this data, researchers are developing a DSS to predict stand growth and timber output for areas of the McGregor Model Forest. In the final stage of the project, they will provide the models to the McGregor Model Forest's decision support framework.

"Insects change forest ecosystems in unknown ways," says Alfaro. "We're trying to quantify how these changes determine the outcome of various forest management regimes." By learning more about forest ecology and using DSS technology for timber management, planners may finally have the ultimate appetite suppressant for Canada's forest pests.

Pacific Forestry Centre's Latest

"Bioherbicides are being developed as ecologically-acceptable alternatives to chemical herbicides."

The Canadian Forest Service (CFS) plays a leading role in Canada and abroad in forest science and technology development. Technology transfer and commercialization are an integral part of the CFS mandate, as is developing partnerships with the provinces, the private sector and universities.

In keeping with this mandate, researchers at the Pacific Forestry Centre have established numerous patents covering a wide range of technological innovation. Some of the most recent patents are based on extensive years of research in the area of biological control.

Whether it's a forest renewal site, an agricultural field or your front lawn, weeds compete with preferred vegetation. In the forest or nursery, weeds can greatly reduce the amount and quality of, for example, pine, spruce and fir yields. Crop losses in British Columbia due to weeds and their associated control is estimated to cost more than fifty million Canadian dollars annually. Traditionally, synthetic chemical herbicides have been used to control weeds, but their use is now barred or restricted in many areas of Canada, the U.S. and Europe.

Bioherbicides are being developed as ecologically-acceptable alternatives to chemical herbicides and are becoming a preferred method of controlling undesired vegetation. An effective bioherbicide causes disease and death in the target weed without adversely affecting the growth of crop plants.

The following patents describe three of the bioherbicides developed at the Pacific Forestry Centre. Further information on these technologies is available on the Canadian Forest Service World Wide Web site: http://www.NRCan.gc.ca/cfs/flic/forlic-e.htm

Microbiological Control of Hardwood Vegetation

Dr. Charles Dorworth, microbiologist at the Pacific Forestry Centre, has developed a biological control strategy, a microbiological control agent and an application device for the management of intrusive hardwood plants. It is the result of ten years of biological control research in hardwood vegetation management.

PFC-MYCOCHARGE™ (U.S. patent 5,340,578; Canadian patent pending) is a tested production strategy of inserting dowels containing PFC-ALDERKILL™, a highly virulent, selective biocontrol fungus. It is an isolate of the indigenous forest tree pathogen, *Nectria ditissima*. PFC-ALDERWAK™ is a durable, hand-operated tool used to perforate a tree stem (or other solid) and insert multiple large-mass inoculations/injections of PFC-ALDERKILL™ under industrial (field) forestry conditions. It can be adapted for application of other encapsulated or tablet-form biological agents other than ALDERKILL™, which is specific to red alder.

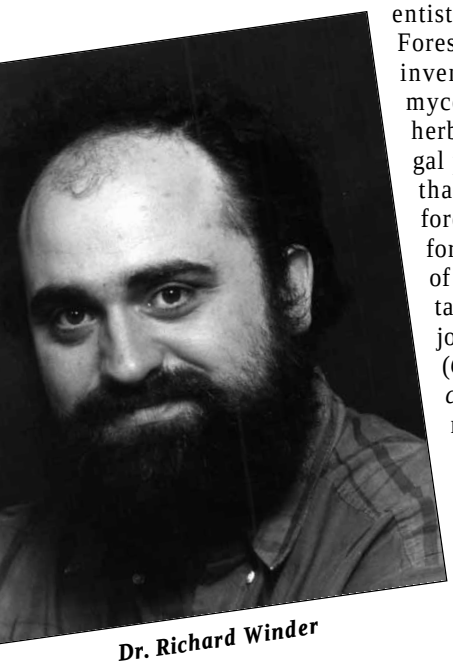
"The inoculation strategy includes inserting living biological control micro-organisms into woody stems in a solid substratum to retard or stimulate growth," Dr. Dorworth explained. "It can also be used to introduce chemicals into trees for the purpose of insect control, or the discouragement of ruminants. As well, it might introduce flavours into orchard trees or colouring materials into furniture wood trees."

The PFC-MYCOCHARGE™ system is a simple, effective strategy that provides forest managers with a biological alternative to chemical herbicides.

Dr. Charles Dorworth

Patents in Biological Control

A Mycoherbicide and Method for Controlling Reed Grass



Dr. Richard Winder

Dr. Richard Winder, scientist at the Pacific Forestry Centre, has invented an effective mycoherbicide (a bioherbicide made of fungal plant pathogens that are native to the forest) and a method for biological control of undesirable vegetation such as bluejoint or reed grass (*Calamagrostis canadensis*) and related grasses (U.S. patent 5,472,690 Canadian patent pending).

"Bluejoint is very hardy, thriving in a wide variety of habitats, and competing very strongly with young tree seedlings for nutrients, water and light," Dr. Winder said. "Dense litter from the weed can cause snow-press and smothering problems, and can delay spring soil thaw. The litter also halts natural regeneration by preventing seeds from reaching the ground before desiccation. And weed litter can provide a safe haven for seedling-eating mammals such as rabbits." All of these factors seriously impair reforestation efforts and timber production.

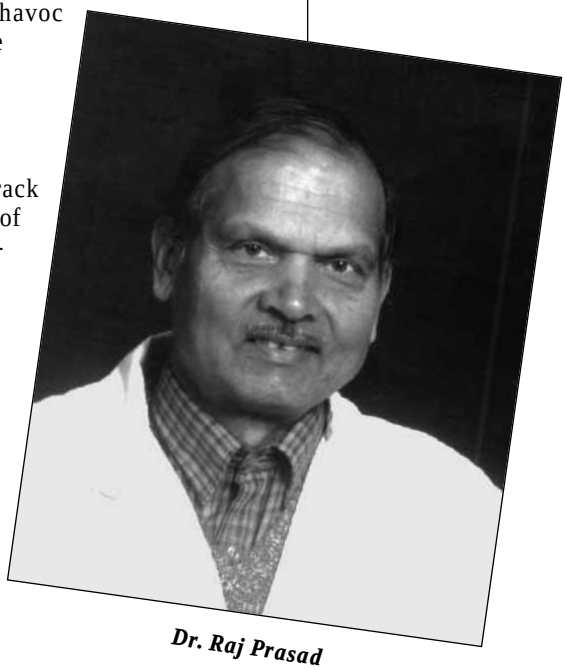
Non-chemical methods of weed control such as grazing by sheep, burning, mowing, mounding, trenching and mulching are not viable or practical for reforestation sites. For example, fire can actually rejuvenate reedgrass, leading to large increases in biomass and seed production, and deep burning can have devastating environmental effects. Dr. Winder's invention provides an alternative method that is more effective than other "natural" methods and more environmentally acceptable than synthetic herbicides.

Biological Control of Common Weed Trees

Dr. Raj Prasad, research scientist at the Pacific Forestry Centre (PFC) collaborated with Dr. Ron Wall (former PFC scientist) and Elaine Sela (former PFC technician) in inventing a bioherbicide formulation, a method of producing it, and a method of applying it to weed trees (U.S. patent 08-4113444 pending, Canadian patent pending). The novel formulation is of the native fungus, *Chondrostereum purpeum*, which is normally found in Canadian forests and fruit orchards. The bioherbicide controls some common forest weed trees that interfere with the productivity of forest crops, such as Douglas fir trees.

"Because the product is safe, environment-friendly and relatively inexpensive," explains Dr. Prasad, "it is a viable alternative to synthetic chemical control. Utility companies whose lines pass through urban areas are anxious to use it instead of chemical herbicides to retard the growth of trees that interfere with transmission lines."

Besides creating havoc above the ground, the roots of trees such as poplar, aspen, alder, maple and birch can block sewer and drainage lines, and crack the foundation walls of houses. The bioherbicide fungus can be used to remedy these situations as well.



Dr. Raj Prasad

The bioherbicide will be commercialized by Mycologic Incorporated, University of Victoria, and the primary users will be B.C. Hydro and Right-of-Ways utilities company, as well as forest companies.

Boreal Mixedwood Committee - "A Quebec Partnership"

"By setting up partnership projects, the Working Group will be able to involve users from the outset."

It's a story with all of the exciting elements - competition, invasion, undesirable species and survival of the fittest. While it may read like the plot of a popular daytime soap opera, this tale actually describes the cycle that occurs in Quebec's mixed forest.

In the past, the mixed forest in Quebec - which includes balsam fir-yellow birch stands and balsam fir-white birch stands - was harvested, mainly by clear-cutting. However, clear-cutting alters forest composition in favour of pioneer (new) species and balsam fir and causes drastic changes in microclimatic conditions. Other species such as mountain maple and raspberry scrub begin to invade cutovers, hampering the second growth of the forest. To help restore the mixed stands, forest managers have used site preparation, planting and application of phytocides (chemicals that are toxic to plants).

Recently, management standards in the mixed forest in Quebec have been re-examined. "In reality, not much is known about mixed stands," explains Dr. Denis Ouellet of the CFS in Quebec. So researchers have set out to better understand the boreal mixedwood forest, how to manage sites properly, and how to overcome the problem of species competition control without the use of phytocides.

The Mixed Forest Working Group was set up in 1994 to promote partnerships in applied research directed at mixed forest management. Its second mandate is to coordinate research and experimentation related to these ecosystems.

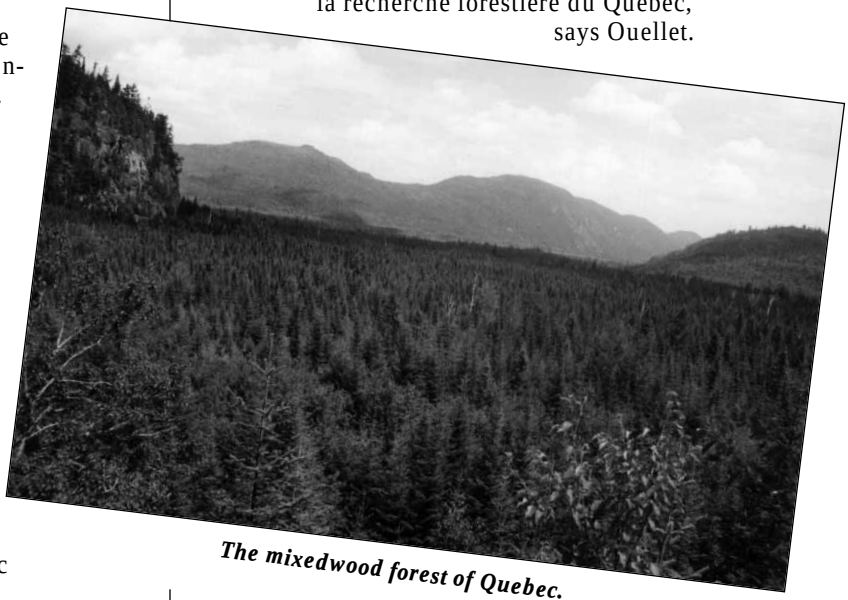
This provincial committee is made up of representatives from the main players in forest research in Quebec - the Canadian Forest Service, the Forest Research Directorate of the Quebec Department of Natural Resources, the Faculty of Forestry and Geomatics at Laval University, UQAM's Forest Ecology Research Group, and the Forest Engineering Research Institute of Canada. The committee also includes a representative from the six regions of Quebec involved in the project.

Specific efforts of the group focus on identifying silvicultural treatments that help maintain a mixed forest composition (as opposed to a single species), and acquiring knowledge and developing tools to manage these ecosystems.

"In the past, reports have been produced by committees, but the information was not passed effectively between the researchers and the users," says Ouellet, who is also Group Chair of the committee. "The Working Group will develop the necessary links between researchers and users."

The results of their work will be shared through the Canadian Forest Service's Effects of Forest Practices Network. This network was established to ensure that scientifically sound forest management techniques, and methods of sharing the information, are developed.

By setting up partnership projects, the Working Group will be able to involve users from the outset in identifying research needs and coordinating efforts as well as human and financial resources. The Working Group is now a Thematic Committee of the "Conseil de la recherche forestière du Québéc," says Ouellet.



The mixedwood forest of Quebec.

They will draw on the expertise of the various organizations involved for more efficient, cost-effective research on mixed forests.

FERNS - Forest Ecological Research Network Sites

"This study will provide the biological and ecological foundation for a more holistic approach to forest management."

Deep in the Black Sturgeon Forest, about 120 km northeast of Thunder Bay, Ontario, smoke drifts from a fresh burn. Scientists have just concluded prescribed fires on clear-cuts as well as in standing timber to compare the ecological effects of harvesting and wildfire on similar sites.

The prescribed fires are one of three integrated components that are helping scientists gain a better understanding of the ecology of the second-growth boreal mixedwood forest and its response to natural and human disturbances.

The Black Sturgeon Boreal Mixedwood Research Project was initiated in 1993 to conduct long-term studies that focus on the ecological values of the mixedwood forest. The main component of the project compares alternative shelterwood and patch cut harvesting methods with clearcutting. The study focuses on a variety of site impacts, including vegetation, soil, trees, and wildlife relationships. The third component, site preparation, looks at the ecological impacts of soil mixing, as well as conventional screefing and herbicide applications following clearcutting.

Ingrid Hedin, researcher at FERIC with Wolverine 3-wheel buncher

"In the past, our ability to apply integrated resource management has been constrained by our relatively poor knowledge of boreal mixedwood ecosystems," explains Project Leader John Scarratt, a research scientist with the Canadian Forest Service in Sault Ste. Marie. "This study will help scientists better understand how individual ecosystem elements respond to disturbance and provide the biological and ecological foundation for a more holistic approach to forest management."

The Black Sturgeon Project is one of a number of research sites located in forested ecozones across Canada that have significant industrial forestry activity. As part of the Effects of Forest Practices Network led by the Pacific Forestry Centre, these Forest Ecological Research Network Sites (FERNS) will ensure that Canada is developing sound forest management techniques and methods of communicating them.

The Black Sturgeon Boreal Mixedwood Research Project is a partnership between the Canadian Forest service, the Ontario Ministry of Natural Resources, and the Forest Engineering Research Institute of Canada (FERIC). It is funded through the Northern Ontario Development Agreement, the federal Green Plan and the provincial Sustainable Development Initiative. Industrial partners include Avenor Inc. and Sturgeon Timber Ltd. This group effort has enabled project managers to raise the profile of the site through technology transfer and by sharing its findings with both partners and the public.

Another FERN site is the Silviculture and Mountain Bark Beetle Proofing Experimental Site in the Rocky Mountains of British Columbia. According to Roger Whitehead, research silviculturist at the Pacific Forestry Centre, lodgepole pine is the leading species on 13 million hectares of land in western Canada - more than twice the forested area of New Brunswick. These forests supply the timber industry with more than a quarter of the annual timber harvest in B.C.

Most of these pine forests however, are dense re-growth that followed wildfires near the turn of the century. Now, more than 50 years of effective fire suppression have left large expanses of dense unmanaged stands which, as they age, are increasingly at risk to mountain pine bark beetle - the most destructive pest of mature pine in North America. Epidemic outbreaks kill trees on large areas which are then usually clearcut to salvage valuable timber, reduce fire hazard, and prevent spread of the outbreak to adjacent stands. "Beetles can drastically change the harvest

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Knowing What is Where

"To find the answer to specific questions requires a sense of the biological big picture."

As a forest manager, being able to account for "what is where" in Ontario's forests is like being asked to find needles in a haystack. A really big haystack. But in order to make smart decisions about harvesting trees, scientists and forest planners need to know what's out there, and what effect change will have on variables such as wildlife and landscapes.

So Dan McKenney, an environmental economist with the Canadian Forest Service (CFS) in Sault Ste. Marie and Australian ecologist Brendan Mackey, have been working on some innovative answers. As a collaborative effort between the CFS, the Ontario Ministry of Natural Resources and the Australian National University, the goal of the Bio-environmental Indices Project (BIP) is to look for ways to examine trade-offs between wood production and conserving biodiversity.

"Too often, people think decisions in forest management are all-or-nothing choices, but they're not," says McKenney. "We're trying to understand the potential of the land to produce different types of products and values, so we can better understand the trade-offs involved in the decisions we make."

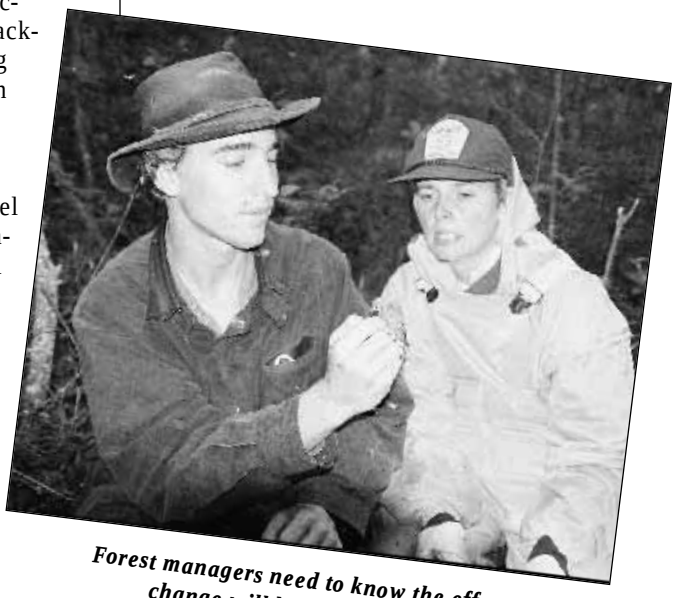
To find the answer to a specific question, such as "Is this old-growth forest unique?" requires a sense of the biological big picture, so to speak. So McKenney and Mackey started by developing and compiling province-wide databases of information on topography, climate, soil, trees and wildlife.

Next, they moved to landscape level modelling - using a geographic information system (GIS) to integrate statistical analysis and the environmental data to develop a sense of the big picture. The results become new data that can be used in a series of computer programs that allow scientists and forest planners to make predictions about what they will find in any given area.

"To know how important a particular stand is to a rare animal, we have to know if there are places that support those conditions," explains McKenney. "If there is a conflict with the wood supply, are there other places that can be harvested? How much will it cost?" By knowing exactly "what is where," whether they are timber values or the less tangible values associated with biodiversity, decision-makers will be in a better position to choose what to protect, where to harvest, and what to restore.

The final stage of the project involves the development of customized PC software programs for specific problems. One such project, SEEDWARE, is a decision support tool used to predict where the best places to plant the eight-to-13-billion seeds that are in storage in Ontario. Using climate data and studies by Denis Joyce, the provincial genecologist, they can determine how far the seeds can be moved without risk from the area they're genetically adapted to.

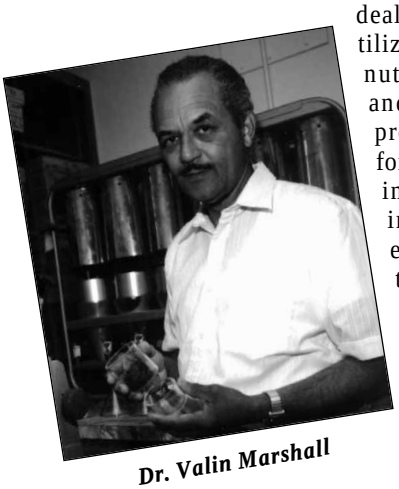
McKenney also hopes to extend BIP across the country in a concept called Natgrid. He points out that they'd like to use the strength of the Landscape Management Network at the CFS to develop partnerships with people across the country. They've already begun by building a National Digital Elevation model and have several other projects underway. And while forest managers across the country will certainly benefit from their work, it seems that for the people involved with the Bio-environmental Indices Project, the haystack just keeps getting bigger.



Forest managers need to know the effect change will have on wildlife.

Staff Comings and Goings

Dr. Valin G. Marshall retired as senior scientist of the Canadian Forest Service on 31 April 1996. While at the Pacific Forestry Centre, Dr. Marshall participated in projects dealing with fertilization and nutrient cycling and was the project leader for research into the impact of environmental changes on biological diversity of forest ecosystems. Recognized internationally for work in soil fauna, Dr. Marshall is one of the few Canadian soil zoologists. His background in acarology, entomology, and soil chemistry led him to research in forest fertilization, environmental protection, and the effects of silvicultural practices on forest ecosystems. Dr. Marshall has published numerous scientific papers, and has had soil animal species named in his honour in Acari, Pauropoda, and Protura.



Dr. Valin Marshall

Forestry Development Officer C**athy McClary** departed the Canadian Forest Service on April 31, 1996. Cathy was responsible for administering the Private Woodlands Program in the northern interior of B.C. under the FRDA II Small-Scale Forestry Program. She assisted private forest land owners in the Prince George, Prince Rupert and Cariboo Forest Regions.

Cathy McClary

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Forest Pest Leaflet 69
by R.W. Duncan

The sequoia pitch moth and the northern pitch moth are described in this Forest Pest Leaflet, explaining hosts and distribution, life history and habits, damage and detection, and control. Includes detailed photos.

The State of Canada's Forests 1995-1996
Sustaining Forests at Home and Abroad

The sixth report on the state of Canada's forests highlights the evolution of the global dialogue on forests and the challenges facing Canadian forest industries in the international market.

Exploring Multiple Use & Ecosystem Management: From Policy to Operational Practice
Proceedings of the FAO-ECE-ILO Joint Committee's International Forestry Seminar in Prince George, B.C., September 9-15, 1995
compiled by K.M. McClain and C.P. McClary

Official report and proceedings of the FAO/ECE/ILO Joint Committee's International Forestry Seminar co-hosted by the Canadian Forest Service and the B.C. Ministry of Forests. The seminar of 200 participants from 32 countries concluded that an international non-binding set of guidelines be prepared to serve as a framework for setting forestry standards. The seminar resulted in a preliminary list of areas the guidelines might cover.

Stand density management diagrams for lodgepole pine, white spruce and interior Douglas-fir
BC-X-360
by Craig Farnden

Stand density management diagrams are graphical representations of stand development, illustrating temporal interactions between stand density or other measures of stocking and various stand parameters such as mean, diameter, top height, and volume. The stand density management diagrams in this report were derived from managed stand yield tables produced by TASS, an individual tree, distance-dependent growth model. The report will assist users in making informed decisions regarding stand level crop planning.

Upcoming Events

Sustaining Ecosystems and People in Temperate and Boreal Forests

An International Conference on Integrating Conservation of Biological Diversity with Social and Economic Goals

September 8 - 13, 1996
Victoria, British Columbia, Canada

This conference will explore practical ways of integrating biological diversity with economic and social systems. Uniting people from a broad range of forestry interests and expertise, the conference will emphasize constructive long-term solutions to ensure biological diversity and the human communities they support.

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Forestry Centre, are also studying the toxins produced by this fungus, especially one called moniliformin, in an attempt to refine the current formulations of *Fusarium* as a bioherbicide and enhance its performance. Their preliminary field work showed that a mixture of moniliformin and a small amount of the standard chemical herbicide had positive results out in the field. The mixture killed the competing weeds, and left the conifer seedlings untouched.

"We may not be replacing the chemicals just yet, but we are significantly reducing them," Shamoun said. Combining fungal and chemical weedkillers reduces the use of chemical herbicides while the CFS searches for an alternative to chemicals altogether.

Shamoun's work has become a focus of the CFS Pest Management Methods Network. His research is currently funded in part by the Canada-B.C. Partnership Agreement on Forest Resource Development (FRDA II). Support was also received from the federal Biological Control of Competing Vegetation Research Network (BICOVER) and the Ontario Vegetation Management Alternatives Program (VMAP), and he hopes to receive support through Forest Renewal B.C., in collaboration with Simon Fraser University, MacMillan Bloedel, the B.C. Ministry of Forests, and The Pas Lumber Company.

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schedule for an area and put large clearcuts where they're not wanted, making integrated management of all forest values very difficult," explains Whitehead.

The study is looking for alternatives to past "band-aid" solutions by attacking the causes of the problem. Interest is in tree susceptibility to attack, rather than the symptom of too many beetles. Thinning to leave the best trees and fertilizing 80 to 100 year old stands may decrease the beetle hazard by promoting individual tree vigour or by altering within-stand climate to conditions less favourable to beetles. Researchers are also examining the cost of obtaining usable timber volume from these late thinnings, growth response of the stand after thinning, and establishment of mixed species (such as fir, spruce and larch) under the remaining trees for the next forest in a modified shelterwood silvicultural system.

The hope is that these treatments will allow older pine stands to be carried to their planned harvest dates without beetle attack, allowing forest cover on a landscape level to be managed in a way that sustains values such as wildlife habitat, recreation, tourism and range, as well as diversifying options for timber management.

"Conducting these experiments in cooperation with our partners in industry and the provincial government created really useful demonstration sites where resource managers can see how the treatments fit," notes Whitehead. "There have been many on-site discussions and we're already seeing some of the results in routine operations."

The Silviculture and Mountain Bark Beetle Proofing Experimental Site was initiated in 1991 by CFS Victoria and the Forest Engineering Research Institute of Canada in partnership with the operations staff of Crestbrook Forest Industries, Galloway Lumber Company and the B.C. Ministry of Forests.