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Canada

Remote Sensing to Detect Forest Disturbances

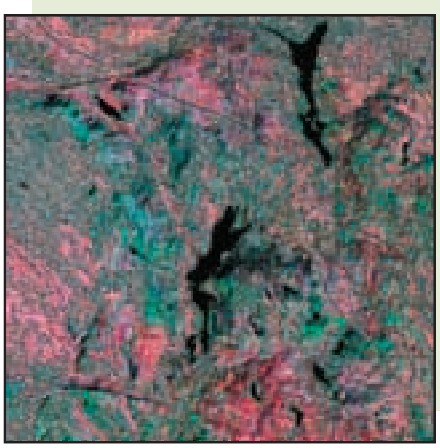
"This program will help researchers, forest managers, and governments to monitor changes to the forest."

With forest covering 42 percent of Canada's landmass, detecting small man-made disturbances from satellite images is not easy. But detecting those disturbances, such as roads and trails, is crucial to determining the overall health of the country's forests as well as tracking global environmental and climate changes. Dr. Joji Iisaka, a research scientist with the Canadian Forest Service, has been studying ways to simplify the process.

It can take up to a month to analyze one satellite image for disturbances. To analyze the whole country would require about 2000 of such images, and, being dependant on weather conditions, would take an inordinate amount of time. Dr. Iisaka has developed a computer program that will automatically detect the presence of roads and trails on remotely sensed satellite images. And it can do so in less than a day for each image.

This program will help researchers, forest managers, and governments to monitor changes to the forest, to plan harvests, and to make other assessments such as fire, hydrology and forest ecology.

"These small disturbances can trigger many ecological and environmental effects such as changes to water, energy and heat balances in the forest," says Dr. Iisaka. "We need to examine the actual amount of disturbance and the impact that disturbance is having on other factors such as water quality and salmon production. We need to know what's going on in Canada's forests and how our disturbances are affecting them."



Potential road segments extracted from the most popular remote sensing image format, Landsat TM, overlayed with original false-color TM image.

By providing an economical, reliable and efficient way to detect man-made disturbances, Dr. Iisaka is providing the first step in determining the impacts of man-made disturbances. Once the roads are detected in the satellite images, the images can be overlayed with images showing other factors, such as insect impact, temperature change, and tree death rate.

While remote sensing images are key to seeing the overall picture, Dr. Iisaka acknowledges that they can't provide as much detailed information as ground-based information can. So, when analyzing images, Dr. Iisaka cross-references information from the two sources. He is then better able to analyze forest disturbances from the remote sensing images and program the computer to understand what each image means.

"We know roads look a certain way, but conventional computer programs for image processing of remote sensing don't provide the functions to analyze spatial characteristics of objects. We have to tell the computer our knowledge of spatial characteristics of objects so it is able to detect things like roads and trails," says Dr. Iisaka. "I developed the method of pixel swapping for this purpose of extracting spatial information from digital images."

Pixel swapping involves swapping pixels within an image to determine the spatial characteristics of the object. If the pixels can be swapped in a specific scheme without changing the image, the result determines the shape, or spatial characteristics, of the objects in the image. In a homogenous image where all the pixels are the same colour, changing them around won't affect the image. If the image, for example, is of black and white horizontal stripes, switching pixels horizontally won't affect the image, but switching them vertically can place white pixels in the black areas and black pixels in the white area. Some vertical swaps won't affect the image though, as they are between pixels of the same colour but on different stripes.

"Pixel swapping is an extension of conventional image analysis and mathematical morphology," explains Dr. Iisaka. "Along with pixel swapping, some spectral and spatial computer definitions of roads and trails were used to make this program."

With this program, Dr. Iisaka is working to make another link between remote sensing and classical forestry. By allowing researchers and forest managers to see the impacts of small disturbances and the results of their ground-based studies on a larger scale, remote sensing and programs such as this one have much to offer forest management.

"We need to have a confident relationship between classical forest information and remote sensing-based observations," says Dr. Iisaka.

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A Burning Curiosity about Mountain Pine Beetles

"The controlled burn reduced the beetle population to a static level."

It's been said that without trees there would be no forest fires. True enough. But without forest fires, would there be healthy trees? The Canadian Forest Service, in collaboration with the BC Ministry of Environment, Lands and Parks, and the BC Ministry of Forests, has been researching the answer to that question in reference to a severe outbreak of mountain pine beetle (*Dendroctonus ponderosae*) in central BC.

Millions of lodgepole pines have been killed by mountain pine beetles in Tweedsmuir Provincial Park, located in central BC. Parts of this area have escaped fire for centuries, leading researchers to wonder if fire could be a biologically effective method of controlling epidemics of this insect.

"With no fire to damage them, many lodgepole pine trees thrived in Tweedsmuir Park and are now a few hundred years old, making them ideal breeding grounds for the mountain pine beetle," says Dr. Les Safranyik, a research scientist at the Pacific Forestry Centre, who has been studying the insect for over 35 years. "As well, mild winters have decreased the winter mortality rate, meaning that possibly billions more mature beetles are surviving each spring. The result has been devastating to the forest."

A burned tree with 100 percent of mountain pine beetle brood killed.

Means of controlling the infestation in the remote Tweedsmuir Park were rather limited. The mature lodgepole pine could not be removed, as laws prohibit harvesting in a park. Eradication of the mountain pine beetle was also not an option as the insect is indigenous to pine stands and an intrinsic part of the ecosystem. So the BC Ministry of Environment, Lands and Parks asked Dr. Safranyik and a team of Canadian Forest Service researchers to look at the possibilities of a prescribed burn to control the infestation.

In the summer of 1995, synthetic pheromones were used to concentrate as many mountain pine beetles as possible into the experimental area, and then 600 hectares were subjected to a controlled burn. It lasted four days and varied in intensity, resulting in various degrees of crown scorch and tree-bole charring. Effects of that fire on the mountain pine beetle population have since been studied and compared to an unburned area.

"Our 1996 survey indicated that there was an immediate average reduction of pre-existing beetle reproduction of up to 50 percent in the highest burn intensity areas," reports Dr. Safranyik. "The controlled burn reduced the beetle population to a static level, with individual, heavily burned trees having up to 100 percent of the brood killed."

The researchers noted that moderate burning did not result in significant brood mortality. "This led us to conclude that to effectively suppress the bark-beetle infestation, fires should be severe enough to burn the bark of trees and should be applied to the entire area of infestation," he explains.

Surveys taken a year later, in 1997, indicated that there were fewer mountain pine beetle attacks in burned areas than in unburned areas, and that beetles were less attracted to trees within the burned area, regardless of burn intensity. Dr. Safranyik suggests that this could be due to either the reduced attractiveness of burned trees, lower local population levels, or a combination of these factors.

"In the future, this research could also help us predict the spatial pattern of natural infestations, and even help us prepare for them," adds Dr. Safranyik. "Overall, it benefits parks and industrial foresters alike."

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Forest Sector Development on the Queen Charlotte Islands

"Economic success will depend on future initiatives based on the region's unique blend of natural and cultural resources."

It is an area of exquisite beauty, rich in cultural history, and biologically unique. But of all the endless positive attributes one could use to describe Haida Gwaii, or the Queen Charlotte Islands, *outstanding economic performance* would not be on that list. And with further commercial timber reductions expected, the already relatively poor economic condition is further threatened.

This isolated group of over 200 islands on the northwest coast of BC has a cool, wet, west coast climate, providing ideal growing conditions for red cedar, Sitka spruce, western hemlock and yellow cypress. But, in part because of its remoteness, harvesting has not yielded financial prosperity on the Queen Charlotte Islands. However, it is this same characteristic – remoteness – along with unique and identifiable cultural and natural resources that may help to improve economic development on the islands. Dr. Brad Stennes and Dr. Bill Wilson, forest research economists with the Canadian Forest Service, have been studying this paradox and looking at potential forest resource options for the region.

"Changes in public expectations on land use, improved information on forest inventory and ecology, all have an impact on forest sector resources in the area," says Dr. Wilson, working at the Pacific Forestry Centre. "Add to these factors emerging consumer expectations on the environmental legacies of products, First Nations' land claims, and ever-increasing market competitiveness, and there is considerable economic uncertainty for the Queen Charlotte Islands. But it's the physical isolation which creates both the challenge and the opportunity to sustainable economic development in the region."

Problems resulting from the isolation of the islands have historically been blamed for the lack of wood processing in the area.

Ninety-four percent of timber harvests are transported to primary processing facilities off the islands, with most of the associated forestry jobs going to non-residents.

"Labour intensive logging practices, such as selection harvesting and the direct export of logs, may bolster economic activity in the region," suggests Dr. Stennes. "Large spruce and hemlock logs are still desirable to the Japanese market and a significant premium is paid for high quality sawlogs, despite the recent economic slump in the Asian market. A community log sort yard on the islands has the potential to create a regional log market, helping to facilitate secondary wood processing on the Queen Charlotte Islands."

But the area is challenged economically by an isolation from potential markets. Being surrounded by rough open waters results in high barging costs. Dr. Stennes suggests, however, that by promoting its uniqueness, the region may be able to find niche markets. Traditional Haida art, log home manufacturing, and making musical instruments with Sitka spruce are options that may help the region cope with the changing forest resource situation.

"Another means of generating economic activity in the face of declining timber harvests is to develop forest-based goods or services that do not rely on timber harvests," says Dr. Stennes. "For example, harvesting wild edible mushrooms, greenery, conifer boughs, aromatic oils, flowers and basketry filler, or even bottled water. However, these options must be considered against the high cost of transporting goods from this secluded area."

The isolation of the Queen Charlotte Islands also challenges the option of developing the area as a tourist destination. Access to the area is by plane or boat, but a lack of transportation on the islands makes movement difficult for tourists.

"However, with improvements in local infrastructure, and most importantly, marketing to off-island residents, this area could draw additional visitors," says Dr. Stennes.

Regional tourism strengths include the Haida culture and history, saltwater and freshwater angling, hunting, hiking, camping, kayaking, or participating in the wilderness experience. These are highly valued and provide economic diversity opportunities for sustainable economic activity in the region.

"It is unfortunate, but sustainable economic development depends on the product of a variety of unknown factors and there is no formula or model that can be employed," says Stennes. "Economic success will depend on future initiatives based on the region's unique blend of natural and cultural resources, a rich array of non-timber forest products, and high quality timber for specialized manufacture and export."

Story continued on page 12.

Seeing the Forest for the Eggs

Studying blackheaded budworm outbreaks on the Queen Charlotte Islands

"Egg sampling is one of the best ways to predict outbreak levels of the blackheaded budworm."

Some say Easter is the best time to hunt for eggs in the forest. But there is a better time. Especially when the eggs you are looking for belong to the western blackheaded budworm (*Acleris gloverana*), an insect that has been causing serious defoliation of western hemlock on the Queen Charlotte Islands in BC.

According to Canadian Forest Service Research technician Rod Turnquist, fall is the ideal time to look for the eggs of the western blackheaded budworm to determine population levels of the insect the following year. For the past several years, he and Dr. Vince Nealis, an insect ecologist at the Pacific Forestry Centre, have been studying the outbreak of this insect on the Queen Charlotte Islands.

"Egg sampling is one of the best ways to predict outbreak levels of the blackheaded budworm," says Dr. Nealis. "The female moth lays her eggs on the needles in the fall. Our data indicate that the number of eggs per branch found in the fall gives a good idea of the population levels of the feeding stages of this insect and its damage the following summer."

Decades of research by the Canadian Forest Service in BC indicate that western blackheaded budworm outbreaks occur throughout the coastal hemlock forests approximately every 10 to 15 years and last about 2 to 4 years. But on the Queen Charlotte Islands, this current outbreak is in its fifth year. Damage, especially in young stands, is severe.

"Although on some of these islands, like Moresby Island, our egg sampling indicated that the population would decline or even collapse this year, in other areas, such as Graham Island, the outbreak was predicted to continue and cause extensive damage to western hemlock," explains Turnquist. "This prediction was confirmed by aerial surveys conducted over the area this past summer. We are currently collecting egg samples from several different sites on the Queen Charlotte Islands, in order to predict population levels for next year."

Outbreak cycles are part of the natural ecology of this indigenous insect on the Queen Charlotte Islands and probably occurred long before modern forestry practices were applied. However, historical data indicate that outbreaks usually didn't last this long nor did they affect young stands to the degree that they are being affected during this current outbreak.

"Our research is designed to examine how damage caused by the budworm in regenerating stands might vary under different silvicultural treatments such as variable stocking rates," says Nealis. "Ideally, we would like to expand the area of study so that we can make predictions that are relevant for the entire management area. Conclusions based on research from, for example, a few study plots are not as reliable as those based on study plots distributed over the entire area of regenerating hemlock. The more information, the stronger our conclusions."

"Since the blackheaded budworm is native to this area, eradication would be impossible and upsetting to the ecosystem," adds Turnquist. "The goal of our research is to understand this insect's relationship with it's principal host, western hemlock, in order to predict impacts so that forest management decisions can be made accordingly."

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Western blackheaded budworm has caused severe defoliation of western hemlock on the Queen Charlotte Islands.

Fertilizer Gives Trees the Lead on Salal

"The fertilizer increased early growth rates so that the trees, rather than salal, began to dominate the plots."

After harvesting, the race to grow begins between tree seedlings and shrubs – and without help from forest managers, some shrubs can get an early lead and hang on to it.

In some western redcedar and western hemlock stands on northern Vancouver Island, the ericaceous shrub salal can persist in the understorey. When stands are harvested the salal quickly spreads and can dominate the site, slowing the trees' growth. Eventually, the trees will grow tall enough to shade out the salal, but this can take a long time if the shrub gets an advantage at the start.

Drs. Brian Titus and Caroline Preston of the Canadian Forest Service and post-graduate student Jennifer Bennett recently finished a soil ecology study led by Dr. Robert Bradley of the University of British Columbia (now at the University of Sherbrooke). They wanted to determine if trees could be given an advantage over salal. They examined field plots that were part of the multi-agency Salal Cedar Hemlock Integrated Research Project (SCHIRP). These plots had been harvested and treated to reduce salal cover and improve tree growth. In the 13 years since treatment, the plots, originally planted with spruce, had naturally regenerated with western hemlock, western redcedar, and salal. Each plot had been treated in one of four ways: brushed of salal, fertilized, brushed and fertilized, or untreated. On some plots the salal still dominated, on other plots the trees overtopped the salal, and on others the trees had closed canopy and begun to shade out the salal.

"In general, the data suggests that fertilization increased nutritional site quality on fertilized plots," says Dr. Titus, a research scientist at the Pacific Forestry Centre, "but the effects of brushing on the forest floor were either negative or non-existent."

Untreated control plot, with salal flourishing in open sunlight and dominating nutrient cycling processes.

Adds Dr. Bradley, "The long-term growth of hemlock observed in fertilized plots may be the result of changes to key ecosystem structures and processes brought about by increased speed of succession and accelerated canopy closure."

The research team measured nutritional site quality by testing the forest floor and salal foliage samples to compare chemical, biochemical and microbial properties. They found that the effects of the fertilizer lasted longer than expected, as an initial dose of extra nutrients typically lasts only 4 to 6 years. The fertilizer increased early growth rates so that the trees, rather than salal, began to dominate the plots. The researchers suggest that the forest floor that began to develop under the trees was of a higher nutritional quality than that which developed under salal.

Because of this, the trees continue to grow well on a forest floor that they themselves were beginning to produce, especially once the salal started to be shaded out with increased canopy development. Although the salal also took advantage of the fertilizer and the improved site nutritional quality to increase its growth rate, the shrub could only reach a certain height. The trees used the fertilizer boost to get above the salal and continue growing.

"As the trees reach crown closure, the salal is choked of sunlight. We want to bring that time forward," says Annette van Niejenhuis, a tree improvement and research co-ordinator with Western Forest Products. "This is great research for us as it puts new tools in our tool bag. Anything that can improve the growth of timber on these sites is of interest to us."

Western Forest Products has already incorporated the results of this and other SCHIRP studies into their forest practices. Trees are now fertilized when they are planted, and older sites that didn't receive fertilizer at the time of planting are receiving it now. The company had tried several other methods to control the salal, but all were costly or of little success. From this study, the company can be assured that the improved long-term growth rates seen 13 years after fertilization can be sustained once trees come to dominate these difficult sites.

These results, the researchers warn, are unique to the regional climate which encourages fast growing trees. Fertilizers aren't the solution everywhere, as trees growing at a slower natural rate may not get enough of a boost from the fertilizer applied at planting to dominate the nutrient cycling process and achieve canopy closure before the fertilizer effect wears off. Dr. Titus has studied similar ecosystems in Newfoundland where a shrub in the same family as salal, Kalmia, can dominate black spruce sites after harvest. There the shrub is best controlled through the use of herbicides because of the slow growth rate of black spruce.

Fertilized treatment plot, with closed canopy, greatly reduced salal cover, and conifers now dominating nutrient cycling processes.

"The silvicultural aim on either coast is to attain canopy closure as quickly as possible, so that ericaceous shrubs are shaded out and nutrient cycling processes are influenced more by the conifers than by the shrubs," says Dr. Titus. "Herbicides and fertilizers are used to gently push ecosystems in the right direction, and then let natural processes take over. We're working with natural successional processes using silvicultural treatments to speed them along their way."

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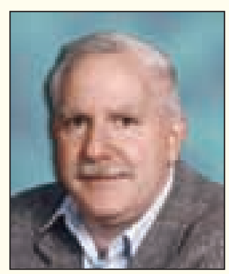
Comings and Goings



Dr. John Manville has recently retired from his position at the Pacific Forestry Centre as a research scientist in analytical organic chemistry. John specialized in the structural determination of bio-active compounds implicated in host-pest interactions.

Dr. Les Safranyik is retiring after over 35 years with the Canadian Forest Service. As a research scientist in entomology, Les is respected worldwide for his knowledge and extensive research on the mountain pine beetle.

Uncovering Armillaria

"Estimates of future damage can be made more easily and accurately using the results of the study."

There's more going on in BC's coniferous forests than meets the eye and for the past three summers Dr. Duncan Morrison, a forest pathologist at the Pacific Forestry Centre, has been digging to uncover how much more. Underground and hidden from view, armillaria root disease rots young stands of trees from the ground up. Only a few of the diseased trees show above-ground signs of being infected, making it difficult to estimate the extent of the disease in a stand.

With this in mind, Dr. Morrison and other researchers with the Canadian Forest Service teamed up with the BC Ministry of Forests to find out more about the relationship between the number of trees with above-ground signs and the actual number of infected trees in 15 to 25 year old stands.

"When a stand is surveyed for armillaria root disease, the measure of disease severity is based on what you see. You have to recognize that you can't see most of it," explains Dr. Morrison. "Results of this research are being incorporated into the BC Ministry of Forests free-growing damage criteria to more accurately estimate armillaria root disease infection."

Prior to this study, survey results were interpreted using the three meter rule: any tree within three meters of a tree killed by armillaria root disease would likely become infected and die too, so it was not considered 'free to grow.' Now, estimates of future damage can be made more easily and accurately using the results of the study.

"This study improved the accuracy and precision of our root disease surveys. The databases created from that study have enabled us to do root disease analysis and modeling that we couldn't have done before," says Don Norris, regional forest pathologist with the BC Ministry of Forests in the Nelson Region. "It's given us a much better appreciation of how much root disease is in these young stands to start off with. It's allowed us to scale our idea of how much infection is out there. We have also used the database to test operational adjustment factors that over time will modify our timber supply planning."

The research was conducted in the southeast corner of BC in the Nelson forest region, where 225 plots in 15 stands throughout three climatic regions were studied. The researchers laid out the plots, tagged all the trees over 1.3 meters in height, checked them for above-ground symptoms, then, with the aid of a machine, pulled them out and checked the roots for disease.

The results in the dry regions were significantly different from those in the moist and wet regions. In the dry region, half of the infected trees showed above-ground symptoms. In the moist and wet regions, only a quarter showed symptoms. Although more trees showed above-ground signs of infection in the dry region, the incidence of diseased trees was lower than in the moist and wet regions.

"What it means is that there is a lot more disease in the moist and wet areas, but you see a smaller percentage of the total. In the dry region, even though there isn't a lot of disease, you're seeing a lot of it," says Dr. Morrison. "Some of the other findings are also important in understanding disease development in young stands. These include: that climate affects how the disease spreads, that there is no difference in incidence of diseased trees around old dead and recently dead trees, and that the incidence of disease is higher inside than outside of the three meter circle around a dead tree."

These results are important to evolving the way stands are managed and to further understand the disease, adds Norris.

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About one-half of the trees in this healthy-appearing stand have Armillaria root disease, but only one-quarter of the diseased trees show above-ground symptoms detectable during surveys.

Effects of Silviculture on Understorey Species

"It's very fortunate that we have this site to assess relatively long-term effects of silviculture on plant species diversity."

Below the canopy of commercially valuable trees live a great variety of other plant species. Silviculture practices can sometimes substantially affect the abundance and diversity of these species, changing the overall composition of the forest ecosystem.

Although there are many studies looking at these effects on a relatively short-term basis, research on the long-term effects is scant. Research scientists Drs. Fangliang He and Hugh Barclay and a team of researchers at the Canadian Forest Service, Pacific Forestry Centre, studied a 51-year-old Douglas fir plantation near Shawnigan Lake on Vancouver Island. The team looked at the response of the understorey vegetation to thinning and fertilization treatments that took place as part of another study done 27 years ago.

"Before the late 1980s, the focus of silviculture was on timber production. Now the notion of silviculture has gradually shifted to integrated management of forested ecosystems, in which species diversity is a big part," says Dr. He. "It's very fortunate that we have this site to assess relatively long-term effects of silviculture on plant species diversity."

Flushing back of understorey vegetation after 27 years since thinning and fertilization treatments.

The study was conducted on a large-scale silviculture experiment site, originally set up in the early 1970s with factorial thinning and fertilization treatments. In 1998, the team conducted a vegetation survey on the site to determine the effects of the treatments on the understorey plant species. Within each treatment plot, they identified the species of vascular and nonvascular plants and estimated the percentage of ground covered by each species.

The study indicated that the number of species changed little from one thinning and fertilization treatment to another, but treatments affected the abundance of understorey species.

"However, these findings are subject to two conditions: the silviculture treatment being at small scale, and the time to regain the diversity being long term," Dr. He emphasizes.

He further explains that in the short term, the impact of silviculture on species diversity is discernible, and on a larger scale the adverse impact of harvest would last longer. However, if there is enough time, for example, more than 30 years, the species diversity will eventually recover as species from the surrounding area re-invade the site. It is important for the harvest site to be small to ensure species from the larger area are not eliminated.

In the 1970s, thinning by removing two-thirds of the timber was considered radical. Now this treatment is considered commonplace. This study supports this level of thinning as the canopy closed 27 years after the treatment and species diversity is recovered.

"If forest managers plan the silviculture carefully, restraining silviculture practices to a relatively small scale, negative effects on biodiversity are able to be reduced or minimized over the long term," says Dr. He.

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Detecting Gall Rust Resistance in Lodgepole Pines

"These results could allow susceptible families to be identified before seedlings are planted on a harvest site."

The future just got a little more predictable for new lodgepole pine plantations in BC.

Young lodgepole pine plantations often fall victim to western gall rust infection – the most damaging stem rust to this tree in BC. The infection causes woody swellings also known as galls, on branches and stems that can cause malformations in young trees.

Dr. Eleanor White and a team of other researchers at the Canadian Forest Service teamed up with the BC Ministry of Forests in a study on lodgepole pine's resistance to western gall rust. They compared a 21-year-old field trial and seedlings taken from the same seedlot to determine how well various families resisted the infection. They also wanted to know if the families that were the most and least resistant in the field study could be identified as such while they were seedlings.

"Based on over 20 years of BC Ministry of Forests data, it was found that there were big differences between the families' resistance," says Dr. White, a research scientist at the Pacific Forestry Centre. "We were wondering if you could pick out, early on, which families would be more resistant."

After testing the 23-year-old seeds for how well they germinated, 19 resistant families and 18 susceptible families were selected for the study. When the seedlings were eight weeks old, 30 of each family were infected by removing a needle and putting gall rust spores on the wound. After a year of growing the trees in the greenhouse, the team inspected them for galls.

Scoring results in a seedling inoculation trial.

Galls on an infected seedling following inoculation.

"It was easy to see from just looking at the seedlings which ones were from resistant and susceptible families," says Dr. White.

Nearly all of the seedlings from susceptible families formed galls in the greenhouse trial, while only half of the seedlings from resistant families formed galls. The resistant families in the field proved to be resistant in the greenhouse as well, even though infection levels were higher in the greenhouse than in the field. Dr. White explains that this is probably due to the direct infection and ideal conditions in the greenhouse that can't be controlled in the field.

"This study confirmed that what we found in the field can be duplicated in the greenhouse," says Dr. Cheng Ying, a research scientist with the BC Ministry of Forests who was involved with this study and the field trial.

These results could allow susceptible families to be identified before seedlings are planted on a harvest site. While the seedlings are growing at the nursery, some from each family could be inoculated to test for resistance. The more resistant families could be planted in an area where gall rust is a concern, such as small clearcuts and shelterwood harvests where the surrounding mature trees are infected. The susceptible ones could be planted in areas where gall rust isn't a concern.

Although there is no guarantee that the resistant families won't get some infection, their chance of growing up with fewer galls is higher. Selecting those families to plant in areas of high gall rust infection gives those lodgepole pine plantations a better chance at a successful future.

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Glossary

Canopy: The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees.

Clearcutting: A forest management method that involves the complete felling and removal of a stand of trees. Clearcutting may be done in blocks, strips, or patches.

Inventory (forest): A survey of a forest area to determine such data as area, condition, timber volume and species for a specific purpose such as planning, purchasing, evaluating, managing or harvesting.

Pheromone: A chemical substance released by animals, including insects, that influences the behaviour or development of other individuals of the same species, e.g., sexual attractants.

Regenerating forests: The continuous renewal of a forest stand. Natural regeneration occurs gradually with seeds from adjacent stands or with seeds brought in by wind, birds, or animals. Artificial regeneration involves direct seeding or planting.

Selection harvesting: Annual or periodic cutting of trees in a stand in which the trees vary markedly in age. The objective is to recover the yield and maintain an uneven-aged stand structure, while creating the conditions necessary for tree growth and seedling establishment. Differs from selective cutting, in which the most valuable trees are harvested without regard for the condition of the residual stand.

Shelterwood: A method of harvesting that involves two cuts: the first leaves trees at intervals to provide the canopy and species required for natural regeneration; the second cut harvests the resulting new crop of trees (which are fairly even-aged).

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Recent Publications

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Glossary

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Silviculture: The theory and practice of controlling the establishment, composition, growth, and quality of forest stands. Can include basic silviculture (e.g., planting and seeding) and intensive silviculture (e.g., site rehabilitation, spacing, and fertilization).

Understorey: The lower level of vegetation in a forest. Usually formed by ground vegetation (mosses, herbs and lichens) and shrubs, but may also include subdominant trees.

Vascular: Containing vessels for the transmission or circulation of plant fluids.

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Funding for this study was provided in part by the South Moresby Forest Replacement Account (SMFRA). In the spring of 2000, the governments of Canada and British Columbia announced an expansion of SMFRA. It is anticipated that further economic development studies will be conducted and that solutions will be sought to mitigate many of the issues identified in this earlier study leading to resource sustainability and community stability.

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