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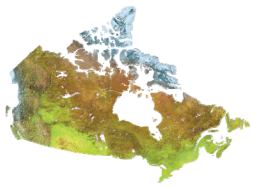
The Great Lakes Forestry Centre (GLFC)



Non-destructive evaluation (NDE) of wood fibre attributes in a high quality red pine plantation

Overview

Canadian Wood Fibre Centre (CWFC) and FPInnovations (FPI) staff are conducting innovative research to identify, locate, and segregate the desirable attributes of wood fibre to maximize value and sustain a more competitive Canadian forest industry. One innovative research project being carried out by the CWFC is studying the utility of employing non-destructive evaluation (NDE) tools for assessing wood fibre attributes. The goal is to identify tools and develop techniques that will identify and segregate trees of varying quality to aid forest resource professionals in optimizing management decisions and better understand the effects of various forest management practices.

Tools that can be used to carry out NDEs of wood quality in standing trees and logs are being assessed nationally by the CWFC for their capability to rapidly and reliably characterize and segregate trees of varying wood quality at the tree/log and stand levels. The properties of wood-based products depend on the quality of the log and the method of processing, whether for solid wood or pulp and paper products. Historically, variation in wood properties resulting from species, site, silviculture, and genetics was difficult to assess in standing trees.

CWFC staff located at the GLFC are assessing acoustic and drill resistance NDE tools that provide surrogate measures of wood stiffness and density at the Kirkwood Management Experimental Forest. Specifically, the tools include the Hitman ST300, Director HM200 and IML Resistograph. Data collected will be used to validate predictive relationships between wood quality properties and tree metrics influenced by stand density management treatments.

The Hitman ST300 is a twin probe tool inserted three centimetres into standing trees at 0.5m and 1.5m. Sending an acoustic wave between the probes, the instrument non-destructively assesses wood quality by indirectly measuring stiffness and other wood properties. The Director HM200 is a hand-held tool that is hit against the butt of a log and used for log segregation by measuring acoustic speed in logs to assess wood stiffness and enhance product grade recoveries. Stiffness and fibre properties have long been recognized as key product variables in solid wood and pulp and paper processing. The IML Resistograph is based on the principle of measuring the drilling resistance of a drilling needle inserted into the tree under constant drive pressure. The energy expended while drilling is measured depending on the drilling depth of the needle. The measurement profile delivers information about the internal condition of the tree and shows annual rings and density "behavior", as well as decayed zones in the wood.

Staff at the CWFC, SSM designed an experimental approach to quantify relationships between NDE testing and wood quality for red pine. Thirty (30) sample trees were selected for harvest from a density-regulated 82-year-

old plantation located 90 km east of Sault Ste Marie, Ontario, in the Kirkwood Forest including the establishment of a control / demonstration plot adjacent to the harvest block.

The Kirkwood red pine plantation, POLYID 730130727, was chosen because of its rich silvicultural history. The plantation was planted on abandoned farmland by prisoners in 1929 and 1930 at an initial planting density of six feet. In 1947 trees were pruned and then gaps were backfilled with jack pine, of which none remains today. In 1970 the plantation was subject to a pre-commercial thinning (PCT) and further pruning. Products from the 1970 PCT included fence poles and pulp. In 1982 it was subject to its first commercial thinning (CT); a second CT was carried out in 1996, producing pulp and saw logs. The clearcut began in 2011 when red pine trees were harvested from the plantation to be made into hydro poles. The clearcut continued the following year and was completed in March and June, 2012, when the removal of sawlogs occurred leaving intact on-site buffers and 25 stems of PR per ha.

For each of the 30 sample trees, diameters, heights and heights to live crown were measured. ST300 standing acoustic velocity (AV) measurements were obtained circumferentially prior to harvest when the trees were going into and then coming out of dormancy. At the time of harvest, ST300 AV measurements were taken at the bottom and top of each 16 foot sawlog to correlate with HM200 Hitman log AV measurements taken from each log's butt. Tree disks were obtained from the bottoms and tops of the first 16 foot sawlogs from which IML-Resistograph measurements will be made at the lab followed by processing of bark-to-bark tangential xylem samples that will be sent to FPInnovations for Silviscan analysis. Silviscan analysis will provide a wealth of data rich in fibre attributes, such as branch size and frequency, wood density, microfibril angle, modulus of elasticity (MoE), module of resistance (MoR) and fibre length and thickness. Correlation and regression analysis will then be used to quantify these relationships between the NDE tools' measurements and the detailed wood fibre quality metrics derived from Silviscan.

Density regulation concepts and practices, including value optimization possibilities, will also be studied. These will include assessing short and long term responses to density manipulation (e.g., initial spacing, precommercial thinning and commercial thinning) in terms of structural yields, growth, allometry, biomass partitioning, wood products, quality and value of boreal conifers. These results will be used to develop silviculture guidelines and provide validation data for testing the CROPLANNER model. CROPLANNER is a decision-support software suite that will assist forest managers in making the transition from a volumetric yield maximization focus to one based on the production of higher value end-products and the provision of a broader array of ecosystem services.

The results from this experiment will also contribute to the national collaborative CWFC database repository for acoustic velocity in selected Canadian commercial species in relation to site, stand and silvicultural conditions. The broad goals of this integrated national NDE initiative include the (1) assessment of NDE tools for enhanced inventory application, (2) evaluation of whether theses tools could be implemented by industry, (3) incorporation of NDE data into predictive modeling of wood fibre attributes, (4) provision of solutions to some of the operational challenges in the use and application of NDE tools, and (5) development of standardized sampling and operational protocols.

New Scientists at the Great Lakes Forestry Centre (GLFC)

Overview

Four scientists have joined GLFC since 2009. New to the Pest Ecology and Management team are Jeremy Allison and Chris MacQuarrie. Isabelle Aubin is a forest ecologist working with the Ecosystem Impacts group and Kara Webster is a soil ecologist with the Soil and Water Sustainability team. Their backgrounds and areas of interest are outlined below.

Jeremy Allison
Dr. Jeremy Allison has been a research scientist with the Pest Ecology and Management team since December 2011. His research is focused on developing an understanding of chemical ecology to improve integrated pest management of insects affecting Canadian forests; and in the long term, to develop a more complete understanding of the role of chemical signals and cues in natural forest systems and the evolutionary forces shaping the chemical ecology of forest insects. Before coming to GLFC Jeremy worked as an Assistant Professor at Louisiana State University (2008 -2011), as a post-doc with Ken Haynes at the University of Kentucky (2008) and with Dan Hare at the University of California (2007). He holds a PhD in Entomology (University of California-Riverside), a Masters in Pest Management (Simon Fraser University) and a HBSc from the University of Guelph.
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Chris MacQuarrie
Dr. Chris MacQuarrie has been a member of the Pest Ecology and Management team since 2010. His research interests include integrated pest management of native and introduced forest insects, biological control, insect population dynamics and insect ecology and behaviour. Prior to joining the team at GLFC he was a post-doc at the Northern Forestry Centre in Edmonton working on the ecology of mountain pine beetle. He holds a PhD in Forest Biology and Management from the University of Alberta (2008), an MSc in biology from the University of New Brunswick (2003) and a BSc from the University of Saskatchewan (2000).
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Isabelle Aubin
Dr. Isabelle Aubin was appointed to the position of Forest Vegetation Ecologist at GLFC in February 2009 and is part of the Ecosystems Impacts team. She completed her PhD at the University of Montreal in 2008 and her MSc at the University of Quebec in Montreal in 1999. As a forest community ecologist, she specializes in understory vegetation dynamics and her main research interest is on forest ecosystem responses to human-induced changes. She has been working on the plant functional trait approach for a decade, using this approach to the applied study of various human-induced disturbances. She is the curator of the TOPIC database and also an adjunct professor at the University of Québec in Rimouski.
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Kara Webster
Dr. Kara Webster joined GLFC as a forest soil ecologist in January 2010. She works as part of the research team that investigates soil and water sustainability. Before coming to GLFC she worked as a post-doc with Jim McLaughlin at the Ontario Forest Research Institute and conducted her PhD research at the Turkey Lakes Watershed. Her main research interests are understanding the controls on the fate of forest soil carbon and how

that fate is linked to other nutrient cycles and hydrologic fluxes. She combines field monitoring, empirical and process-based ecosystem modelling, and GIS mapping to investigate soil processes across various spatial scales.
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Great Lakes Forestry Centre officially opens the Insect Production and Quarantine Laboratories and Invasive Species Centre

Overview

On July 31st, 2012 the Minister of Natural Resources, The Honourable Joe Oliver along with Mr Brian Hayes, Member of Parliament for Sault Ste Marie and Mr David Orazietti, member of the Ontario Legislative Assembly for Sault Ste. Marie, officially opened the new Insect Production and Quarantine Laboratories (IPQL) and the Canada-Ontario Invasive Species Centre (ISC). The IPQL and ISC are located at the Great Lakes Forestry Centre in Sault Ste Marie, Ontario. The state-of-the-art IPQL is the only one of its kind in Canada dedicated to rearing native and alien forest insects.

Staff of the new facility (IPQL and ISC) will work with their partners to further advance forest research on efforts to combat invasive species and to inform policy makers to protect Canada's forest.

The facility, located in Sault Ste. Marie, Ontario, at the Great Lakes Forestry Centre (GLFC) is a $16.3 million partnership (of which $11.4 was for construction of the building) between the federal and Ontario governments. It will support Natural Resources Canada's (NRCan) research on alien invasive insects in collaboration with the Ontario Ministry of Natural Resources (OMNR) and the Canadian Food Inspection Agency. The facility also houses a new domestic insect production facility. This 1600 square meter facility has an area for producing domestic forest insects for forest research and a level 2 quarantine area for rearing and working with insects not native to Canada (often called alien invasive species).

The IPQL is managed by NRCan and focuses on production and quarantine of several species of insects in laboratories with special control facilities such as pressurized areas to contain the insects. The insect production facility at the GLFC was established in 1963 and is the only facility in North America to rear forest multiple insect pest species and the only one in the world to rear spruce budworm, a native North American species that is responsible for large areas of damage and defoliation in spruce forests. The insects that are reared in the facility are used in forest research at the GLFC, other CFS research centres, provincial/state agencies and numerous universities across Canada and the United States. The insects are also used for educational purposes at a number of institutions. The new quarantine facility replaces the previous GLFC quarantine facility, which was too small for the type of work being done. The new facility has a larger working area and provides a state-of-the-art environment to conduct research on many of the forest insect pests threatening Canada's forests.

In 2011, the federal government (Natural Resources Canada, Canadian Food Inspection Agency and Fisheries and Oceans Canada) and the Ontario Ministry of Natural Resources signed a memorandum of understanding (MOU) to promote greater cooperation and coordination of efforts to manage the threats created by invasive terrestrial and aquatic organisms to Canada's ecosystems. As a result of the MOU the ISC, a non-profit agency that promotes greater sharing of information and more coordinated research efforts between federal and provincial agencies, was created in April of 2011. The ISC will play an important part in developing strong ties with other federal, provincial, state and municipal governments, First Nations, universities, and other non-profit agencies to address the increasing threats alien species pose to Canada's ecosystems and its economy.

This new facility will allow NRCan and its partners to respond more quickly to threats to Canada's forest ecosystem and develop effective control measures and policies to support those measures. To learn more about the new facility please visit the IPQL and the Invasive Species Center.
http://cfs.nrcan.gc.ca/pages/320?lang=en_CA (insect rearing)
http://www.invasivespeciescentre.ca/Default.aspx (ISC)

GLFC Webinar Report

On September 18th, 2012 the Great Lakes Forestry Centre presented the fifth instalment in its webinar series "Insights into pest ecology from historical data. Can old dogs teach us new tricks?" by Dr. Chris MacQuarrie. Chris presented research on Mountain pine beetle (MPB), forest tent caterpillar (FTC) and Jack pine budworm (JPBW) where historical data was used to explore the biology and ecology of these important forest insect pests. Chris explained that some of the typical hurdles that are encountered when doing research on these species, for example the cost of doing the work; the large geographic areas that may be involved; and, the time required to complete the work, can be sometimes be overcome using historical data. For example, with MPB Chris and his colleagues used data from five different decades to demonstrate that thinning a stand has a significant effect on the population dynamics of mountain pine beetle. This result means that it is likely important to know the silvicultural history of a forest when trying to predict the impact of this insect. This information may also be able to help us understand the effects that MPB might have on jack pine stands as the beetle moves eastward across Canada. The work on FTC used 60 years of aerial survey data to show that there are distinct populations of the insect in Quebec and Ontario that outbreak at different times, and at varying intensities, and that there are some populations that can serve as 'pacemakers' which influence the behaviour in other populations. In the study of JPBW he used roughly 20 years of data to support previous NRCan research that showed the intensity of defoliation within a stand is related to the amount of the previous year's defoliation, but he was also able to show that variables such as stand and site characteristics likely play a significant role. Chris completed his presentation by cautioning that previously collected data sets may have variable quality, different methods of collection and be collected from different regions, which could affect the analysis and the ability to interpret the results. To access his presentation and the audio file please visit the following site: ftp://ftp.nrcan.gc.ca/cfs/glfc/.

For more information on this work please contact the GLFC and visit the CFS publication website as we are expecting two Frontline Express articles from Chris on FTC and JPBW in the near future.

Ten-year results from forest harvesting impacts study

Overview

GLFC scientists recently collaborated on an analysis of tenth year results from the North American Long Term Soil Productivity (LTSP) network of research sites. Data assessed included planted tree and total above-ground biomass across 45 installations, as well as concentrations of nitrogen and phosphorus in foliage. Scientists were interested in determining whether biomass production or foliar nutrition had a tendency to decrease with increased organic matter removal and whether these results were evident at the 10 year mark. They also looked at the relative importance of vegetation control compared to other stand treatments.

The LTSP network includes more than 100 core and affiliated sites, 18 of which are in Ontario. The remainder are in BC and throughout the US and represent a range of climates, soil conditions and species. The network of

research sites allows researchers to evaluate short- and long-term effects of forest harvesting and post-harvest treatments and their interactions on site productivity.

Soil productivity represents the capacity of the site to capture carbon and produce biomass. Properties that may be influenced by harvesting and silvicultural activities include soil porosity and site organic matter. Porosity can be reduced by site compaction during harvesting, but effects vary depending on soil type. Intensity of site organic matter removal may have different impacts on seedling establishment than on long term growth. The relative importance of vegetation control was also considered, although impacts may vary, depending on whether productivity is measured for the entire plant community or only the crop trees.

Four broad climatic groups are represented, including Warm Humid, for sites in the southeast US; Mediterranean, for sites in California; Western Montane, for sites in higher elevations in the western interior; and Boreal-Great Lakes, for sites in the northern cool temperate and boreal climates near the Great Lakes. Three different levels of harvesting were tested, including stem-only harvest, full-tree harvest and full-tree harvest with forest floor removal. Soil compaction and vegetation control effects were also investigated.

Ten year results showed no consistent impacts study-wide due to varying amounts of organic matter removal. This was true for both planted tree and total above-ground biomass. It is expected that effects may be seen in the future, as more stands approach canopy closure and demand for soil nutrients increases. On average, greater soil compaction actually resulted in an increase in planted tree biomass on the sites, which were mostly coarse textured soils, particularly when organic matter was not removed. This response appeared to be associated with improving soil physical properties. The use of herbicides generally increased planted tree biomass and the concentration of nitrogen in foliage, but not necessarily total stand biomass.

This network of long term study sites allows researchers to make North American-wide comparisons of the effects of harvest-related site and soil disturbances on site productivity. Increasingly valuable information will be obtained with future measurements as impacts will likely change as the stands develop, reflecting evolving environmental constraints, plant community development and recovery from treatment.

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Upcoming 2013 webinars

Mark your calendars for these upcoming presentations.
Subscribers to the GLFC e-Bulletin will receive an e-mail notification with complete details in advance of the webinar.

Date	Time	Title	Presenter
January 15, 2013	1:30 p.m. Eastern	Birds and budworm: the long and the short of it	Dr. Lisa Venier
March 18, 2013	1:30 p.m. Eastern	Development of the next generation of the Canadian Forest Fire Danger Rating System	Dr. Mike Wotton

GLFC recent Publications

If you would like to order any of the publications listed below, please contact Publications at the following e-mail address: glfc.publications@nrcan.gc.ca

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