Natural Resources Canada / Ressources naturelles Canada

The Great Lakes Forestry Centre (GLFC)

e-Bulletin

Issue 34, Spring 2018

Canada

Comings and Goings

We welcome Claudette Trudeau, a new policy advisor in the Planning and Operations Division. Claudette will be the lead for providing policy advice and briefings to the Centre Leadership Team and support our Indigenous engagement strategy. She will also be responsible for establishing and maintaining effective relationships with industry, provincial partners, other stakeholders and Indigenous communities in Ontario to advance the mandate of the CFS. Contact Claudette for more information.

Street tree surveys for Canadian communities

Overview

A survey tool developed by researchers at GLFC that enables the identification of street trees using Google Street View will assist communities in their ability to respond to the threat of invasive insects.

Invasive forest insects, such as emerald ash borer (*Agrilus planipennis*) and Asian longhorned beetle (*Anoplophora glabripennis*) can wreak havoc on both natural and urban landscapes. One of the key costs associated with these insects is their impact on urban forests – specifically trees near human infrastructure, which typically need to be removed swiftly following attack and often at considerable expense to municipalities, utility companies, and property owners.

In order to support efforts to estimate the potential economic impact of invasive forest insects, members of the Economic Analysis and Geospatial Tools group at GLFC devised a rapid survey to estimate the composition of street trees in urban centres across the country. (Contact GLFC for a copy of the Forestry Chronicle article publication by Pedlar et al. 2013 that explains the survey in more detail.) The original design involved surveyors walking or driving a sample of street segments (0.5 km in length) across each urban centre. Using this approach – and with the efforts of both CFS employees and volunteer groups – surveys were completed in 51 communities, providing a first glimpse of patterns in street tree composition across eastern Canada.

In order to improve survey coverage and cost-effectiveness, the original approach was recently modified such that street segments are now being surveyed using Google Street View. Early results indicate that this approach has an accuracy of approximately 70% for species-level identifications and nearly 90% at the genus level. To date, more than 300 surveys have been completed in 32 communities across eastern Canada. These data will support ongoing in-house economic impact analyses – including a current effort to estimate the potential costs associated with Asian longhorned beetle. There is also significant external interest in the project and collaborative ties have been established with Health Canada and the Canadian Urban Environmental (CANUE) Health Research Consortium. More surveys and ongoing quality control efforts are planned for the upcoming fiscal year.

Emerald ash borer (EAB) in Winnipeg

Overview

With the recent discovery of EAB in the city of Winnipeg, GLFC researchers are helping to ensure that their latest scientific research is being used to develop the best management strategies to cope with this serious invasive pest.

On December 7, 2017, the Canadian Food Inspection Agency announced that EAB had been detected in Winnipeg, Manitoba. Prior to the announcement, this invasive species was known to be located only in Ontario and Quebec. GLFC researcher Dr. Krista Ryall is assisting the city of Winnipeg with its response and management plan to ensure the best allocation of resources using the most recent scientific information. Previously developed sampling and monitoring techniques will be deployed to determine the extent of the EAB infestation. Research has shown that early detection and delimitation is critical for the development of effective management plans for EAB. Using the information obtained through the initial delimitation survey and the detailed ash street-tree inventory for the city, Dr. Denys Yemshanov will use computer models to test optimal surveillance and tree removal scenarios for Winnipeg. Information from these models will enable the city to implement optimal sampling techniques for monitoring of EAB populations and to evaluate the potential impacts of tree removal programs.

Next, EAB's population dynamics and cold tolerance in a prairie climate will be studied in a project by Dr. Chris MacQuarrie. Cooler climates may slow the development of populations, with more EAB developing in a two-year life cycle as compared to the one-year life cycle typically seen in southern Ontario, for example. Moreover, it is possible that younger larvae are less able to withstand cold winter temperatures and thus experience higher mortality as compared to the typical later-instar or prepupal stage, which overwinters in areas with a one-year life cycle. Both of these factors could likely affect the rate of population growth and spread and thus influence the mortality rate of trees. If the colder temperatures indeed influence the EAB population as predicted, then the lower growth of EAB populations combined with higher mortality of larvae during the overwintering period may assist the city of Winnipeg in its efforts to manage this devastating insect pest.

Finally, Dr. Ryall will evaluate whether Winnipeg is a candidate for the release of biological control agents in the long-term. Three species of parasitoids have been released in Ontario and Quebec since 2013 against EAB. Most recently, a cold-tolerant species of parasitoid, originally from Russia, has been released in Ontario; this species may be an optimal candidate for the conditions present in Winnipeg. Biological control agents would eventually contribute to the maintenance of ash on the landscape following the predicted initial wave of ash mortality.

Overall, CFS research will provide Winnipeg with leading-edge scientific information to inform their management strategies.

Novel assessment methods for tracking exotic emerald ash borer (EAB) parasitoids

Overview
New, more effective and accurate techniques for tracking exotic EAB parasitoids have been developed in the laboratory and are adaptable for field use.

Field trials with non-stinging parasitic wasps for control of EAB were initiated in 2013 using two exotic wasp species from China, the native range of EAB. *Oobius agrili*, (an egg parasitoid that lays its eggs inside the eggs of EAB) and *Tetrastichus planipennisi* (a larval parasitoid that inserts its ovipositor through a tree's bark and lays its eggs on the EAB larvae) were released at various field sites in Ontario where EAB had become established. As a standard protocol, selected trees can be felled and bolts incubated in the laboratory to observe adult *T. planipennisi* emergence. The emergence outcome is used to measure *T. planipennisi* release success, evaluate parasitism levels and aid prompt management decisions regarding additional releases of this parasitoid. For *O. agrili*, finding parasitized EAB eggs in the field is very difficult and sometime impossible. Sentinel EAB eggs are used to attract-trap *O. agrili* adults as a means to determine their presence, establishment and spread in the release location. This process can be followed by either dissection of the presumed parasitized EAB eggs to observe *O. agrili* development stages or incubation of the parasitized EAB eggs for adult *O. agrili* emergence.

The described processes for establishment and parasitism assessment are tedious, time consuming and require a person trained in identification of these parasitoid species.

Molecular biologist Dr. George Kyei-Poku has designed several easy-to-operate, rapid, highly sensitive, accurate and cost-effective ways to molecularly identify adults of these parasitoids and most importantly their presence at various developmental stages in EAB eggs or larvae. The loop-mediated isothermal amplification (LAMP) method that he employs can be performed at a constant temperature of 65°C and results can be accomplished within one hour. One specific advantage of this technique is that the assays are tolerant to impure samples. The parasitoid adults and EAB specimens suspected of parasitism are simply ground in water or sodium hydroxide, boiled for a few minutes, and part of the subsequent mixture is used for the amplification process.

Various detection formats for visualizing the LAMP products can be used, depending on the application type and specific requirements. In the laboratory, positive LAMP products containing parasitoid DNA can be detected in agarose gels as ladder-like streaks. To shorten the detection time, special dyes are added into the tubes and the positive LAMP reaction changes color from yellowish to greenish (Figure 1, i and ii).

Recently, Dr. Kyei-Poku has adopted two exclusive LAMP product detection systems. First is the lateral flow dipstick format, a technology similar to a pregnancy test, which requires a specially prepared cardboard stick to be inserted into a tube containing diluted LAMP products tagged with specific probes. A color signal produced on the control line and the test line is an indicator of the presence of the target parasitoid (Figure 1, iii). The second platform for rapid detection is the use of the Genie equipment, a portable fluorimeter whereby a fluorescence signal can synchronize with the amplification of products for the generation of real-time data. Melt curves are an indicator of positive products containing parasitoid DNA, (Figure A; Figure 1, iv).

Dr. Kyei-Poku has since obtained significant results and has detected signals in DNA mixtures with a single *T. planipennisi* parasitized EAB larva in 150 non-parasitized EAB larvae.

When taken into the field for use on-site, the LAMP assays and detection formats will lead to less time processing samples, more accurate detection and cost efficiencies, and will result in a well developed monitoring strategy for determining parasitoid establishment especially on large release sites.

For more detailed information on these techniques, contact Dr. George Kyei-Poku.

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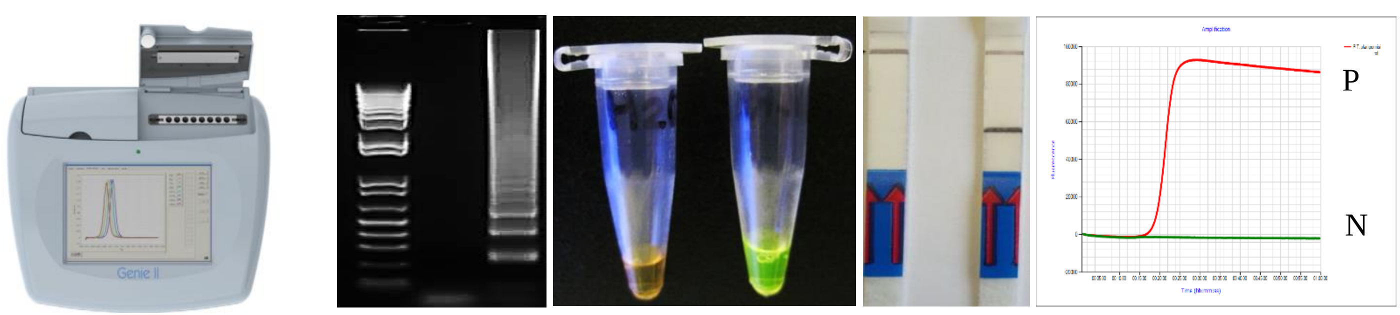

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Figure 1. Example of a loop-mediated isothermal amplification (LAMP) assay performed with the Genie equipment and LAMP product detection with various formats. (i) Agarose gel; (ii) green dye; (iii) Lateral Flow Dipstick Assay and (iv) Real-Time data through fluorescence signal.
P = positive sample/presence of target parasitoid species; N = negative sample/water

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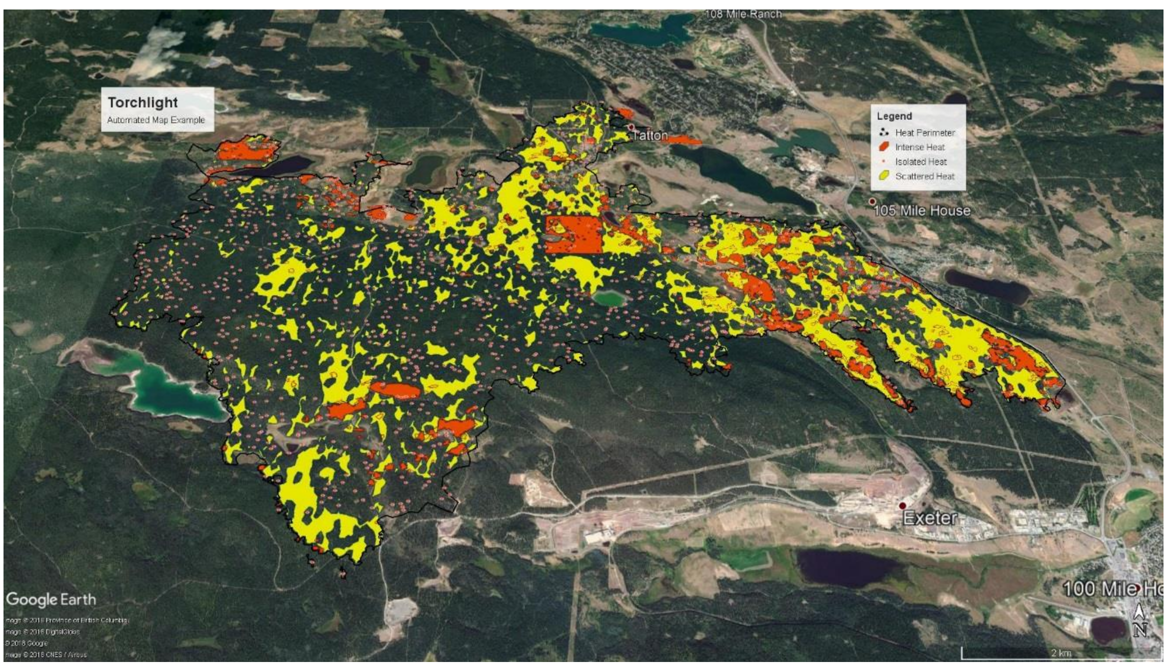
"Torchlight": A new remote sensing tool for tactical fire mapping

Overview
In emergency forest fire situations where there is imminent threat to communities, "Torchlight" can provide increased intelligence to wildfire operations teams.

As a result of climate change, wildfires are becoming an increased threat to Canadians, with fire seasons becoming longer and more intense. Costs associated with fire suppression are increasing for the provinces, particularly as populations, including Indigenous communities, increase in and near forests.

This growing threat and impact of wildland fire in Canada calls for a change in how wildfires are fought. The need for change was highlighted in the Canadian Council of Forest Ministers renewal of the Canadian Wildland Fire Strategy (2016) and reviews of the 2016 Fort McMurray fire, which recognized the value of developing a federally led infrared mapping system for wildfire support.

The Great Lakes Forestry Centre's (GLFC) Dr. Joshua Johnston is leading a team that has established a new remote sensing tool for tactical fire mapping that will meet some of these needs. "Torchlight" maps active fire perimeters and shows hotspots, scattered heat and isolated heat from wildfires, providing situational awareness for complex, largescale firefighting efforts. It is intended to be deployed in emergency situations, where there is an imminent threat to life, infrastructure or values. The increased intelligence can assist wildfire operations teams with resource allocation.



Example of an automated map showing the areas of intense (orange), isolated (red) and scattered (yellow) heat.

A "Proof of Concept" program was set up for the summer of 2017, but due to BC's Wildfire State of Emergency, the province requested information over a 72-day period, from July 10th to Sept 19th. In response, the GLFC team provided mapping products on 58 days, relating to 215 fire events. This means that Natural Resources Canada was able to offer an unprecedented level of tactical support to BC during what may very well be the longest lasting wildfire related state of emergency on record. As of Sept 27th, 2017, BC's area burned was 1,212,132 ha, which is nearly 8 times the 10-year average.

An after-action review was completed and results indicate that this was highly valued by operational fire management staff. Constructive feedback from the survey is currently being considered for when the next version of "Torchlight" rolls out. The 2018 version will include automated mapping.

The torchlight logo with Latin motto "*spectantibus noctis*", meaning "Night Watchers", in reference to the tool's ability to map fires overnight, thereby serving as a night watch for evacuated communities.

For more information on this program, contact Josh Johnston.

Mapping current and future wildfire risk

Overview
GLFC fire researchers are part of a group developing a set of fire risk maps for Canada, which will ultimately enhance the country's resilience to wildfire.

Funding provided by the Department of National Defence's Canadian Safety and Security Program is providing fire scientist Dr. Xianli Wang and his colleagues a chance to develop a fire risk mapping project. The researchers will establish a protocol for producing fire risk maps as well as create the first generation of maps, which will indicate the probability of a fire burning at a particular location in a given year. These maps will be of particular value to fire management agencies in terms of managing fuel (enhancing FireSmart preparations) and planning for safer communities. Fires that encroach on communities can result in evacuations, health impacts due to smoke, property loss, and loss of employment and business income. A nationally consistent assessment of fire risk and potential for high intensity fire across the landscape, especially near communities, is key for planning and prioritizing wildfire mitigation programs.

The outcome of this work will result in estimations of fire risk for both the current and future with a consideration of climate change. This study will assemble Canada-wide long-term historical fire and daily weather databases, remote sensing products for daily fire growth, and future fire weather scenarios from a collection of the most updated global climate models. The project will produce a series of Canada-wide, baseline fire characteristics (including burn probability, fire intensity and fuel consumption) and fire risk maps for current and future climate change scenarios across Canada.

Outputs from this project will provide a better understanding of not only the current spatial distribution of fire risks but also the potential shifts in wildfire threat over time and space with consideration of climate change. By combining burn probability and fire danger (hazard) with urban and wildland interface distributions (vulnerability), communities will have a useful risk assessment tool. The information will be invaluable for fire management and community planning, including fuel management, urban and industrial wildfire protection, development planning, and insurance purposes.

"Chemoindicators" used for stream biomonitoring

Overview
The use of a simple spectral technique for analyzing organic compounds in water samples offers a way to enhance the assessment of biological condition within aquatic ecosystems.

The characterization of benthic invertebrate communities is a long-standing and well-established approach to assess the overall health or integrity of aquatic ecosystems, particularly lotic (flowing) habitats. Benthic macroinvertebrates are commonly used as bioindicators of the biological condition of waterbodies. These organisms, which include small aquatic organisms and the larval stages of many insects, are reliable indicators because they are easy to collect, inexpensive to process and differ greatly and predictably in their tolerance to disturbances. Their community composition is considered an integrated reflection of the cumulative (spatial and temporal) effects of the stressors to which they are exposed. The only downside to this indicator approach is the inability to differentiate the causes of effects, particularly given the cumulative nature of many stressors within a watershed.

Dr. Erik Emilson and colleagues at GLFC aim to complement the traditional bioindicator approach with an additional "chemoindicator" (an inexpensive and easy-to-use spectral tool) to collect a variety of information about the nature of the thousands of organic molecules that are present in a given water sample. The tool is well suited to the chemodiverse nature of organic molecules present in aquatic ecosystems that originate from a variety of spatial and temporal components and processes within a forested watershed. Our laboratory is working on better linking spectral signatures to ecosystem functions within an aquatic ecosystem (including biogeochemical processes tied to nutrient and carbon cycling) as well as to processes occurring within the forest. The goal is to develop chemoindicators that can be extracted with widely available spectrophotometers and used in combination with traditional bioindicators to better detect the causes of declines in biological condition within aquatic ecosystems. This will facilitate our improved understanding of the pathways through which forest management activities and other anthropogenic and natural disturbances may alter aquatic ecosystem function and lead to improved management approaches to mitigate these impacts.

For more detailed information on this study, contact Dr. Erik Emilson.

Restoration of fragmented boreal landscapes for caribou protection: a modelling approach

Overview
GLFC scientist Dr. Denys Yemshanov used modelling techniques to find optimal locations for seismic line restoration in the Cold Lake area, Alberta.

Oil and gas exploration in boreal regions of western Canada involves the clearing of seismic lines to locate and access resource deposits (e.g., bitumen), which create linear disturbances in forests. Legacy seismic lines have caused habitat fragmentation and increased predator access leading to a subsequent decline of some wildlife populations, particularly woodland caribou (*Rangifer tarandus*). Ecological restoration of seismic lines helps slow the decline of caribou populations but is costly. Decision makers strive to develop strategies that maximize the capacity of wildlife populations to access suitable habitat while keeping project costs within a defined budget.

Dr. Yemshanov and his collaborators designed an economic model with the objective of determining landscape restoration strategies that maximize the habitat area that can be accessed by a wildlife population in a fragmented landscape. He adopted a graph theoretic approach that depicts a fragmented forest as a network of interconnected habitat patches. The model shares conceptual similarities with a budget-constrained Generalized Steiner Network problem. He compared two economic restoration scenarios that aim to restore the populations' local and long-distance access to suitable habitat.

He applied the model to find optimal locations for seismic line restoration in the Cold Lake area, Alberta, Canada. Optimal restoration involves a mix of two strategies. The first strategy establishes short-distance connections between forest patches with large areas of intact habitat and the second strategy establishes long-distance corridors between areas with known species locations and largest amounts of suitable habitat. The model reveals the trade-offs between these strategies and finds the least-cost restoration solutions under a limited budget. The approach is generalizable and can be applied to other species and habitat types.

Dr. Yemshanov presented his work on this project in a webinar February 6th. The slide presentation and audio recording are available here.

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.

Aubin, I.; Boisvert-Marsh, L.; Kebli,H.; McKenney, D.; Pedlar, J.H.; Lawrence, K.; Boulanger, Y.; Gauthier, S.; Hogg, T.; Ste-Marie, C. 2018. Tree vulnerability to climate change: improving exposure-based assessments using traits as indicators of sensitivity. Ecosphere 9(2):e02108.

Brockerhoff, E.G., Barbaro, L., Castagneyrol, B., Forrester, D.I., Gardiner, B., Gonzalez-Olabarria, J.R., Lyver, P.O.B., Meurisse, N., Oxbrough, A., Taki, H., Thompson, I.D., van der Plas, F., Jactel, H. 2017. Forest biodiversity ecosystem functioning and the provision of ecosystem services. Biodiversity and Conservation 26(13):3005-3035.

Buttle, J.M.; Beall, F.D.; Webster, K.L.; Hazlett, P.W.; Creed, I.F.; Semkin, R.G.; Jeffries, D.S. 2018. Hydrologic response to and recovery from differing silvicultural systems in deciduous forest landscape with seasonal snow cover. Journal of Hydrology 557:805-825.

Faber-Langendoen, D.; Baldwin, K.; Peet, R.K.; Meidinger, D.; Muldavin, E.; Keeler-Wolf, T.; Josse, J. 2017. The Eco Veg Approach in North America: U.S., Canadian and International Vegetation Classifications. Phytocoenologia: http://10.1127/phyto/2017/0165.

Fleming, R.L.; Leblanc, J-D.; Weldon, T.; Hazlett, P.W.; Mossa, D.S.; Irwin, R.; Primavera, M.J.; Wilson, S.A. 2018. Effect of vegetation control, harvest intensity, and soil disturbance on 20-year jack pine stand development. Canadian Journal of Forest Research 48:1-17.

Hannam, K.D.; Venier, L.; Allen, D.; Deschamps, C.; Hope, E.; Jull, M.; Kwiaton, M.; McKenney, D.; Rutherford, P.M.; Hazlett, P.W. 2018. Wood ash as a soil amendment in Canadian forests: what are the barriers to utilization? Canadian Journal of Forest Research 48:1-9.

Huber, J.T.; Thuróczy, C. 2018. Review of *Anaphes* Haliday (Hymenoptera: Mymaridae) with keys to European species and a world catalogue. Zootaxa 4376(1):104p.

Inan, C.., Muratoglu, H., Arif, B.M., Demirbag, Z. 2018. Transcriptional analysis of the putative glycosyltransferase gene (amv248) of the Amsacta moorei entomopoxvirus. Virus Research 243:25-30.

Jain, P.; Wang, X.; Flannigan, M.D. 2017. Trend analysis of fire season length and extreme fire weather in North America between 1979 and 2015. International Journal of Wildland Fire 26(12):1009-1020.

Johnston, L.M.; Flannigan, M.D. 2017. Mapping Canadian wildland fire interface areas. International Journal of Wildland Fire 27(1):1-14.

Raponi, M.; Beresford, D.V.; Schaffer, J.A.; Thompson, I.D.; Wiebe, P.A.; Rodgers, A.R.; Fryxell, J.M. 2018. Biting Flies and Activity of Caribou in the Boreal Forest. The Journal of Wildlife Management: http://10.1002/jwmg.21427.

Rousseau, L.; Venier, L.; Fleming, R.L.; Hazlett, P.W.; Morris, D.; Handa, T. 2018. Long-term effects of biomass removal on soil mesofaunal communities in northeastern Ontario (Canada) jack pine (*Pinus banksiana*) stands. Forest Ecology and Management: https://doi.org/10.1016/j.foreco.2018.02.017.

Samková, A.; Janšta,P.; Huber, J.T. 2017. Anaphes flavipes: redescription, neotype designation, and comparison with A. nipponicus (Hymenoptera: Chalcidoidea: Mymaridae). Acta Entomologica Musei Nationalis Pragae 57(2):677-711.

Thompson, D.G.; Tonon, A.; Beltran, E.; Hernandez, F. 2018. Inhibition of larval growth and adult fecundity in Asian long-horned beetle (Anoplophora glabripennis) exposed to azadirachtins under quarantine laboratory conditions. Pest Management Science: http://10.1002/ps.4810.

Venier, L.A.; Mazerolle, M. J.; Rodgers, A.; McIlwrick, K.; Holmes, S.; Thompson, D. 2017. Comparison of semiautomated bird song recognition with manual detection of recorded bird song samples. Avian Conservation and Ecology 12(2)2.

Yemshanov, D.; McKenney, D.W.; Hope, E.; Lempriere, T. 2018. Renewable energy from forest residues—How greenhouse gas emission offsets can make fossil fuel substitution more attractive. Forests 9(2):79.

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