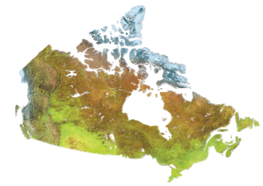
Natural Resources Canada | Ressources naturelles Canada
Issue 10, Summer 2010

e-Bulletin

The Great Lakes Forestry Centre (GLFC)



GLFC research to be showcased in national e-lecture series

Overview

A selection of research being undertaken by scientists at the Great Lakes Forestry Centre (GLFC) will be the focus of a fall 2010 series of national electronic lectures hosted by the Canadian Institute of Forestry.

A selection of research being undertaken by scientists at the Great Lakes Forestry Centre (GLFC) will be the focus of a fall 2010 series of national electronic lectures hosted by the Canadian Institute of Forestry. The series, entitled ‘The Forest on your Desktop’, will feature seven one-hour lectures focused on work being led from GLFC. Topics will cover aspects of forest fire research, invasive forest insects, watershed-level ecosystem impacts, vegetation classification, and insect genomics. The e-lectures, which will be broadcast most Wednesdays between Sept. 22 and Nov. 10, are free and open to everyone. Pre-registration is required. For more information visit the Canadian Institute of Forestry at http://www.cif-ifc.org/.

Testing new methods for assessing forest resilience and sustainability in the boreal forest

Overview

Forest-dwelling birds are important indicators of a forest's ability to withstand ecological change. Measuring bird distribution and abundance in the vast boreal forest is a daunting task that ecologists have had to do in person in the field. New technologies are presenting opportunities to automate this task and reduce costs. Canadian Forest Service scientists in Ontario are striving to refine the timing and frequency of the recording of bird songs and to develop analysis techniques for automated interpretation of the recordings back in the laboratory.

Understanding the resilience of an ecosystem is critical to ensuring its sustainability. Resilience describes the capacity of an ecosystem to absorb disturbances, such as forest management, storms, fire and climate change without changing its fundamental nature. A resilient ecosystem has the capacity to withstand shocks and surprises and, if damaged, to rebuild itself. An ecosystem with low resilience can be susceptible to even minor disturbances that can cause a shift to a less desirable state that is difficult, expensive, or even impossible to reverse. Biodiversity plays a crucial role in ecosystem resilience by spreading risks and making it possible for ecosystems to reorganize after disturbance.

Measuring the resilience of our forests and monitoring the sustainability of our forest management is a key role of the Canadian Forest Service. Attempts to measure resilience and sustainability usually involve assessing changes in species composition and ecosystem processes in response to disturbances. One of the best available species groups used to assess change in forest ecosystems is birds. Forest birds are an integral part of the ecosystem and they respond to ecological changes through changes in community composition over time. Birds have been used as indicators of sustainability since the first attempts to measure human impacts on ecosystems for a number of reasons including their well defined taxonomy, their responsiveness to forest change, and a high degree of public interest in them that has led to the collection of large quantities of baseline data.

The ongoing interest in the boreal forest has led to questions about the impact of forest management and climate change on the more remote boreal forest ecosystems. To support their biodiversity studies at the CFS, scientists Lisa Venier and Steve Holmes are exploring new recording and digital sound analysis technology to automate the collection of bird community composition data in the remote settings of the boreal forest. The technology has particular relevance in the boreal forest because of the limited availability of baseline data from volunteers in the sparsely populated region. Collecting community composition data with this technology will cost less and be more efficient, and will allow for data to be collected over larger areas and longer time frames. This is the type of data needed to assess resilience and sustainability of Canada's boreal forest ecosystem.

The technology being tested was developed by Wildlife Acoustics Inc. The Song Meter is a small, weatherproof, and programmable recording unit that can be left in remote sampling locations for the breeding season collecting auditory data on a predefined recording schedule. The CFS has been collecting data using these units for the past three years to help define the optimal recording protocol to balance the quality and quantity of the data. The recorded surveys can be interpreted by experienced birders, which is time consuming, but the CFS is exploring the potential of digital sound analysis software (also produced by Wildlife Acoustics Inc.) to automate some of the data processing. This is the most difficult part of the work because it involves teaching the software how to recognize the songs of many different species (building song recognizers), and each species has lots of variation in their song. Learning to recognize the key components of a bird's song is something that the human brain does relatively well but it is much more difficult to automate the process for a computer. The teaching process involves collecting many 'clean' recordings of each species that the software can use for comparison and identifying the most characteristic components of each song. These song recognizers then need to be tested using hours of recorded surveys to assess their ability to identify the presence of species and distinguish between other similar species.

The technology is cost-effective and although being tested in the boreal forest is transferable to other forest regions and other countries. Successful development of these approaches has the potential to significantly improve our ability to collect high quality indicator data to measure resilience and sustainability. Ultimately, we need to understand species' responses to disturbance to understand how our ecosystems are changing. All of this information will directly address the CFS mandate to support sustainable use of forests and improve Canada's international reputation for environmental responsibility.

For more information on Natural Resources Canada's Great Lakes Forestry Centre research related to measuring forest biodiversity, please contact Great Lakes Forestry Canada.

More computing power leads to new risk modelling tools for managing alien invasive forest pests

Overview

Invasive alien forest pests, including insects, diseases and plants, have changed the forested and urban landscapes of North America over past centuries. Predicting the hot spots for such invasions can be challenging given the high degree of uncertainty related to pest introduction, spread and degree of damage. A recent collaboration between Dr. Denys Yemshanov of the Great Lakes Forestry Centre and scientists in the United States has led to the development of powerful modelling tools to address such uncertainty. The models, which factor in the element of uncertainty, will allow land managers to develop more reliable strategies to combat potential or existing invasions of alien pests. Ultimately, user-friendly versions of these models will facilitate more effective decision making by pest management agencies in the face of limited human and financial resources.

North America has seen the inadvertent introduction of numerous invasive forest insects, diseases and plants since the arrival of early settlers who brought plant material to the New World from Europe. Invasive species have caused significant damage to trees and forests as they have spread throughout the continent, in some cases nearly eliminating certain tree species (e.g., American chestnut, butternut). Two notable pests that are being actively managed are Dutch Elm Disease that was discovered in 1930, and the Emerald Ash Borer, which was first observed in 2002; both continue to decimate the populations of elm and ash trees across North America. When destructive invasive pests such as these are discovered today, defensive actions are initiated to slow their spread and eliminate populations to minimize negative impacts on the forested landscape. Implementing such strategies can be costly, so tools for assessing risk and best directing mitigation efforts can help ensure that resources are deployed most effectively.

Pest risk maps have been part of the risk assessment process for many years, as they help determine the degree of risk an invasive organism might represent across broad geographical regions. These maps can influence where land management and regulatory agencies direct their efforts and resources to best protect our forests and other natural resources. They are powerful visual communication tools to describe where invasive alien species might arrive, establish or cause harmful impacts. These maps assist in strategic and tactical pest management decisions, such as potential restrictions on international trade or the design of pest surveys and domestic quarantines.

However, maps often do not reveal the uncertainties about the new invader. The information about new or anticipated invasive organisms is often incomplete and yet the decision to eradicate or manage the pest has to be made quickly. This situation calls for new methodologies that could address uncertainties and knowledge gaps and help strengthen decisions.

A GLFC scientist has combined his expertise with that of researchers at North Carolina State University, United States Department of Agriculture (USDA) APHIS (Animal and Public Health Information System), USDA Forest Service and Michigan State University to improve existing pest risk mapping techniques and develop new ones. As computing power has increased it has become possible to develop a new set of methodologies that improve the risk mapping process and make the maps more robust to uncertainty about new invasive threats. Denys Yemshanov, a research scientist at GLFC, has focused his work on developing a new family of pest risk mapping techniques that could better communicate uncertainty to decision makers. Yemshanov has addressed one of the key challenges faced by scientists assessing risks of new invasive pests – incorporating uncertainties and information gaps in the pest risk mapping process. Where there are gaps in knowledge about how the pest might behave in a new environment, decision-makers must rely on experts who have studied the pest in other geographic regions. Most risk models focus on what is known about the new organism – uncertainty often goes unrepresented in pest risk maps and therefore is not properly taken into account by decision makers and regulators. The notion of uncertainty changes the decision making outcome and therefore must be included in the pest risk mapping process.

To address uncertainties, Yemshanov's models predict two specific behavioral aspects of the organism in its new environment – what is known about the pest of interest and what we suspect is unknown about it. Predicting the "unknown" aspect is a special challenge and calls for new analytic methods to look beyond the traditional statistical framework. The new technique includes several approaches to address uncertainties and knowledge gaps, such as sensitivity and extreme events analyses, where verification and validation provide estimates of model errors, worst-case scenarios and an information gap framework. The latter methodology was published in the February 2010 issue of the journal Risk Analysis and is particularly appealing for decision makers. It maximizes the robustness of risk predictions to errors in data and models and estimates how much uncertainty the risk maps could tolerate without losing their value for decision making.

This technique addresses what was a big disconnect between scientists who create the invasion models and risk maps and those who face uncertainties and must make tough decisions about managing new invasive pests. New analytical methods such as the one described begin the task of linking risk modelling and decision making components in a seamless "robust decision making framework". Making risk maps that incorporate and communicate uncertainty for those who need to implement their findings will lead to more effective decisions and better allocation of resources to manage invasive alien pest problems. While the use of new risk mapping techniques still requires significant technical expertise, work is underway to develop more practical, user-friendly risk mapping tools that could help analysts, forest practitioners, agencies and regulators to better estimate risks and uncertainties of new invasive threats.

For more information on research about risk mapping by Natural Resources Canada's Great Lakes Forestry Centre, please contact Great Lakes Forestry Canada.

New field guide assists in prescribed burning for tallgrass prairie restoration

Overview

Up until 2009, prescribed burning operations to restore the endangered tallgrass prairie ecosystem of southern Ontario were guided by fire behaviour prediction models that had been developed using data from experimental burning projects in forests. A collaborative project was initiated in 2007 to examine the accuracy of these models and to evaluate several other fire spread models, and develop a rapid fuel load assessment method for this ecosystem type. The new models that resulted are more effective in predicting fire spread in this ecosystem, and are now being documented in the Field guide for estimating fire behaviour in the Ontario tallgrass prairie fuel type.

Tallgrass prairie is a fragmented ecosystem that depends on frequent fire to prevent woody plants from encroaching and to encourage the production of seeds from the prairie species. It is characterized by grasses that reach up to three meters in height, and a variety of wildflowers and fauna. Its most easterly extent in Canada is Southern Ontario from about the Trent River to the Windsor area. Of the 1000 km^2 of tallgrass prairie that once covered Southern Ontario only about 3% remains, mainly in small, fragmented pockets, making it one of the most endangered ecosystems in Canada.

There are a number of reasons for the decline of this fire-dependant ecosystem, but one major cause is the practice of fire exclusion carried out over this entire area since the start of the 20th Century. Over the past two decades there has been an increasingly active prescribed burning program in Southern Ontario aimed at restoring this endangered habitat. In late 2007 the Canadian Forest Service (CFS) joined with the Ontario Ministry of Natural Resources (OMNR) and the Elgin Stewardship Council on a research project aimed at better understanding fuels and fire behaviour in the tallgrass prairie ecosystem. A two year research project was carried out by a Masters student from the University of Toronto (U of T). This student was one of the first students trained as part of the Great Lakes Forestry Centre's (GLFC) partnership in fire behaviour with the U of T Faculty of Forestry. This partnership was established in late 2006 to provide a location in Canada where graduate level students could study the physical aspects of wildland fires.

The research project saw development of a rapid fuel load assessment method for the tallgrass prairie type as well as the evaluation of several existing fire spread rate models for grass. Fire behaviour observations collected over two spring field seasons revealed that the currently used model for predicting grass fire spread rate used in Canada (the CFS's Forest Fire Behaviour Prediction (FBP) System) did not predict spread rate in this fuel type at all; consequently a new spread rate model was recommended. Coincident with this fire behaviour research, scientists from GLFC developed a new way of predicting the moisture content of grass which, through incorporating the effects of solar radiation, explained the way grasslands can go from soaking wet to dry and ready to burn in just a few hours.This grass moisture model has been combined with the newly developed fuel load and fire spread rate models and is being released this fall at a national fire conference as the Field guide for estimating fire behaviour in the Ontario tallgrass prairie fuel type.

The new field guide, which will assist prescribed burners throughout Southern Ontario, predicts that fire can occur in grass just hours after significant rainfall has occurred, an outcome that the original Canadian FBP System spread models do not predict. CFS and Ontario Parks staff tested the predictions of this new field guide in April 2010 at Rondeau Provincial Park. A series of grass-covered plots, created by existing borders within the park, were burned over a full day. Weather in the days prior to the burns had been extremely cold and wet; over 25 mm of rain had fallen and light snow was in the air on the evening before the burns. The old FBP System model predicted no fire spread would be possible at any point during the day; burns ignited every hour from 10:30 a.m. onward began as very slow moving fires but increased to high intensity grass fires (with spread rates around 40 m/min) by early afternoon.

This day of controlled burning provided an excellent demonstration of the effectiveness of these new models that will be documented in the tallgrass prairie fire behaviour field guide. In addition results suggest the prescribed burn prescription-setting process for this fuel type should be reconsidered. CFS scientists and other members of this tallgrass fire behaviour project team are working with OMNR to bring this new fuel guide into operational use.

For more information on Natural Resources Canada's Great Lakes Forestry Centre research related to wildland fire, please contact Great Lakes Forestry Canada.

The Turkey Lakes Watershed: reflecting upon the first 30 years

Overview

The Turkey Lakes Watershed is a research site near Sault Ste. Marie that has provided valuable scientific information for the past 30 years. Initially focused on examining the impacts of acid rain on a forested ecosystem, the scope of the research has expanded to include studies of forest harvesting impacts, forest carbon budgets, climate change, and others. Research is undertaken with a view to gaining a better understanding of whole ecosystem effects of various human-caused disturbances on this northern hardwood forest. Ongoing monitoring of the research area has created a continuous record of ecosystem status that will help answer the science questions of today and tomorrow and continues to influence policy.

Long-term ecosystem monitoring is an essential component of environmental science. Long-term monitoring and research provide the understanding of how ecosystems respond in the short- and long-term to various disturbances, evaluate the cumulative effects of ecosystem stressors, measure the effectiveness of environmental regulations, create the scientific foundation for criteria and indicators of sustainable forest management, and provide the critical data sets required for the development and validation of ecosystem models.

Research at the Turkey Lakes Watershed (TLW) has its origins in the concerns that arose in Canada and the United States during the 1970s over the effects of acid rain. At that time, governments in both countries undertook research programs to understand the magnitude of the international problem and identify solutions. A part of the Canadian response was the establishment of the TLW in 1980 through a collaboration involving three federal departments -- Natural Resources Canada, Environment Canada and Fisheries and Oceans Canada with the cooperation of the Ontario Ministry of Natural Resources. Many universities have also contributed to the research at the TLW over the years. One of the founding principles of the TLW was to focus on understanding the physical and biological processes controlling the response of the ecosystem to disturbances. This focus on processes has meant that the results from TLW can be used to address current and emerging policy questions.

The TLW is a mixed hardwood forest situated near the northern edge of the Great Lakes-St. Lawrence Forest Region. It is located approximately 50 km north of Sault Ste. Marie, ON and 12 km inland from Lake Superior. The watershed encompasses 10.5 km^2 and contains a chain of five lakes and numerous headwater streams. The forest is dominated by sugar maple (90%); the last commercial harvesting was carried out in the 1950s for high quality yellow birch. Road access is maintained year-round to facilitate data collection in any season.

Long-term studies at the TLW have required monitoring and assessing numerous physical and biological variables, including meteorology, chemical deposition (e.g., sulfate and nitrate), soil solution chemistry, stream discharge, stream and lake chemistry, forest growth and condition, soil chemical properties, fish populations and aquatic food webs. In addition, numerous shorter-term research projects have been conducted to gain insights into the processes governing ecosystem behaviour, such as fish habitat manipulations, variable intensity forest harvesting and measurements of forest carbon budgets. Some of these research questions are discussed below.

Canadian Forest Service (CFS) Research Highlights and Outcomes

Acid Rain. Acid rain is formed by the combination of atmospheric water with nitrogen and sulphur oxide emissions from fossil fuel combustion and metal smelting. The initial focus of research at the TLW was to study the impacts of acid rain on a forested ecosystem, and data collection on acidifying depositions continues to this day. The research conducted at TLW and elsewhere clearly demonstrated the widespread and serious impacts of acid rain on terrestrial and aquatic ecosystems, which resulted in a series of policies and regulations in Canada and the United States, culminating in the 1991 Canada-US Air Quality Agreement, to limit the emissions of sulphur. Ongoing monitoring at TLW has shown a decrease of approximately 40% in sulphur deposition at TLW and a parallel decline of sulphur in stream and lake water. While there has been a significant improvement in the acidity of stream and lake water, other indicators of recovery from acid rain, such as alkalinity, have not responded as strongly, suggesting that recovery is not complete and further reductions in deposition are required. The 2004 Acid Rain Science Assessment showed that 0.5 to 1.8 million km^2 in Eastern Canada may still be at risk from acid deposition. New regulations on the emissions of nitrogen and sulphur in Canada and the United States have been proposed and the TLW will continue to influence the Canadian government on the effectiveness of air pollution policies.

Forest Harvesting. A variable intensity forest harvesting experiment was initiated in the summer of 1997. The treatments consisted of controls, a selection harvest (29% basal area removal), a shelterwood harvest (42% basal area removal) and a diameter limit harvest (89% basal area removal). CFS researchers are monitoring stream flow and chemistry, soil solution chemistry, vegetation response and impacts on aquatic ecosystems. In general, the impacts on stream flow, stream chemistry and aquatic ecosystems were moderate and short-lived. In some cases, the impact of road building was more severe than the harvesting. Results from the TLW harvesting experiment have influenced the development of the most recent revisions to Ontario’s Forest Management Guidelines.

Forest Carbon Budgets. Northern forests are well known as significant reservoirs of carbon and the forests at the TLW are no exception. Research has shown that, on average, the forest ecosystems at TLW contain roughly 350,000 kg ha^{-1} of carbon, with two-thirds of the total in the soil. Ongoing work, in partnership with the University of Western Ontario, is examining the distribution of soil carbon pools (reservoirs of carbon) and fluxes (release of carbon from reservoirs to the air and water) across a headwater catchment. The study has demonstrated that topography, through its influence on hydrology, has a large influence on the size and quality of the carbon pools, the magnitude of the fluxes from those pools and on the sensitivity of those pools and fluxes to a changing climate. This research is helping researchers to understand the role of forests in the global carbon cycle and refine methods for forest carbon accounting.

Climate change. Average annual temperature at the TLW is currently increasing by about 1°C per decade. This increase is driven primarily by TLW's proximity to Lake Superior, which has seen average lake temperature increase by a similar amount due to a reduction in ice cover on the lake. The increase in temperature at the TLW is causing reductions in the number of days with ice cover on the lakes, a decline in the average water yield from the headwater basins and an increase in the number of days with no flow in the headwater streams. Current research is evaluating the impacts of the warmer climate on forest growth, biogeochemical cycles and carbon budgets. The results will assist in the development of adaptation strategies to climate change.

For more information on research at the Turkey Lakes Watershed by Natural Resources Canada’s Great Lakes Forestry Centre, please visit www.tlws.ca or contact Great Lakes Forestry Canada.

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

Mayfield, M.M.; Bonser, S.P.; Morgan, J.W.; Aubin, I.; McNamara, S.; Vesk, P.A. 2010. What does species richness tell us about functional trait diversity? Predictions and evidence for responses of species and functional trait diversity to land-use change. Global Ecology and Biogeography 19: 423-431.

Miller, D.R.; Millar, J.G.; Mangini, A.; Crowe, C.M.; Grant, G.G. 2010. (3Z,6Z,9Z,12Z,15Z)-Pentacosapentaene and (Z)-11-Hexadecenyl Acetate: Sex Attractant Blend for *Dioryctria amatella* (Lepidoptera: Pyralidae). Journal of Economic Entomology 103: 1216-1221.

Pang, A.S.D. 2010. Possible role of plant allelochemical in clearance of bacteria from the gut of spruce budworm, *Choristoneura fumiferana*. The Open Microbiology Journal 4: 26-29.

Podur, J.; Wotton, M. 2010. Will climate change overwhelm fire management capacity? Ecological Modelling 221: 1301-1309.

Ryall, K.; Silk, P.J.; Wu, J.; Mayo, P.; Lemay, M.A.; MaGee, D. 2010. Sex pheromone chemistry and field trapping studies of the elm spanworm *Ennomos subsignaria* (Hübner) (Lepidoptera:Geometridae). Naturwissenschaften 97: 717-724.

Slack, J.M.; Lawrence, S.D.; Krell, P.J.; Arif, B.M. 2010. A soluble form of P74 can act as a per os infectivity factor to the *Autographa californica* multiple nucleopolyhedrovirus. Journal of General Virology 91: 915-918.

Smith, D.R.; Kaduk, J.D.; Balzter, H.; Wooster, M.J.; Mottram, G.N.; Hartley, G.; Lynham, T.J.; Studens, J.; Curry, J.; Stocks, B.J. 2010. Soil surface CO_2 flux increases with successional time in a fire scar chronosequence of Canadian boreal jack pine forest. Biogeosciences 7: 1375-1381.

Thompson, D.; Chartrand, D.; Staznik, B.; Leach, J.; Hodgins, P. 2010. Integrating advanced technologies for optimization of aerial herbicide applications. New Forests 40: 45-66.

Subscribe/ Unsubscribe

To subscribe or unsubscribe or to receive future issues of this bulletin electronically, visit http://cfs.nrcan.gc.ca/e-bulletin?lang=en_CA.

Contact us/Reader feedback

Great Lakes Forestry Centre
Canadian Forest Service
1219 Queen Street East
Sault Ste. Marie, Ontario P6A 2E5
email: glfc.ebulletin@nrcan-rncan.gc.ca