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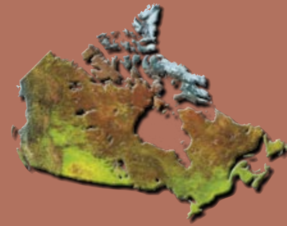
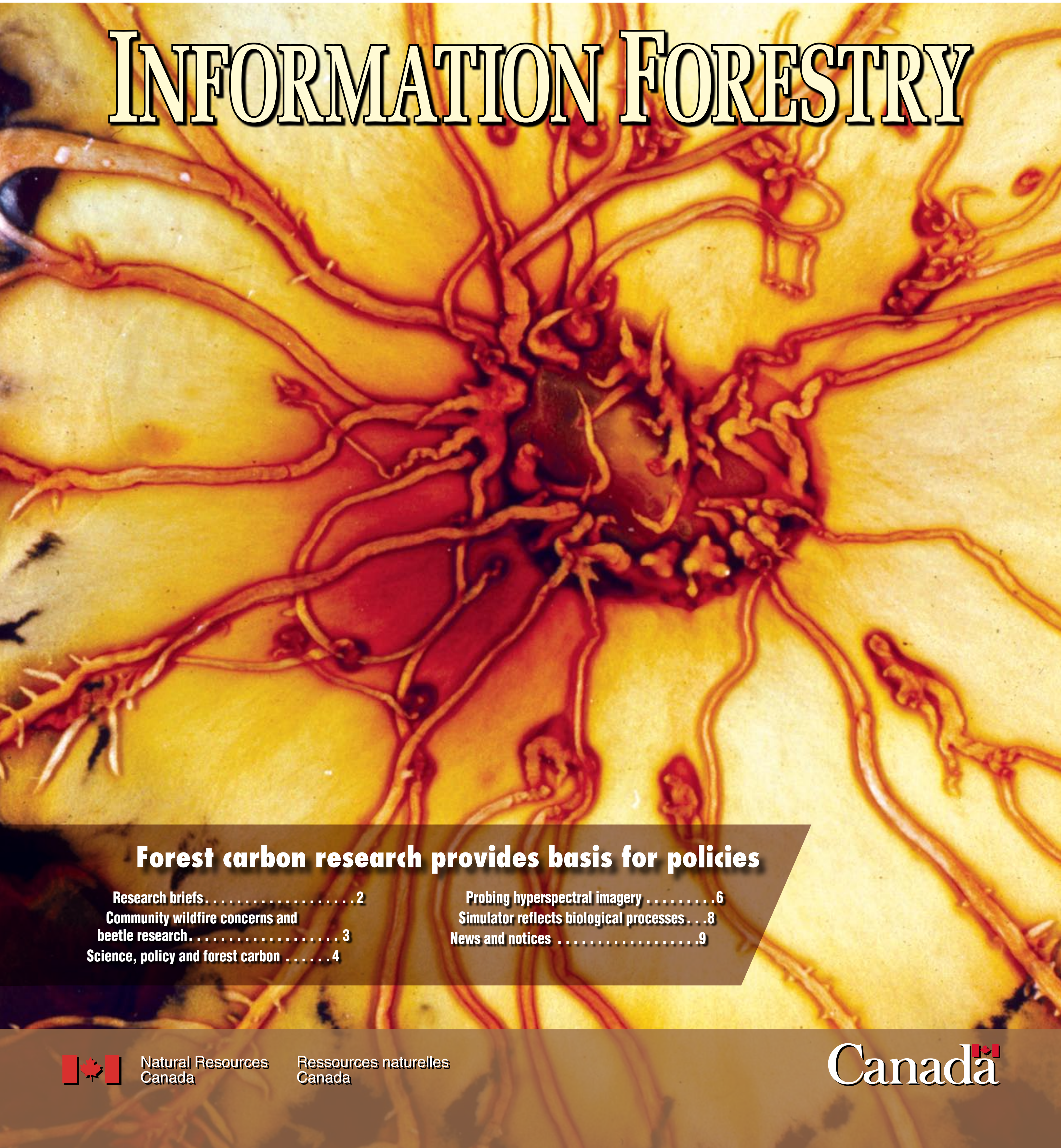


INFORMATION FORESTRY



Forest carbon research provides basis for policies

Natural Resources Canada
Ressources naturelles Canada

Canada

Satellite data reveals snow cover trends over 24 years

Snow cover patterns in western and northern Canada are changing. Distribution of snow cover is increasingly concentrated, and snow cover conditions present in recent years differ from those found just 20 years ago.

Scientists from Natural Resources Canada, the University of Victoria, and the Meteorological Service of Environment Canada analyzed space-borne microwave data collected from 1978 to 2002 for Canada's non-mountainous interior—the prairies, parkland, western boreal forest and plains, taiga and tundra.

"The information tells us where the snow is and where it isn't, across the landscape and across time," says Canadian Forest Service Research Scientist Mike Wulder, the study's leader. "The snow conditions relate back to hydrology, habitat, biodiversity, drought, fire risk, and other values in these ecozones, including forests, throughout the year."

Passive microwave satellites measure ground temperature. As snow depth and density increase in an area, the amount of microwave energy, or heat, scattered also increases and is picked up by the sensors. Wulder **(mwulder@pfc.cfs.nrcan.gc.ca)** and colleagues used these data to derive and analyze values for amount of snow cover for the 24-year period.

According to their results, mean cumulative differences in snow cover were lower in forested regions than in open environments, and variation in cumulative snow cover became both more extreme and spatially clustered with time, with greater variability occurring in the prairies and north. In some years, more snow accumulated in the forested boreal plains than in other ecozones, but these large-magnitude events were inconsistent with overall, multi-year snow cover trends in the boreal forest during that period.

The researchers undertook the study to increase their understanding of passive microwave sensor snow cover measurements and how they vary between ecosystems, with this information guiding analysis of images collected over the summer. That, says Wulder, will help improve algorithms and models that characterize vegetation conditions and change in Canada's forests.

Photo: © Laura Wiberg, iStock (1209524)

Researchers analyzed space-borne microwave data to determine changes in snow cover conditions over the past 20 years in Canada's non-mountainous interior—including the prairies.

Researchers examine effects of beetle control on budworm

Does thinning mixed pine stands for mountain pine beetle worsen British Columbia's western spruce budworm outbreak?

"We're trying to determine whether management prescriptions undertaken to mitigate one pest problem might be exacerbating or reducing another pest problem," says Natural Resources Canada Insect Ecologist Vince Nealis, leader of a study examining that for the Canadian Forest Service and British Columbia Ministry of Forests and Range.

With mountain pine beetle affecting more than nine million hectares of British Columbia forest, the province is removing susceptible pine from the landscape to increase value recovery from at-risk pine. In many cases, they are leaving Douglas-fir that may be infested by western spruce budworm, an insect that for almost 30 years has caused detectable damage over greater areas of the province than has mountain pine beetle.

"We have a major budworm outbreak in the interior right now." says Nealis **(vnealis@nrcan-rncan.gc.ca)**. "And although spruce budworm doesn't cause spectacular tree mortality across a landscape the way beetle does, it does significantly reduce tree growth and productivity."

Western spruce budworm larvae feed on buds and needles of Douglas-fir, a valuable timber species in the province.

The researchers sampled branches from thinned and control stands in 2006 to measure budworm populations and defoliation rates and estimate effects of partial clearing on budworm populations.

"We want to know more than just the bottom line about damage," says Nealis. "We're also trying to determine why the patterns of damage occur: Do budworm moths lay more eggs in the cleared stands, but losses are greater? Or, do the moths lay fewer eggs, but survival is better?"

Final results from the two-year study will be available in 2008.

Community fire concerns give new life to study

A research trial near Cranbrook, British Columbia, originally designed to determine effectiveness of pine forest management in reducing mountain pine beetle damage, is providing information on how to reduce risk in the community–forest interface across Canada. The Regional District of East Kootenay, in partnership with the Canadian Forest Service, received a pilot project grant from the Communities at Risk for Wildfire Program administered by the Union of British Columbia Municipalities.

The project extends from an existing study. "When we set this experiment up initially, we weren't thinking about fire behaviour at all" says project leader and Canadian Forest Service Research Silviculturist Roger Whitehead.

A research team from Natural Resources Canada and the Forest Engineering Research Institute of Canada (FERIC) initiated a study 15 years ago in response to local industry questions about beetle proofing—the thinning of mature pine stands to reduce infestation by mountain pine beetle. The study found that commercially thinning mature pine stands to wide inter-tree spacing can cost-effectively reduce susceptibility to mountain pine beetle while harvesting some fibre immediately and improving stand growth and tree quality for the future.

Beetle proofing can be useful in areas with a lot of susceptible pine and where preservation of some mature forest cover is important. For instance, stand thinning might be appropriate to protect recreation values, riparian-zone integrity or scenic views. Amount and distribution of surrounding susceptible forest stands are adjusted through stand replacement; consistent monitoring and aggressive direct control of beetle hot spots in surrounding areas are also required.

By building upon existing research, East Kootenay communities are getting answers at a fraction of the cost of an independent study, prompting Regional District of East Kootenay Emergency Services Coordinator Gundula Brigl to say, "This is a win–win situation. By forming a partnership with the Canadian Forest Service, the regional district will benefit from the latest research, with wide potential application in future operational projects, while the Canadian Forest Service gains access to funding."

Ultimately, Whitehead **(rwhitehead@pfc.cfs.nrcan.gc.ca)** says that "the community allows us to test some assumptions from earlier work" and, in return, "the product we give communities is an assessment of how their risk to fire may be reduced by thinning."

What interests fire behaviour researchers about the data is the extensive monitoring of dynamics between fuel and weather conditions when the microclimate is altered by thinning. The existing study represents a comprehensive and complete record for these variables in pine forests. When fire behaviour researchers reviewed it, they noted that these same observations would be invaluable in modeling fire behaviour.

Now the question has arisen—could thinning prescriptions designed for beetle control also reduce the threat of wildfires in interface areas?

Although early indicators are favourable, the new trial examines whether the weather–fuel relationship is valid in thinned stands. The test site is demonstrating to communities how government, industry, and research are providing more ecologically responsible alternatives to clearcutting, the traditional prescription for interface threats.

And these findings may have broader implications. Lodgepole and jack pine comprise a common fuel type in Canada. This research may be an important tool for combating wildfires and mountain pine beetle nationally, if the beetle should spread into Canada's boreal forest.

Natural Resources Canada, Canadian Forest Service maintains a website of mountain pine beetle-related programs and research; visit mpb.cfs.nrcan.gc.ca.

This site in the East Kootenays was thinned to uniform five-metre spacing in the winter of 1996–97 by Tembec Inc., a partner in the original beetle-proofing project.

Analyses of carbon risks determines whether forests

Sustainable harvesting of Canada's forests contributes little to overall atmospheric carbon emissions, according to a Canadian Forest Service Science–Policy Note released by Natural Resources Canada earlier this year. With 10 percent of the world's forests located within its boundaries, this is good news for Canada's forest industry.

Only 40 to 60 percent of a tree's carbon is removed from the forest when harvested logs are transported to mills. About half of this wood continues storing carbon long after harvest as it is processed into construction materials and other long-lived products. The dead roots, branches and other tree components not removed during harvest become dead organic matter and, as they decompose, add to litter and soil carbon pools. At the same time, new trees are grown in place of those harvested, and remove carbon from the atmosphere.

However, within Canada's managed forests, large wildfires, insect infestations and other natural disturbances release far more carbon into the atmosphere than does harvesting. In extreme fire years, these fire-caused emissions have represented up to 45 percent of Canada's total greenhouse gas contributions.

These conclusions are based on analysis of the carbon-storing and -releasing capacities of Canada's forests. Using the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3), the Canadian Forest Service's Carbon Accounting Team summarized conditions in Canada's managed forests based on inventory data and other information about the country's forests provided by the provinces and territories, entomologists, fire researchers and other scientists. The team entered those data into the simulation framework of the model to assess the contribution of Canada's managed forest to the global greenhouse gas budget. For the past two years, the results have contributed to Canada's *National Greenhouse Gas Inventory Report* published by Environment Canada, the most recent report covering the period 1990 to 2005.

About half of the wood removed from Canada's managed forests is used in construction and other long-lived products, and continues storing carbon long after harvest. Photo: © Kristen Johansen, iStock (1866137)

Science-based policy

The same national modelling framework has been used to answer policy questions, which required the ability to project carbon budgets and forest dynamics into the future to assess the risk that the managed forest would be a source in the near future. The primary audience for the assessment's results is federal policy makers—those who recently had to decide whether forest management should be part of Canada's strategy to meet its greenhouse gas emission reduction targets under the Kyoto Protocol. In using the best available information and science, involving experts from all provinces and territories, and focussing on the needs of decision makers, the carbon risk assessment project demonstrates the ability of the Canadian Forest Service to synthesize information and provide scientifically based advice for policy development.

"The analysis made it pretty clear that under the current rules, it was not in Canada's interest to elect forest management for reporting under the Kyoto Protocol," says Darcie Booth, Acting Director General of the Policy, Economics and Industry Branch of the Canadian Forest Service, and chairperson of the National Forest Sinks Committee that oversaw the project. "The analysis allowed us to base our policy decisions on the best science and information available."

It also provides a starting point for discussions on the role of forests in future international agreements on climate change, and for thinking about how forest management activities might affect future forest carbon, says Werner Kurz (**wkurz@nrcan.gc.ca**), Canadian Forest Service Research Scientist and leader of the Carbon Accounting Team. "In smaller, more populated countries—which includes most developed countries—forests are managed very intensively, are easily accessed and managers have detailed information on the forest. Canada's forests are vast and many parts are inaccessible; only a portion of the forest is managed. To support management planning, we need to better understand the consequences of different management options on forest carbon."

contribute to Canada's greenhouse gas emissions

Contributions to global discussion

The research on Canada's national forest carbon dynamics and management strengthened Kurz's role as one of 168 lead authors of the United Nation's Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, *Climate Change 2007: Mitigation of Climate Change*, released in May, 2007, following earlier release of companion reports on climate change science, impacts and adaptation. "The forestry chapter of this report clearly identifies the contribution that global forests and forest sector activities can make toward reducing greenhouse gas emissions."

The IPCC Fourth Assessment Report reviews and synthesizes current climate change research worldwide. *Climate Change 2007: Mitigation of Climate Change* was reviewed by 485 international experts. The report's statement that forests can aid in mitigating climate change received a "High agreement, much evidence" rating, meaning it was supported by most of the chapter's authors and reviewers and by a significant amount of evidence.

The report emphasizes the consequences of different kinds of forest management, and differentiates between harvesting under sustainable forest management and deforestation, as conversion of forests to other land uses such as agriculture, industry, and urban uses are called. "Thirteen million hectares of forests worldwide are lost each year to deforestation—mostly in the tropics," Kurz says. This contributes 5.8 billion tonnes of carbon dioxide emissions annually—more carbon than the global transportation sector emits. "And although afforestation—the conversion of non-forested land to forests—reduces net loss of forest area to 7 million hectares per year, the amount of carbon per hectare contained in young forests is less than that contained in older forests."

The goal, he says, "is to find a balance globally and regionally between sustainably harvesting forests to meet society's needs using a renewable resource and using the forest as a carbon sink. Forests provide timber, fibre and energy. If Canada reduced harvesting, those needs would still have to be met, for example, through aluminum, steel, and plastic—products whose production contributes to fossil fuel emissions." Reducing harvesting in Canada could negatively affect emissions because the global demand for these products will remain. Wood products are traded internationally, therefore reductions in harvesting in Canada would likely result in increased harvesting and emissions elsewhere.

For information on forest carbon accounting research at the Canadian Forest Service, visit carbon.cfs.nrcan.gc.ca. *Does Harvesting in Canada's Forests Contribute to Climate Change?* Canadian Forest Service Science–Policy Note May 1, 2007, available at cfs.nrcan.gc.ca/news/473 and via the Canadian Forest Service Online Bookstore: bookstore.cfs.nrcan.gc.ca. *Climate Change 2007: Mitigation of Climate Change* can be downloaded at www.ipcc.ch. Canada's *National Green House Gas Inventory* reports can be downloaded from www.ec.gc.ca/pdb/ghg/index.html

In extreme fire years, forest fires in Canada's managed forests can release as much as 45 percent of the country's greenhouse gas emissions. Photo: © Macpablo_Campbell River.

Remote sensing methods allow researchers to map tr

Natural Resources Canada researchers and their colleagues recently used imagery recorded by a satellite orbiting 700 kilometres above the Earth to map five individual tree species growing along British Columbia's coast. The researchers also used similar airborne imagery to map chlorophyll, water content, and nitrogen levels within west coast forest canopies' leaves.

"Hyperspectral imagery is helping us push towards getting better typing of what exactly it is we're looking at on the ground," says Research Scientist David Goodenough, of the Canadian Forest Service. "Canada contains 10 percent of the world's forest, and we report on those forests. Using this technology, we can obtain information not available from other sensors that measure only a few spectral bands."

Hyperspectral sensors, the source of data used by Goodenough **(dgoodeno@nrcan-rncan.gc.ca)** and his colleagues, document up to 490 different wavelengths of sunlight (400 nm to 2500 nm) reflecting off the Earth's surface. Each kind of ground cover—indeed, often each species of ground cover—absorbs and reflects a specific combination of wavelengths. If these are identified, validated and made available, they could be used to improve forest inventory and health information, as well as increase information about biodiversity, natural disturbances and the effects of climate change in Canada's forests.

For instance, by comparing mapped leaf nitrogen, chlorophyll or water content against known profiles of normal chemistry for species, researchers can pinpoint stands of highly stressed trees. "We can't identify the source of the stress," Goodenough says. "It could be disease; it could be insects; it could be drought; it could be chemicals in the ground. But if there are large departures from levels considered normal, a forest manager may want to go look at what is causing those departures."

Precise hyperspectral ground data help the researchers calibrate and validate data obtained from satellite or airborne sensors. David Goodenough, Remote Sensing Research Associate Andrew Dyk and other members of the research team wear black when collecting field data to increase accuracy of the ground measurements.

Pioneering technologies

Goodenough's work with hyperspectral imagery fits into a long history of pioneering research by Canadian Forest Service scientists into use of remote sensing technologies to gather forest information. Forester H.E. Seely led the way in the 1930s when he determined how to identify tree species and calculate timber volume from aerial photography. Today, Seely's successors partner with organizations such as the Canadian Space Agency, the Canada Centre for Remote Sensing, NASA (the U.S. National Aeronautics and Space Agency), the European Space Agency, the Japan Aerospace Exploration Agency, universities and industry to find ways to use satellite and airborne data to map and classify forested land cover and its changes across Canada, and to track forest health, structure, biomass and natural disturbances.

Hyperspectral sensors generate in-depth, spectrally layered data packages. Together, these stacks of spectral images reveal objects and data that cannot be picked up by multispectral sensors—sensors that record far fewer spectra or combine ranges of visible, near-infrared and infrared wavelengths into far fewer spectral bands, as NASA's Landsat does. Although hyperspectral imagery has been used to map some mineral deposits and geology in Canada's north, its use in forestry is in the developmental stage.

"It's not a turnkey technology and it has a long way to go before it can provide nationally operational products," says Jeff Dechka **(jdechka@nrcan-rncan.gc.ca)**, Director of Forest Information at the Pacific Forestry Centre. "Research is required to determine the benefits and limitations of the technology. Ultimately, users will decide if it is easy to use, economical and efficient, and if it provides sufficient additional information to support their needs."

ee species and foliar chemistry on the west coast

"We're developing applications to demonstrate how this information might be used, and we're developing the methodologies to extract the information for those applications," says Olaf Niemann, a University of Victoria professor and scientist who works with Goodenough. The biggest challenge, he says, is processing and extracting information from the masses of data. "Processing is a continuum between getting the data as a raw photon count, which is really what we're looking at in terms of the sensor, to a spectrum that is understandable and repeatable from image to image, from sensor to sensor, and from date to date."

Determining reference spectra

A key product of the research undertaken by Goodenough, Niemann and their colleagues is the contributions they are making to forest spectral libraries—collections of known, tested spectra of different kinds of ground covers, tree species and foliage chemistries obtained from hyperspectral imagery.

These reference spectra could be used by forest managers to obtain information about particular stands or sample areas within the forests they oversee. As with any spectra-based remote sensing technology, different land-cover and vegetation types are often represented within single data pixels. To obtain useful, operational information from these data, users must be able to identify and separate, for example, lake, tree canopy, bare ground and shrub spectra. Each reflects a unique spectrum with a characteristic shape, but often the spectra of different covers combine and create new, mixed spectral shapes.

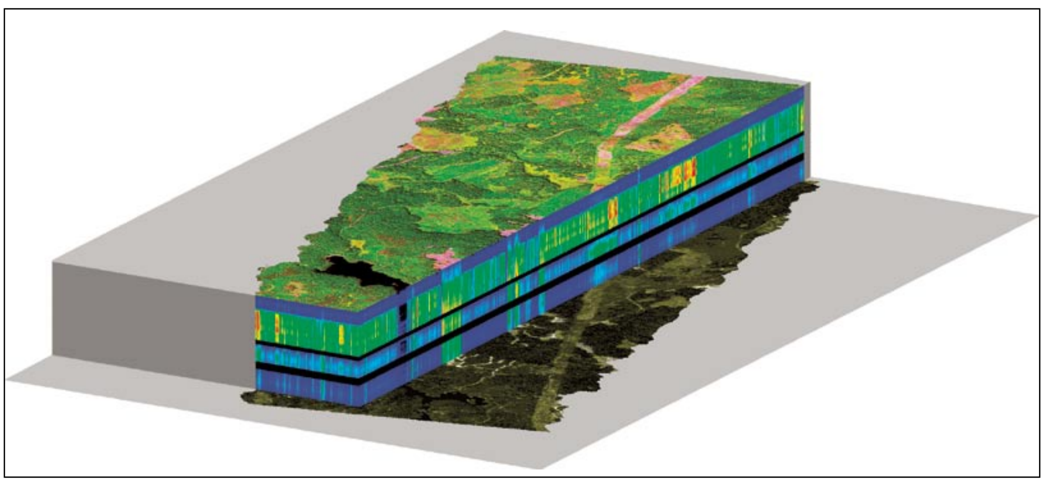
To unmix the spectra, Goodenough says, "You have to know what the spectrum of a tree is, compared to that of a shrub, compared to bare ground, compared to soil, and stressed trees, compared to healthy trees, and so on."

Field crews help Goodenough and Niemann determine and validate those reference spectra by gathering very precise field data. In fact, crews collecting hyperspectral data on the ground now dress in non-reflective black: when they first started, they measured the spectral properties of their clothing and found the red safety vests they were wearing, for instance, reflected a lot of energy back onto the vegetation around them, and distorted the field data.

"This is part of the learning," says Goodenough. "We're building up the skills, figuring out how to get accurate ground measurements for this kind of technology."

Hyperspectral imagery is currently available from NASA's EO-1 satellite. Germany is building a satellite with a hyperspectral sensor, and Canada is working with Italy on a study to build and launch a satellite with a hyperspectral sensor. Airborne sensors such as that owned by the University of Victoria or by Borstad & Associates, which are flown aboard fixed-wing aircraft, produce data that are commercially available.

The technology has potential. Dechka says, "As the benefits of hyperspectral imagery are realized and toolkits for analysis and generation of forest information products are developed, users may find that it becomes a source of information to enhance decision making, just like Landsat has over the years."



This data cube was created from a hyperspectral image taken by AVIRIS (Airborne Visible/Infrared Imaging Spectrometer) in 2002 over the Greater Victoria Watershed District. This image contains 204 spectral bands in the visible and infrared wavelengths. Each layer in the cube cut-out is one band. The top layer shows a false colour composite, which consists of two bands in the infrared and one band in the visible wavelengths. Pink represents areas with no vegetation; light green, young forest; dark green, mature forest, and; black, water. The grey-scale part of the cube shows the image at a single band, 2400 nm, the largest wavelength detected by AVIRIS.

Root rot spread simulator measures up against field data

On the cover: Fungi that cause root rot disease in British Columbia forests include *Armillaria ostoyae.*

A computer program developed by Natural Resources Canada to track forest root disease and predict its impact generates results that are remarkably similar to field observations of tree mortality and infection.

Canadian Forest Service Research Scientist Fred Peet tested the simulator against field data documenting infection of stands of Douglas-fir seedlings by *Phellinus* and *Armillaria*: he compared numbers of root contacts, infected root collars, and trees killed over periods of up to 60 years, as well as incidence of below-ground infection.

It even captured and explained another published observation: temporary interruptions in infection spread within about 10 years after stands are planted.

"They're due to seedling spacing and rate of root growth," says Peet, who retired this summer. Root Rot Tracker demonstrated that infections that occur up until the interruption are infections from old stumps to young trees. "Then comes this pause in infection, which corresponds to the period in a stand when roots of new trees are not yet touching each other. Once these roots grow long enough, you get tree-to-tree infection among young trees."

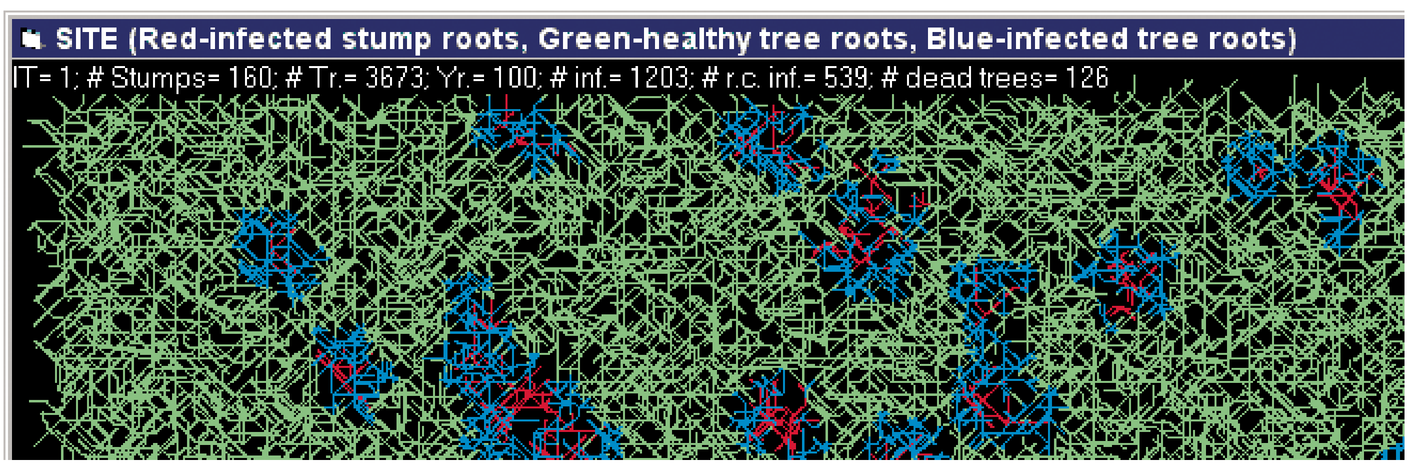
Root Rot Tracker mathematically captures biological information about fungus and root growth: when Peet developed the program, he was determined it simulate these biological processes as they occur in nature. He also designed the program so that forest managers can adjust the values of input variables to correspond to different root diseases, seedling spacing, stump spacing, growth rates, stand treatments, and other information representing a stand.

"It's a very powerful tool," says forest pathologist Alex Woods, of the British Columbia Ministry of Forests and Range. "Because it captures the processes that drive disease behaviour instead of just incorporating measurements from the field, you can make greater inferences about what's going on in a stand, and extrapolate that information about disease impact over a much larger area."

Woods is working to integrate the simulator with the British Columbia's main growth and yield model, TASS (Tree and Stand Simulator). Integration should be complete within a couple of years.

Root diseases, caused by fungi such as *Phellinus, Armillaria* or *Tomentosus*, can reduce stand volume by 40 to 70 percent, depending on fungus and host species and site age and conditions. The fungi exist naturally in forests; however, harvesting can disrupt natural controls. Infected stumps harbour the fungi in their roots. When the site is replanted, seedling roots eventually contact infected stumps and roots and, in time, each other, allowing the infecting fungus to spread throughout the young stand. Managed plantations can lead to exacerbated disease conditions. Infection reduces a root's ability to absorb and transfer nutrients from the soil, decreasing tree growth and weakening the tree. If the infection travels up a root to the root collar, the fungus may spread to the tree's other roots: this ultimately may kill the tree.

Land and forest managers can obtain Root Rot Tracker on CD-Rom by contacting the Pacific Forestry Centre. For information on root diseases, visit www.pfc.cfs.nrcan.gc.ca/pathology.



Root Rot Tracker simulates spread of root disease through forest stands. Users can adjust input-variable values to correspond to different root diseases, seedling and stump spacing, growth rates, and other information representing a particular stand.

Centre integrates wood research

A team of researchers based at the Pacific Forestry Centre forms an integral part of a new Natural Resources Canada virtual forestry research centre. Taking advantage of new communications technologies, the Canadian Wood Fibre Centre has no one physical location; instead it is made up of forest researchers located across the country in the Canadian Forest Service's five regional centres.

It is part of a broader national plan to integrate and coordinate Canada's forest research. The centre's 10 scientists, professionals and technical staff in Victoria, British Columbia, will be working with 45 colleagues across the country on research projects to investigate and further Canada's knowledge of wood fibre quality attributes, and of how best to grow, identify and use wood fibre over the long term.

"Our focus in the Canadian Wood Fibre Centre is economic competitiveness," says Raoul Wiart **(rwiart@nrcan-rncan.gc.ca)**, Director, Operations, of the Canadian Wood Fibre Centre. "One of our objectives is to close the loop in the relevancy of our research to industry and our other clients. As part of the Canadian Forest Service, we will be contributing our expertise in forest-level research, but that will be guided by the market direction and downstream production research of our collaborators at FPInnovations, industry, and the provinces."

Recently known separately as FERIC (the Forest Engineering Research Institute of Canada), Forintek Canada Corp., and PAPRICAN (the Pulp and Paper Research Institute of Canada), FPInnovations merges those three research institutions to become the world's largest public–private forest research and development organization. Its main objectives include increasing efficiency and synergies in forest research in Canada, and strengthening industry's voice on forest-related issues.

Working collaboratively together, and with universities, the provinces and industry, FPInnovations and the Canadian Wood Fibre Centre will stimulate the research, development and innovation needed for Canada's forest industry to be competitive.

Control, safety and diversification receive beetle money

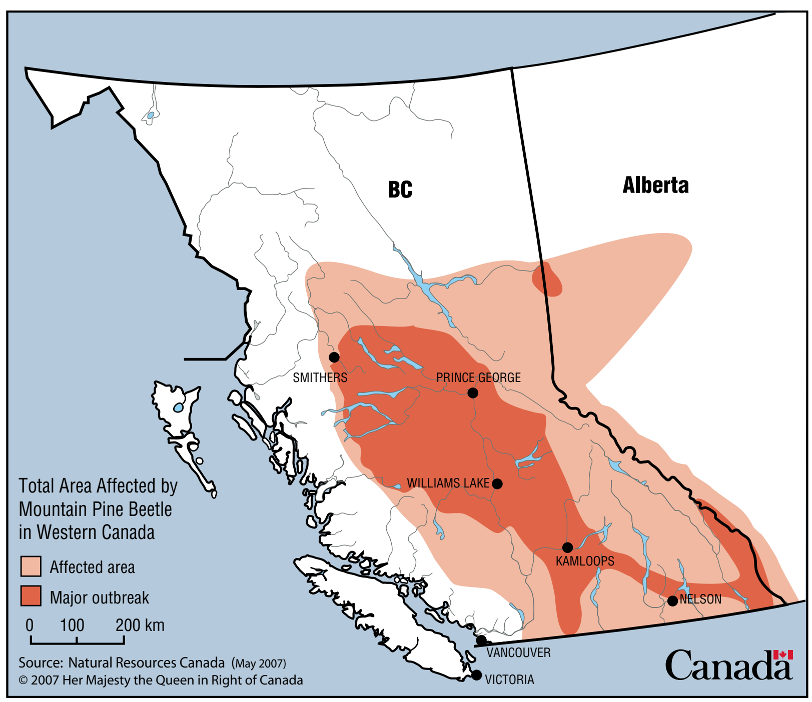
The Federal Mountain Pine Beetle Program recently received another $39.6 million from the federal government for ongoing work with the province and communities to address the mountain pine beetle infestation in British Columbia.

The investment included the following:

- $26 million to be provided through Natural Resources Canada this year for efforts to control the spread of the beetle;
- $6.5 million, through Natural Resources Canada, for actions to protect communities, including First Nations communities, and forest resources from wildfire threats in the beetle-affected area;
- $6 million to be invested in geoscience projects over the next two years to encourage new economic activity in energy and mineral resource exploration by the private sector; and
- $1.1 million this year to support the development of options for recovering the economic value from timber killed by the beetles.

The Government of Canada announced the Mountain Pine Beetle Program in January, 2007, and pledged $200 million to support a comprehensive response to the infestation and its consequences. To date, the government has allocated $64.4 million of the funds. The Forestry Component of the Canada–British Columbia Mountain Pine Beetle Program will receive $100 million over three years to use in projects to control the spread of the beetle, recover economic value from beetle-killed wood, and protect and find sustainable solutions for beetle-affected forest resources and communities.

Additional specific funding allocations, including support for transportation infrastructure and economic diversification projects to meet the needs of affected communities, will be announced throughout the year.
Visit mpb.cfs.nrcan.gc.ca for more information.



Scientist advises NASA on satellite and data needs

A successful satellite program is more than a satellite, says Natural Resources Canada's Mike Wulder. "It includes how rapidly you get the satellite data to a processing centre, process those data, and make them available to the people who need them."

With his recent appointment as science advisor to the National Aeronautics and Space Administration (NASA) Landsat Data Continuity Mission through the Landsat Science Team, Wulder **(mwulder@pfc.cfs.nrcan.gc.ca)** helps to ensure that users' needs for Landsat satellite data, in Canada and elsewhere, are addressed.

Wulder works with remotely sensed data to map large-area forest land cover, detect change in Canada's forests and estimate forest inventory for the Canadian Forest Service. He joins 15 other scientists and engineers who advise the U.S. Geological Survey and NASA on issues pertaining to data from Landsat, a series of Earth-observation satellites that have collected images of Earth's surface since 1972.

"We're there to promote scientific opportunities for these data," he says. "But our primary role is to ensure continuity and development: that the information collected by the satellites during the last 35 years remains accessible, that continuity exists in the data generated by the next system, and that what we've learned from how we've used the data in our work up to this point is incorporated."

Landsat satellites provide images for people who work in forestry, agriculture, geology, regional planning, mapping, and global change research. The imagery suits Canada's forest data needs: it covers large areas of ground at a given time and provides a level of detail useful for forest management, forest monitoring and forest science.

The latest satellite in the Landsat program, Landsat 7, was launched in 1999 and is scheduled for replacement by 2011.

Details on the Landsat Science Team can be viewed at ldcm.usgs.gov/into.html. For information on Wulder's research, visit www.pfc.forestry.ca/profiles/wulder/projects_e.html

Carbon program fosters collaboration

One-third of the world's forest is found in the boreal ecoregion, and 90 percent of boreal forests are found in two countries: Russia and Canada. Earlier this year, Natural Resources Canada's Canadian Forest Service worked with the Russian Academy of Sciences to test application of the carbon accounting tool, the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3), to Russia's forests.

The CBM-CFS3 helps Canada report changes in forest carbon stocks to meet international forest carbon balance reporting requirements.

"Russia has the same UN reporting requirements as we do for forest carbon," says Canadian Forest Service Senior Research Scientist Werner Kurz **(wkurz@nrcan.gc.ca)**. "Russia is interested in exploring Canadian technology for estimating forest carbon budgets, and Canada is interested in testing the model on a wider range of boreal forest ecosystems types."

This shared need to analyze forest carbon balances is one reason why both countries have set up a cooperation agreement and committed resources towards joint Canadian–Russian scientific collaboration. The cooperation is now in its second year. In 2006, one Russian scientist participated in a CBM-CFS3 training workshop and a second scientist visited the Pacific Forestry Centre for three weeks.

"We started testing the model using data from a 7-million-hectare management unit northeast of Moscow," says Kurz. "This past March, we spent a week at the Centre for Problems of Forest Ecology of the Russian Academy of Sciences in Moscow." While there, Canadian researchers presented to senior members of the Russian Federal Forest Agency a summary of work done in Canada and results of the model testing.

As the collaboration continues, researchers have begun translating the model's interface into Russian and applying the model to other regions within Russia.

Information on the carbon budget model is available at carbon.cfs.nrcan.gc.ca

Canadian Forest Service Research Scientist Werner Kurz (second from left) travelled to Russia earlier this year to present a summary of forest carbon budget modelling work done in Canada. Natural Resources Canada is working with the Russian Academy of Sciences to test application of the Canadian Forest Service's carbon accounting tool to Russia's forests.

People

Arrivals

Barrie Phillips joins the Canadian Wood Fibre Centre (CWFC) team as Senior Liaison Officer. Phillips's main job will be to encourage the provinces to collaborate with the CWFC and the newly formed FPInnovations in areas of mutual interest. He comes to us with 12 years of experience as manager in the British Columbia Ministry of Forests and Range's research branch, the last two years as acting director. He brings experience from working with the Canadian Council of Forest Ministers Innovation Working Group and with CWFC as one of four provincial representatives on the Fibre Centre Design Team. Other experience includes teaching forest management at the University of Alberta and working as a forestry consultant.

Phillips is based out of the Pacific Forestry Centre.

Departures

Herbarium and Biodiversity Technician **John Dennis** retired this spring after 35 years with the Canadian Forest Service. Dennis operated and managed a disease diagnostic clinic for reforestation nurseries across Canada from 1984 to 1999. At the Pacific Forestry Centre, he maintained specimens in the mycological herbarium, and provided research and technical support for fungus biodiversity research. He was also the Canadian Forest Service seed officer for the Organisation for Economic Co-operation and Development (OECD).

Research Scientist **Fred Peet** retires this summer after more than two decades at the Pacific Forestry Centre. After receiving a Ph.D. in Physics from the University of British Columbia, Peet worked for the Canada Centre for Remote Sensing in Ottawa before joining the Canadian Forest Service. In 1984, he began full-time studies of problems in forest entomology and pathology. As part of this, he developed a mathematical simulator to describe tree-to-tree spread of forest root diseases by root contact (see story, page 8).

Accolades

Five students working on forest-related research with Pacific Forestry Centre scientists received Pacific Forestry Centre Graduate Student Awards this past spring. The $5,000 awards were initiated in 2003 to encourage young people to pursue forest research as careers and to develop the forest centre's relationships with forest-research departments at Canadian universities.

From the University of Victoria:

Liliana Benitez is working with Forest Economist **Brad Stennes** to research policy instruments for using wood residue to produce electricity in British Columbia.

Nicole Dafoe is working in Research Scientist **Abul Ekrammoddoullah's** lab to characterize defensive proteins in the phloem of hybrid poplars.

From the University of British Columbia:

Samuel Coggins joins Research Scientist **Mike Wulder** to examine integration of multi-scale high-spatial resolution remotely sensed imagery with spread modeling into a mountain pine beetle monitoring program to guide mitigation activities.

Robbie Hember, under supervision of Research Scientist **Werner Kurz**, is forecasting Pacific Northwest forest carbon pools under 21st century climate change and disburbance scenarios.

From the University of Northern British Columbia:

Darin Brooks is predicting advance regeneration density in lodgepole pine stands in the northern interior of British Columbia, under supervision by Research Scientist **Phil Burton**.

Matthew Klingenberg is working with **Brian Aukema** to examine how spatial patterns of post-mountain pine beetle salvage harvesting affect Warren root collar weevil pressure in regenerating stands.

Fred Peet

John Dennis

Sources

A New Simulator for the Spread of Forest Root Diseases by Individual Root Contacts

Snow cover variability across central Canada (1978–2002) derived from satellite passive microwave data

Social dimensions of community vulnerability to mountain pine beetle. Mountain Pine Beetle Initiative working paper 2005-26

"Beetle-proofed" lodgepole pine stands in interior British Columbia have less damage from mountain pine beetle. BC-X-402

An examination of 10 lodgepole pine stands, 5 to 14 years after selective cutting to reduce stand susceptibility to mountain pine beetle. BC-X-410

Developing Canada's national forest carbon monitoring, accounting and reporting system to meet the reporting requirements of the Kyoto protocol

Does harvesting in Canada's forests contribute to climate change? Science-Policy Notes, May 2007

Hyperspectral image processing

Hyperspectral remote sensing of conifer chemistry and moisture

Compressed hyperspectral imager for forestry

EVEOSD Forest Information Products from AVIRIS and Hyperion

New from the bookstore

Heat disinfestation of mountain pine beetle-affected wood. Uzunovic, A.; Khadempour, L. Mountain Pine Beetle Initiative Working Paper 2007-14.

Operational extractives management from mountain pine beetle-attacked lodgepole pine for pulp and papermaking. Allen, L.; Uloth, V. Mountain Pine Beetle Initiative Working Paper 2007-15.

Méthode d'évaluation des attributs de la durée de conservation des arbres tués par le dendroctone du pin ponderosa. Harrison, D. Note de transfert de technologie 35-f.

Assessing the accuracy of mountain pine beetle red attack damage maps generated from satellite remotely sensed data. White, J.C.; Wulder, M.A.; Grills, D. Technology Transfer Note 36.

Inventaire forestier du Canada 2001. 2006. Power, K.; Gillis, M.D. BC-X-408F.

An examination of 10 lodgepole pine stands, 5 to 14 years after selective cutting to reduce stand susceptibility to mountain pine beetle. Whitehead, R.; Russo, G.; Hawkes, B.; Armitage, B. BC-X-410.

Biomass estimation for vegetated areas of Canada. Boudewyn, P.; Song, A.; Gillis, M. BC-X-411.

Families of *Chalcidoidea* (Hymenoptera). (Familles de *Chalcidoidea* (Hymenoptera). Huber, J.T.; Bolte, K.B. Poster (Affiche).

Does harvesting in Canada's forests contribute to climate change? Canadian Forest Service Science-Policy Notes.

Events

Forest Nursery Association of BC/WFCNA Joint Meeting
September 17–19; Sidney, BC

National Forest Week
September 23–29
Information: www.canadianforestry.com/html/outreach/forest_week_e.cfm

National Science and Technology Week
October 12–21
Information: www.nrcan-rncan.gc.ca/nstw-snst/index_e.htm

2007 National Forestry Conference: Forests in Settled Landscapes – Working Together to Protect and Enhance
Canadian Institute of Forestry
August 19–23; Toronto, Ontario

57th Annual Meeting Joint Meeting of the Entomological Society of Canada and the Entomological Society of Saskatchewan
30 September–3 October 2007; Saskatoon, Saskatchewan
Information: www.sfn.saskatoon.sk.ca/science/ess/ESS-ESC/intro.html

A Global vision of Forestry in the 21st Century: International Congress
September 30–October 3; Toronto, Ontario
Information: www.forestry.utoronto.ca
Contact: Amalia Veneziano, a.venesiano@utoronto.ca

Forest Pest Management Forum 2007
December 4–6, 2007; Ottawa, Ontario
Information: cfs.nrcan.gc.ca/subsite/pest-forum/home

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