Natural Resources Canada Ressources naturelles Canada
The Great Lakes Forestry Centre (GLFC)
e-Bulletin
Issue 30, February 2017
Canada

Comings and Goings

We welcome Dr. Josh Johnston, fire research scientist.

Josh came to the Canadian Forest Service (CFS) after working for the Ontario Government (Aviation, Forest Fire and Emergency Services) for 7 years as a fire ranger, and for the final 3 of those years as a crew leader. In 2010 he took a position with CFS as a Forest Fire Analyst, initially assisting with work being done on the next generation of the fire danger rating system, and since 2011 has specialized in the study of active fire thermal remote sensing, and in particular the study of wildfire behaviour using infrared imagery analysis. Josh holds degrees in Fine Arts and Mathematics, and in December 2015 he successfully defended his PhD thesis entitled "Infrared Remote Sensing of Fire Behaviour in Canadian Wildland Forest Fuels" at King's College London in the UK.

Modelling presentations given

Various members of the Economic Analysis and Geospatial Tools group at GLFC delivered a variety of seminars over the last several months.

Spatial Climate Models

Forest economist and team leader Dan McKenney gave a presentation at the Adaptation Canada 2016 national conference in April, where researchers and practitioners from various sectors exchanged ideas to better understand both needs and opportunities regarding information and tools that have been developed to understand and manage climate risks. Dan's talk was on "High resolution climate models for Canada: methods, limits and applications." For over two decades, Dan and his group have been developing spatial climate models that cover both Canada and the continental US utilizing the thin plate smoothing splines algorithms as implemented in ANUSPLIN. This work is in partnership with The Australian National University, Environment and Climate Change Canada and the US NOAA National Climate Data Center. Time steps range from historical monthly models from prior to 1900, daily models from 1950 and high resolution interpolations of climate change projections for a broad range of parameters. The models are widely used across North America with users inside and outside the forestry world ranging from other researchers, state and provincial agencies, other federal departments and the private sector.

In June, Dan was invited to the Guelph Biomathematics and Biostatistics Symposium 2016, a yearly event held at the University of Guelph. The principal objective of the symposium series is to facilitate collaborations between mathematicians, statisticians and bioscience researchers. This year the theme was on spatial models in ecology. Dan and Professor Mike Hutchinson, a visiting colleague from the Australian National University, jointly received the honorary Gordon C. Ashton Memorial Biometrics Lecture award. Dan spoke on "Spatial ecology: some experiences, needs and opportunities for Canada".

Spatial patterns in ecological phenomena such as species distributions, abundance and productivity are shaped by factors such as climate, soils, competition, and human influences. This presentation summarized some of the modeling work on this subject that has been carried out by the Geospatial Analysis group at the Great Lakes Forestry Centre over the past two decades. In particular, it focussed on the role of climate in shaping tree species' distributions and productivities - with a view to how these patterns and processes may be affected by ongoing climate change. He also shared some cautionary tales about working with spatial data; while maps can provide decision makers with critical information in a compelling format, it is important to remember that they are only as good as the underlying models and data from which they were developed.

Some of Dan's future work will include improved baseline climate maps for the country and historical climate anomaly maps.

Dan also gave a talk on the spatial climate models to Aquanty, a research spin-off from the University of Waterloo specializing in advanced computer simulations of how water, energy, and dissolved solutes move through the terrestrial environment. Aquanty is an example of an organization using these models to support their own environmental modeling work.

Modelling future timber supply

Forest Landscape Biologist John Pedlar attended the Greenhouse Gas Modelling Forum in Shepherdstown, West Virginia, September 26-28. The forum was an opportunity for carbon modellers and policy workers to exchange ideas and present recent work. John presented findings from a recent effort that aimed to assess the impact of climate change on future timber supply in Canada. This effort – a component of the CFS Forest Change Program – was headed up by GLFC scientists Dan McKenney, Denys Yemshanov and John and involved integrating expertise and data from a variety of CFS sources. Specific inputs included: national grids of forest attributes (e.g., age, volume, and species composition), a database of mill locations and harvesting capacities, current and future estimates of annual area burned, and regional growth and yield estimates. Two modelling environments were employed: 1) at the national scale using Denys Yemshanov's Forest Bioeconomic Model (FBM) and 2) at a study area in northern Ontario using NETLOGO, an agent-based modelling platform. The results of this effort are currently being summarized in a CFS information report.

Optimizing control of invasive pests

Scientist Denys Yemshanov gave a presentation at the 10th Annual Meeting of the International Pest Risk Research Group (IPRRG) hosted by the European Food Safety authority in Parma, Italy where he won the Best Presentation medal. He talked about a model he developed that helps mangers find the best management strategy when faced with a new pest invasion. He showed how the model was used to assess the risk of spread of Asian longhorned beetle in the Greater Toronto area. The model can be applied to other species and geographic regions.

His talk: "Optimal control of biological invasions with eradication success benchmarks and management of the risk of uncertain program costs" [1.4 Mb PDF] was based on collaborative work with the US Forest Service. The abstract is as follows: Uncertainty about future outcomes of biological invasions is a major hurdle in the planning of pest management programs. We present a pest management model that incorporates the uncertainty about the spread of a non-native pest and minimizes the expected costs of a pest control program. The model accounts for aspirational eradication success targets and applies the Conditional Value-at-Risk concept to control the uncertainty of the program costs.

We demonstrate the approach by assessing the costs of surveys and eradication efforts outside the quarantine area established following the discovery of a residual population of the Asian longhorned beetle (ALB, *Anoplophora glabripennis*), a harmful invasive pest that has been found in the Greater Toronto Area (GTA), Ontario, Canada. We use historical data on ALB spread in GTA to generate a set of stochastic scenarios that characterizes the uncertainty of the pest's extent and impact in the GTA. We then use these scenarios in our optimization model to find the costs of the survey and host tree removal program that achieves a desired probability of eradicating the pest in the managed area while minimizing the expected program costs. We have also applied the model constraint that enables controlling the risk of uncertain program costs when dealing with the uncertain outcomes of pest invasion. Our results provide a practical approach to assess the costs of pest management programs for given assumptions about the uncertainty of the pest's spread, the costs of pest's survey and eradication, a desired probability of eradication success and decision-maker's tolerance for eradication failure. Our model is generalizable and can be applied to a broad range of species and geographic conditions to help support economic decisions on surveillance and control of invasive species under uncertainty.

This presentation is also available on our webinar website.

The effects of emerald ash borer on urban woodlots

Ecologist Isabelle Aubin gave a presentation to the Canadian Urban Forest Conference that took place in Laval, Quebec September 26-29th, 2016. Her presentation was entitled: "Ecological impacts of human disturbances on urban forests: quantification, assessment and prediction".

Forests in urban environments face multiple stresses that significantly alter their structure and function. A major challenge in ecology is the development of approaches and tools that capture the impact of the complex interactions of different stressors, the assessment of the ecological value of the resulting communities (often with no comparable communities in natural environments) and prediction of these novel ecosystem responses to future disturbances. In this presentation, she examined these three questions using emerald ash borer as a study case. This exotic Coleoptera has killed millions of ash trees in North America since its detection in 2002. She discussed the ecological impacts of this infestation on urban forests and presented results of a long term monitoring experiment located in the epicentre of the Canadian invasion (in southern Ontario). In comparison to forests in an agricultural or forested setting, urban woodlots experienced greater transformation following ash tree mortality, with a heavy invasion by exotic plant species and poor tree regeneration. A loss in resilience was observed in many urban woodlots. She discussed new approaches that allow for early risk assessment.

Upcoming workshop on Remote Sensing of Fire

Canadian wildfire remote sensing researchers and practitioners as well as their international counterparts will be brought together for the first time in June 2017.

Fire researchers Tim Lynham and Josh Johnston are helping to setup Canada's first "Remote Sensing of Fire" workshop to be held in Montreal June 20-22, 2017 as part of the Earth Observation Summit. For the first time, the emerging community of Canadian wildfire remote sensing experts and their international counterparts will be brought together. The workshop will provide an opportunity for participants to share their views on the opportunities offered by remote sensing in wildfire management and research and to recommend an action plan.

The workshop will be jointly organized by the Canadian Forest Service (CFS) of Natural Resources Canada (NRCan) and the Canadian Space Agency. For more information on the Earth Observation Summit 2017, consult their website.

GLFC management team field tour

In October 2016, the Great Lakes Forestry Centre's management team spent three days on a field tour in northeastern Ontario to see first-hand some of the research sites and to meet with stakeholders and clients to communicate GLFC research activities, discuss stakeholder research needs, and identify opportunities for collaboration.

In Rose Township, near Thessalon, they visited the area where fire research trials are conducted. Fire researchers discussed the emerging use of remote sensing tools to determine forest fire conditions and provide intelligence on active forest fires. The area also has a spruce budworm research site, where insect traps, lures, population size and dispersal are being investigated. An Ontario Ministry of Natural Resources and Forestry (OMNRF) Forest Health Technical Specialist showed the group a site where redheaded pine sawfly and pine false webworm infestations are present and discussed the impact and potential control mechanisms for these insects.

The Sharpsand Creek salvage harvest site along Highway 129 was visited, where the ecological impacts of post-fire salvage harvests are being studied by monitoring changes in aspects such as understorey vegetation, tree recruitment, downed woody debris and soil invertebrates. The team was then updated on continuing studies at the Island Lake and Ripple Lake research areas near Chapleau, where collaborative research is being undertaken with the OMNRF to better understand the impacts of biomass harvesting and wood ash application on forest sustainability.

The managers also met with industry representatives of Tembec (Chapleau), White River Forest Products and Rentech (Wawa), where they discussed forest management and toured sawmill and pellet mill operations. In addition to discussing a number of active field research studies being conducted by their scientists, the team strengthened connections with the forest sector and provincial government and improved awareness of current forestry developments in Ontario. The tour increased the awareness of the number of challenges facing the forest industry and the exciting opportunity for improved use of our forest resources and the diversification of Ontario's forest sector.

Publications of interest

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

Airborne optical and thermal remote sensing for wildfire detection and monitoring

The newest member of the Fire Research team, Josh Johnston, reviewed the latest remote sensing techniques in fire management and research.

This paper focuses on providing a comprehensive review of wildfire detection techniques and the current state of the art technologies (for human, airborne, UAV, and satellite systems). This review was conducted to summarize what new technologies have recently emerged, and what are currently being used for fire detection in the operational arena. The field of remote sensing of fire is growing rapidly and it is important to provide this review to document recent advances and the relative value of the various tools. The impact of this paper is narrowly focused. The intention is to provide a status report and some documentation on the utility of current systems. From a research stand point it is valuable to know which technologies have been taken up by operational users, and why. And for groups tasked with developing detection systems this paper will provide valuable guidance in terms of what the end user needs are. From an operational stand point, the province of Alberta alone spends ~$6 million/year on fire detection. It is possible that this paper can assist operational decision makers in identifying alternative lower cost methods of fire detection. Airborne optical and thermal remote sensing for wildfire detection and monitoring is available on our publications website.

Records of unsuccessful attack by Asian long-horned beetle

To ensure success of the Asian long-horned beetle (ALB) eradication program in the Toronto area in 2003, a study was undertaken by GLFC research scientist Jean Turgeon and his colleagues to determine whether tree species not officially targeted for survey or treatment were indeed not suitable; otherwise beetle populations that might be in these trees would escape detection and could perpetuate the infestation.

Discovery of the ALB in Ontario, in 2003 led to the implementation of an eradication program. The plan consisted of removing all infested trees and all trees belonging to a genus considered suitable for complete development of this wood-borer that were found within 400 m of an infested tree; however, many of the trees within that 400 m belonged to genera for which suitability for development of the

insect was questionable or unknown. The objective of this study was to acquire knowledge on host plant selection by the insect outside of its native range and to compare it to that observed in other invasions in the US and in Europe.

Over 3000 such trees visually inspected annually for the three years following removal of infested trees. All but one tree were unattacked: a European ash (*Fraxinus excelsior*) tree had signs of oviposition and early-instar development, but not of adult emergence. Before the survey, only one other species with questionable suitability had been found, a little leaf linden (*Tilia cordata*) that had many signs of oviposition, but no evidence of full development, suggesting resistance to ALB. Both of these trees were within 200 m of the most heavily infested Norway maple (*Acer platanoides*) tree found in that infestation, suggesting that colonization of trees with questionable or unknown suitability might occur, mostly where population pressure is high. Records of unsuccessful attack by *Anoplophora glabripennis* (Coleoptera: Cerambycidae) on broadleaf trees of questionable suitability in Canada is available on our publications website.

Canada's Timber Supply: Current Status and Future Prospects under a Changing Climate

This report, written by GLFC research scientist Dan McKenney and his research team contains an update of certain sections of the 1991 Forestry Canada Information Report "Canada's Timber Supply: Current Status and Outlook" and preliminary results of a computer-based national timber supply study examining potential impacts of climate change. Although the analysis must be considered preliminary due to various data and computational challenges, it would appear that significant increases in delivered wood costs are plausible over the course of the century. British Columbia and Quebec appear most likely to bear the brunt of the changes, with many mills potentially facing delivered wood shortages and/or cost increases of greater than 25% - even by mid-century. Canada's Timber Supply: Current Status and Future Prospects under a Changing Climate is available on our publications website.

A review of functional traits

Which traits to stay, which traits to move: forest ecology researcher Isabelle Aubin reviews functional traits to assess sensitivity and adaptive capacity of temperate and boreal trees to climate change.

This paper summarizes what is known about characteristics of boreal and temperate forest trees in relation to how they respond to climate change. Tree species could respond in three ways: 1) they can tolerate new conditions, 2) adapt to new conditions or 3) "move" to a new location. We describe key characteristics that could be affected by climate-induced changes to water availability, temperature, CO_2 and disturbance regime and how it relates to the three described outcomes. While we have good information for commercial tree species, we lack knowledge about characteristics for large numbers of species and how those characteristics could interact. This information is critical for practitioners and modellers to conduct vulnerability assessments. We call on scientists across forest science disciplines to develop new standards for data collection, documentation, aggregation and sharing so that full use can be made in such assessments. Traits to stay, traits to move: a review of functional traits to assess sensitivity and adaptive capacity of temperate and boreal trees to climate change is available on our publications website.

Recent Publications

Allison, J.; Cardé, R. 2016. Pheromones: reproductive isolation and evolution in moths. Chapter 2 in *Pheromone Communication in Moths: Evolution, Behavior, and Application*, 414 p.

Allison, J.; Cardé, R. 2016. Variation in moth pheromones: causes and consequences. Chapter 3 in *Pheromone Communication in Moths: Evolution, Behavior, and Application*, 414 p.

Allison, J.; Graham, E.; Poland, T.; Strom, B. 2016. Dilution of Fluon before trap surface treatment has no effect on longhorned beetle (Coleoptera: Cerambycidae) captures. *Journal of Economic Entomology* 109(3): 1215-1219.

Allison, R.; Johnston, J.; Craig, G.; Jennings, S.; McAlpine, R. 2016. Airborne optical and thermal remote sensing for wildfire detection and monitoring. Sensors (special issue: *Sensors for Fire Detection*) 16(8): 1310.

Bhagath Kumar, P.; Kasi Viswanath, K.; Tuleshwori Devi, S.; Sampath Kumar, R.; Doucet, D.; Retnakaran, A.; Krell, P.J.; Feng, Q.; Ampasala, D.R. 2016. Molecular cloning and structural characterization of Ecdysis Triggering Hormone from Choristoneura fumiferana. *International Journal of Biological Macromolecules* 88: 213-221.

Bourgeois, B.; Gonzalez, E.; Vanesse, A.; Aubin I.; Poulin, M. 2016. Spatial processes structuring riparian plant communities in agroecosystems: implications for restoration. *Ecological Applications* 26(7): 2103-2115.

De Laport, A.V.; Weersin, A.J.; McKenney, D.W. 2016. Effects of supply chain structure and biomass prices on bioenergy feedstock supply. *Applied Energy* 183: 1053-1064.

Doucet, D.; Retnakaran, A. 2016. Targeting cuticular components for pest management. Pages 369-407 in E. Cohen and B. Moussian, eds. *Extracellular Composite Matrices in Arthropods*, Springer.

Haavik, L.; Allison, J.; Hartshorn, J.; MacQuarrie, C.; Nott, R.; Ryan, K.; Stephen, F.; de Groot, P.; Turgeon, J. 2016. Non-lethal effects of nematode infection in Sirex noctilio and S. nigricornis. *Environmental Entomology* 45(2): 320-327.

Haavik, L.; Dodds, K.; Ryan, K.; Allison, J. 2016. Evidence that the availability of suitable pine limits non-native Sirex noctilio in Ontario. *Agricultural and Forest Entomology* 18(4): 313-445.

Hauer, G.; Luckert, M.; Yemshanov, D.; Unterschultz, J. 2015. A real options-net present value approach to assessing land use change: a case study of afforestation in Canada. *Forest Policy and Economics*. 50: 327-336.

Hope, E.; McKenney, D.; Pedlar, J.; Stocks, B.; Gauthier, S. 2016. Wildfire suppression costs for Canada under a changing climate. *Plos One* 11(8):1-18.

Lyons, B.; Van Frankenhuyzen K.; Kyei-Poku, G.; Blais, M. 2016. The use of fluorescent powders to track autocontamination of emerald ash borer (Coleoptera: Buprestidae) by the entomopathogen *Beauveria bassiana* (Ascomycota: Hypocreales). *Biocontrol Science and Technology* 26(8): 1113-1128.

MacDonald, J.; Goacher, R.E.; Abou-Zaid, M.; Master, E.R. 2016. Comparative analysis of lignin peroxidase and manganese peroxidae activity on coniferous and deciduous wood using ToF-SIMS. *Applied Microbioogy and Biochemistry* 100(18): 8013-8020.

Millar, J.; Haynes, K.; Dossey, A.; McElfresh, J.; Allison, J. 2016. Sex attractant pheromone of the luna moth, *Actias luna* (Linnaeus). *Journal of Chemical Ecology* 42(9): 869-876.

Miller, D.; Allison, J.; Crowe, C.; Dickinson, D.; Eglitis, A.; Hofstetter, R.; Munson, A.; Poland, T.; Reid, L.; Steed, B.; Sweeney, J. 2016. Pine sawyers (Coleoptera: Cerambycidae) attracted to alpha-pinene, monochamol, and ipsenol in North America. *Journal of Economic Entomology* 109(3): 1205-1214.

Noyce, G.; Fulthorpe, R.; Gorgolewski, A.; Hazlett, P.; Tran, H.; Basiliko, N. 2016. Soil microbial responses to wood ash addition and forest fire in managed Ontario forests. *Applied Soil Ecology* 107: 368-380.

McKenney, D.W.; Yemshanov, D.; Pedlar, J.; Allen, D.; Lawrence, K.; Hope, E.; Lu, B.; Eddy, B. 2016. Canada's timber supply: current status and future prospects under a changing climate. Natural Resources Canada, Canadian Forest Service. Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. Information Report GLC-X-15, 75p.

Turgeon, J.; Jones, C.; Smith, M.; Orr, M.; Scarr, T.; Gasman, B. 2016. Records of unsuccessful attack by *Anoplophora glabripennis* (Coleptera: Cerambycidae) on broadleaf trees of questionable suitability in Ontario. *Canadian Entomologist* 148(5): 569-578.

Webster, K.; Akumu, C.; Bhatti, J.; Bona, K.; Dimitrov, D.; Hilger, A.; Kurz, W.; Shaw, C.; Theriault, C.; Thompson, D. Wilson, S. 2016. Development of a forested peatland carbon dynamics module for the Carbon Budget Model for the Canadian Forest Sector -Workshop Report. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. Information Report GLC-X-14, 43 p.

Webster, K.; Hazlett, P.; compilers. 2016. Long term ecological research at the Turkey Lakes Watershed: 35 anniversary of interdisciplinary, cooperative research, program booklet and workshop summary. Natural Resources Canada, Canadian Forest Service, Great Lakes Forestry Centre, Sault Ste. Marie, Ontario. Information Report GLC-X-13, 25 p.

Wilson, B.; Beuzelin, J.; Allison, J.; Reagan, T. 2016. The active space of Mexican rice borer (Lepidoptera: Crambidae) pheromone traps. *Journal of Chemical Ecology* 42(9): 888-895.

For information regarding reproduction rights, please contact Public Works and Government Services Canada (PWGSC) at: 613-996-6886 or at:
copyright.droitdauteur@pwgsc-tpsgc.gc.ca
© Her Majesty the Queen in Right of Canada 2017 ISSN 1715-8036 Great Lakes Forestry Centre, e-Bulletin