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Analysis of Fort McMurray fire helps refine fire behaviour prediction tools

Overview
GLFC fire researchers are part of a collaborative effort to conduct a detailed analysis of this devastating fire and to provide recommendations to enhance future fire prediction capabilities.

At 4:03 pm on May 1, 2016, the Horse River Fire (more commonly known as the Fort McMurray fire) started just 7 km southwest of downtown Fort McMurray, Alberta. With strong westerly winds and extremely dry spring burning conditions, the fire quickly grew in size to over 800 ha. Less than 2 days later, the wildfire burned over Fort McMurray in several locations. The impacts of the fire were unprecedented, causing the largest wildfire evacuation in Canada's history and destroying about 2,400 homes and other structures. The fire resulted in $3.7B of insured losses and represents the most expensive natural disaster in Canadian history.

In early 2017, the Great Lakes Forestry Centre, Alberta Agriculture and Forestry, and the University of Alberta joined in a collaborative research agreement to conduct a detailed fire behaviour analysis of this fire. The purpose of the 3-year study is to assess current fire behaviour prediction tools and databases and to provide recommendations to enhance future prediction capabilities. Dr. Bill de Groot, Alan Cantin and Natasha Jurko have been using Horse River Fire data from the period May 1-6, 2016, which was the most critical period of fire behaviour, to analyze models and simulation procedures with the Canadian Forest Fire Danger Rating System (CFFDRS). More specifically, they are examining fire weather and fuels databases to assess optimum modeling procedures and the level of spatial and temporal resolution necessary to most accurately predict burning conditions with the Canadian Forest Fire Weather Index (FWI) System, and resulting fire behaviour with the Canadian Forest Fire Behaviour Prediction (FBP) System. The FWI and FBP Systems are subsystems of the CFFDRS, which is a primary product of the Canadian Forest Service developed over the last 9 decades of fire research. GLFC has played a key role in the design and evolution of the CFFDRS for the last half century and GLFC leads development of the "Next Generation" (NG-) CFFDRS. Results from this study of the Horse River Fire will provide important information towards scientific models of the NG-CFFDRS and towards technology transfer recommendations for its practical application in fire management.

The Horse River Fire provides an excellent testing ground for fire behaviour modeling because it provides an example of extreme fire behaviour over many days. This fire activity was also well documented and there are many ground and space-based datasets available to evaluate the fire behaviour. Although this study is only in its first year, initial results are proving very helpful in understanding current fire behaviour model strengths and limitations, and in evaluating databases and simulation procedures to improve prediction accuracy. These findings will result in recommendations to the Province of Alberta on fuels databases and new standard fuel types that will assist provincial fire behaviour analysts on future wildfires. Over the next 2 years of the study, Chelene Hanes and Dr. Mike Wotton (through the University of Toronto) will join Bill, Alan and Natasha to conduct further detailed analyses of fuels and weather, and build more robust fuel moisture models in the NG-CFFDRS.

Fire trends: 1959-2015

Overview
A comprehensive analysis of fire trends based on data up until 2015 showed a doubling in the number of large fires, a lengthening of the fire season and an unexpected decrease in the area burned by human-caused fires.

Canadian forest fire regimes have been well documented based on records of large forest fires between the late 1950s and the 1990s. GLFC's fire researchers Chelene Hanes and Dr. Xianli Wang recently led a study that analyzed trends in the fire regime using fire statistics up to 2015. The analysis of more recent changes in fire regimes across the country had not previously been attempted due to known limitations with the fire datasets. For the period 1980-2015, data examined included area burned, number of fires, fire cause and seasonality for fires of all sizes. For large fires (≥200 ha) national statistics from the period 1959-2015 were used, based on two zonation systems: the homogeneous fire regime zones and ecozones. Nationally, the results show that area burned has almost tripled since 1959, with a doubling in the number of large fires, which are predominately caused by lightning. Conversely, the area burned by human-caused fires has decreased by 50% and the number of human-caused large fires has declined by 78% since 1980. The results also show that over the last 57 years, large fires have been getting bigger in size. The fire season is getting longer by an average of almost two weeks, with a significantly earlier start of one week and with less area burned in the summer months, potentially shifting to the shoulder seasons (spring and fall). Spatially, trends in fire regimes are variable across the country depending on the zone. In general, increased trends in area burned, number of large fires and lightning caused fires are more prevalent in the West. Human-caused fires are either stable or declining throughout the country.

Many of these results were expected based on previous studies at smaller regional scales or for a single parameter, such as area burned. Climate change studies have predicted longer fire seasons, greater area burned and increased number of fires. However, the decreased trends for fires of all sizes and large human caused fires are not consistent with previous work. These trends are unexpected and further study is needed to better understand the influencing factors, which may include fire suppression, changes in education, fire management policies or other factors. Further research is also needed to determine whether these trends will continue, or if changes in climate will override human influences and shift the trend in human-caused fires.

Metabarcoding technique used for boreal forest monitoring

Overview
An advanced DNA technology that identifies many aquatic organisms at once has shown to be an effective tool in monitoring boreal forest ecosystems.

Research scientist Dr. Lisa Venier conducts research on forest biodiversity, which requires the monitoring of standard indicator species that are ecologically relevant and sensitive. Monitoring also needs to be carried out in a cost-effective manner. A recent study compared the use of DNA meta-barcoding technology with hands-on identification of invertebrate specimens. The hands-on identification method has been used for decades in the study of ecosystem diversity, but is time consuming and costly as it requires the manual collection and identification of individual species. Cutting-edge DNA barcoding technology developed by the University of Guelph can help speed up and improve the monitoring process, as the method is a quick and highly accurate way to detect many different aquatic organisms in water. The new technology allows more information to be gathered and the data can more easily be reproduced and interpreted than with the standard morphology approach. Another important aspect of the work is that it can be applied to an environmental gradient, measuring fluctuations in conditions based on various stressors and processes.

Biomonitoring is an important measure of ecosystem health. Accurate and timely information about the boreal ecosystem is needed, particularly with expected climate change effects such as rising temperatures,

which leads to degradation of permafrost, as well as more intense droughts and wildfires. Stream health is an important indicator of overall forest health and biodiversity.

For more detailed information on this study, contact Dr. Lisa Venier.

CRITTER database for comparison of invertebrates launched

Overview
CRITTER is a Canadian Repository of Invertebrate Traits established to promote the use of functional traits among ecologists studying invertebrates across Canada.

CRITTER is part of the Traits of Plants in Canada (TOPIC) Network, whereby species with a similar set of characteristics are grouped together, facilitating comparison between ecosystems. The database will be officially launched at the Quebec Centre for Biodiversity Science annual symposium in December. The new database was established to stimulate, facilitate and promote the use of functional traits among ecologists studying invertebrates across Canada. Network members are currently addressing key research questions in biodiversity science, global change, forest ecology and management, and interaction ecology.

The CRITTER database has the goal to compile existing knowledge of functional traits of invertebrates in Canada and is organized in two modules. The literature review module compiles functional trait data from the scientific literature and is available to any researcher willing to provide an equivalent contribution towards the database. The empirical data module is a repository for functional traits that have been measured on invertebrates in a variety of ecosystems in the field or lab. Currently, the CRITTER database documents approximately 50 functional traits and has entries for over 400 different taxa. The compilation of this knowledge has the additional advantage of fostering potential collaborations among researchers according to an established data sharing procedure.

For more information contact Dr. Isabelle Aubin.

Digital soil mapping in Ontario underway

Overview
GLFC's forest soil ecologist Dr. Kara Webster is part of a collaborative effort to develop digital soil mapping tools at test sites across Ontario.

Soils play a fundamental role in forest productivity and are of particular importance in forest management planning and operations. Ontario's forests grow on a diverse assortment of landscapes, such as the steep slopes of the Canadian Shield, the rolling glaciated landscape of the Great Lakes - St. Lawrence region and the lacustrine plains of the Clay Belt. These diverse landscapes create a heterogeneous soil layer, with unique physical and chemical properties that are challenging to map. There is a need to better refine the soils information for Ontario's enhanced Forest Resources Inventory (eFRI), as the current soil data layers are either absent or too coarse in resolution to be useful. While digital soil mapping has been successfully implemented at local scales, success at broader regional scales has been limited because of the fundamental differences in the underlying geology, topography and climate that affect soil properties in different landscapes.

In this project, we are establishing some test sites that take into account the diversity of landscape conditions within the province. These areas include the Petawawa Research Forest, the Hearst Forest and the Romeo Malette Forest in northeastern Ontario. The sites will be useful for developing a digital soil mapping strategy across Ontario.

Currently, soils within eFRI are mapped based on photo interpretation, with inferences from landscape position and vegetation associations. Digital soil mapping incorporates a variety of data sources, including topographic attributes derived from digital elevation models and other available data, such as bedrock and surficial geology, and vegetation which can be used to predict soil properties.

A knowledge synthesis was conducted to assess the current 'state of the art' of digital soil mapping and to evaluate the best digital soil mapping approaches. As a result of this synthesis, the project will use an ensemble approach, such that different machine learning algorithms will be tested to evaluate how well they can map soils in the different landscapes. The study will focus on predicting key soil properties that influence forest productivity and site suitability, specifically soil texture, depth and moisture regime. The project will make use of an extensive set of plot data from a variety of sources including eFRI ground validation plots, National Forest Inventory and Provincial Forest Inventory plots, provincial growth and yield plots and Ecological Land Classification plots.

Once established, digital soil map projects will be useful for not only forest management, but also for other applications such as carbon accounting, site productivity, enhanced harvest scheduling and road construction, sensitive site mapping, habitat availability, and non-traditional forest products.

This project is funding by the Forestry Futures Trust in collaboration with the Ontario Ministry of Natural Resources and Forestry.

Potential pathogen for mountain pine beetle (MPB) control identified

Overview
A serendipitous find of fungus in a laboratory colony of MPB may hold potential for biological control.

In classic biological control programs, identification of natural enemies within a population is a useful starting point. Samples from MPB populations collected from locations in Alberta and British Columbia were used to establish a laboratory colony of MPB in GLFC quarantine facilities in 2009. The colony was maintained for ecological studies, including the selection of potential candidates for classical biological control strategies. In 2014, the anticipated beetle progeny from logs that had been infested with adult MPB for colony maintenance did not emerge. When the infested logs were peeled to ascertain a cause for the non-emergence of the progeny, a total collapse of the laboratory MPB colony was observed. Closer inspection revealed dead MPB were infected with a fungus with morphological characteristics similar to *Beauveria* species. The identified *Beauveria* species was isolated and molecularly characterized as a new fungal isolate belonging to the *B. pseudobassiana*(MPB-UBK) group. Comparative analysis with notable commercial entomopathogenic fungi isolates showed MPB-UBK to be significantly more potent. In addition, it has all the attributes and qualities that makes it a better isolate for withstanding adverse environmental conditions.

MPB-UBK has the potential to be used as part of a strategy for mitigating and controlling the spread of MPB populations through classical biological approaches in a trap based auto-contamination-dissemination fashion. MPB is the most destructive native insect pest to most North American pine species and under the right conditions can erupt into large-scale outbreaks and cause significant losses to mature healthy stands. Field-testing of the new *B. pseudobassiana* would be the next step in developing a potential biological control agent against this destructive pest.

For more detailed information on this study, contact Dr. George Kyei-Poku.

Photos (left to right): Healthy adult MPB (BC Ministry of Forests), dead adult MPB with MPB-UBK mycelia outgrowth 3 days post-mortem, dead MPB covered with MPB-UBK conidia 14 days post-mortem and peeled log with MPB-UBK infected MPB cadavers.

Update on emerald ash borer (EAB) research

Overview
GLFC's Insect Production Unit will start rearing a new species of parasitic wasp that attacks EAB eggs and field trials are planned for another species that may be well suited for use on larger trees in urban areas in our cold climate. Collaboration with European researchers is underway to better understand the risk of EAB invasion in the UK.

In late June 2017, the first locally produced wasps of the species *Tetrastichus planipennisi* ("Tet") were released at Fort St. Joseph, a National Historic site near Sault Ste. Marie. The Insect Production Unit is preparing to rear a second species, *Oobius agrili*, which is even smaller than Tet, barely the size of a grain of pepper. Field trials with this species have been underway since 2015, using wasps obtained from the US Department of Agriculture, Animal Plant Health Inspection Service rearing facility in Brighton, Michigan. The goal is to produce locally grown wasps of this species for 2018 research trials. Preliminary test results from releasing this species in urban city streets appear promising.

In 2017, permission was also received to release a third species, *Spathius galinae*, originally from Russia, which causes high levels of parasitism on EAB larvae infesting green ash. Approximately 700 of this species were obtained from the US lab and released at two sites in eastern Ontario. This species is of a larger size, so is capable of attacking EAB in larger trees with thicker bark. It is also very cold tolerant and is predicted to establish well in Canada's cold climate.

In total, there are 20 sites across Ontario and Quebec where releases have occurred. The intention is that the wasps will spread from these sites and establish additional populations. While they are not expected to control EAB in the short term, the goal is that there will be more of an impact in the future once the majority of ash have been killed, and the EAB population is lower.

Follow-up sampling to evaluate whether Tet has become established is underway. Tree samples are placed in rearing containers to allow development and emergence of EAB and any associated parasitoids. Results look promising to date, with Tet found in each of the six sites where sampling has been completed and in about 64% of all trees sampled. This supports US findings, where establishment was

high. A further four sites will be sampled over the winter and in spring 2018, the bark of some infested trees will be peeled to evaluate how many EAB larvae are being attacked by the parasitoid.

It will be several years before it can be determined whether these parasitoid releases are reducing the emerald ash borer populations enough to effectively protect ash trees. In the US, where the program is a few years ahead, a new study shows a high level of parasitism on EAB attacking the younger ash cohort, which is regenerating post-EAB. This is very promising as it may indicate a lower equilibrium of EAB in the future.

Emerald ash borer is a problem not just in North America but possibly in Europe as well. Entomologist Dr. Chris MacQuarrie is part of a new collaboration with forestry researchers in the UK and the University of Toronto. Their project will examine EAB ecology, including the effect of temperature and climate on range expansion in Canada and invasion risk in the UK. The project is jointly funded by Forest Research and Defra (Department for Environment, Food & Rural Affairs) from the UK, the Canadian Forest Service, the University of Toronto, and SERG International in North America. Chris also hosted a delegation from the UK and the Netherlands who were on a fact-finding tour in North America to learn about research on EAB and Bronze birch borer. The group visited sites in southern Ontario as well as GLFC, where they gave a seminar and met with staff.

Tree plantings at GLFC arboretum to mark Canada 150 and to strengthen Indigenous relationships

Overview
Special tree planting ceremonies at GLFC's arboretum included the involvement of a local school, the city of Sault Ste. Marie and two area Indigenous communities.

Over 450 trees grow on the grounds of GLFC and the adjacent arboretum, representing 88 species. In 2017, a special renewal effort began, both to replenish losses of large mature tree due to disease and storms, to mark Canada's 150th anniversary, and to strengthen relationships with our two area Indigenous communities. With the goal of planting trees native to Canada, a total of 60 trees were planted, of which 16 were new species. Many of these were representative of western Canada, including subalpine fir, amabalis fir, western redcedar, yellow-cedar, Rocky Mountain Douglas-fir and limber pine. A number of whitebark pine seedlings were also planted, which was of particular significance to the GLFC arboretum as it is listed an endangered species.

Two trees were planted to recognize Canada's 150th anniversary. In June, school children from Queen Elizabeth Public School were excited to be involved in the planting of a large sugar maple tree, purchased with money they had raised themselves. During National Forest Week in September, a red maple tree was planted to in conjunction with the City of Sault Ste. Marie. Plaques were set in place at both trees to honour the occasions.

In October, two sugar maples were planted during a special ceremony to recognize the commitment by GLFC to strengthen relationships with our two area Indigenous communities – Batchewana First Nation and Garden River First Nation. Key components of the event were presentations from the Chiefs of each community that highlighted the Indigenous perspective on forest management and forest values, including non-timber forest products. The Director General of GLFC responded to their presentations and spoke about GLFC's former participation with Indigenous programming and forestry, as well as about the science that is currently being conducted at the Centre. The ceremony included drummers, a

pipe carrier, a water ceremony and jingle dress dancers, along with the unveiling of tree plaques in recognition of each Indigenous community.

Photo on left: Local school children at the planting of "their" sugar maple tree.
Photo on right: Director General Dr. David Nanang (centre) with Chief Sayers of Batchewana First Nation (left) and Chief Syrette of Garden River First Nation (right).

Webinar reports

Overview

On October 3, 2017, forest entomologist Dr. Jeremy Allison gave a webinar entitled: "Factors affecting the performance of semiochemical-baited intercept traps for forest Coleoptera".
On November 15, forest biologist John Pedlar spoke about assisted migration as a tool for climate change adaptation.

Jeremy presented the results of field trapping studies that characterized the impact of different trap design factors on the capture of Cerambycidae, a meta-analysis to look for patterns in the effects of trap design on the capture of forest Coleoptera, and walking wind-tunnel and field trapping assays that attempted to characterize the impact of trap silhouette on plume structure and trap active space. To see the slide presentation or listen to the audio recording go to ftp.nrcan.gc.ca/cfs/glfc/.

John gave a webinar as part of the CIF-CFS lecture series "Innovative Solutions to Respond to the Challenges of a Changing Climate". He spoke about assisted migration as a tool for climate change adaptation. John's work focuses on species distribution modelling and forest responses to climate change. Recently he has been a member of two CFS task groups that have explored topics such as assisted migration and the implications of climate change for timber supply in Canada. To see the slide presentation or listen to the audio recording go to Assisted migration as a tool for climate change adaptation in Canada.

Recent Publications

- To order copies of these publications, please contact the Great Lakes Forestry Centre publications assistant.
- Publications are available in English unless otherwise indicated.

Emilson, C.E.; Thompson, D.G.; Venier, L.A.; Porter, T.M.; Swystun, T.;Chartrand, D.; Capell, S.; Hajibabaei, M. 2017. DNA metabarcoding and morphological macroinvertebrate metrics reveal the same changes in boreal watersheds across an environmental gradient. Scientific Reports. 7: 12777.

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Pisa, L.; Goulson, D.; Yan, E.C.; Gibbons, D.; Sánchez-Bayo, F.; Mitchell, E.; Aebi, A.; van der Sluijs, J.; MacQuarrie, C.; Giorio, C.; Long, E.Y.; McField, M.; Bijleveld van Lexmond, M.; Bonmatin, J.M. 2017. An update of the Worldwide Integrated Assessment (WIA) on systemic insecticides. Part 2: Impacts on organisms and ecosystems. Environmental Science and Pollution Research. pp.1-49.

Roe, A.; Dupuis, J.; Sperling, F. 2017. Molecular Dimensions of Insect Taxonomy in the Genomics Era. Pages 547-573 in R. G. Foottit and P. H. Adler, eds. Insect Biodiversity: Science and Society. John Wiley & Sons, Ltd, Chichester, UK.

Rousseau, L.; Venier, L.; Hazlett, P.; Fleming, R.; Morris, D.; Handa, T. 2018. Forest floor mesofauna communities respond to a gradient of biomass removal and soil disturbance in a boreal jack pine (*Pinus banksiana*) stand of northeastern Ontario (Canada). Forest Ecology Management. 407:155-156.

Venier, L. A. ; Work, T.T.; Klimaszewski, J.; Morris, D.M.; Bowden, J.; Kwiaton, M.M.; Webster, K.; Hazlett, P. 2017. Ground-dwelling arthropod response to fire and clearcutting in jack pine: implications for ecosystem management. Canadian Journal of Forest Research 47: 1614–1631.

Xu, Q.; Fox, G.; McKenney, D. 2017. Soybean yield trends. FARE Share, University of Guelph newsletter, Issue 17.

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