Comings and Goings

We wish research scientists Drs. Kees van Frankenhuyzen, Dean Thompson and Doug Pitt all the best in their retirement.

Kees is an entomologist well known for his work with improving the efficacy of *Bacillus thuringiensis,* a biopesticideused against spruce budworm and other forest pests. Dean is an environmental chemist working in the area of ecotoxicology. Over his career he studied the fate of many forest pesticides, and is particularly recognized for his research on the effects of the herbicide Glyphosate on non–target organisms. Doug is a respected silviculture researcher who has been part of the Canadian Wood Fibre Centre housed at the Great Lakes Forestry Centre (GLFC). His work included enhanced inventory methods and promoting forest value through optimal establishment, composition, and growth. All three of our three departing scientists had earned international reputations for excellence in their individual areas of expertise. Their impacts on forest management practices and policies are a long lasting legacy to their work. The wide number of scientific publications of Kees, Dean, and Doug, around 100 each, can be found on the Canadian Forest Service (CFS) publications website.

Insect Production Unit rears first parasitic wasps for emerald ash borer (EAB)

Since 2013, a USDA rearing facility in Michigan has provided a supply of wasps for field trials. With their help, a "made-in Canada" rearing program has begun.

In December 2016, GLFC's Insect Production Unit successfully produced its first batch of parasitic wasps that target and attack the emerald ash borer. The wasps will be used in trials that have been underway since 2013 to test their effectiveness in reducing infestation levels and limiting spread of EAB. Previous field trials were carried out with parasitic wasps generously provided by the US Department of Agriculture, Animal Plant Health Inspection Service rearing facility in Brighton, Michigan.

Tetrastichus planipennisi is a tiny (smaller than a fruit fly), non-stinging parasitic wasp native to China that is very host specific. The female lays numerous eggs on a single EAB larva and once they hatch, will feed on the EAB host, eventually causing it to die.

Growing these wasps in captivity requires a clear understanding of their complex life system. It presents a challenge due to the four elements required: 1. A greenhouse for growing "ever- bearing ash" (*Fraxinus uhdei)*, which produces new leaves continuously to provide a year-round food source for the captive EAB colony; 2. Black ash tree saplings of 4-8 cm that can be cut bi-weekly to provide EAB larvae with fresh, healthy phloem to feed on; 3. A year-round EAB laboratory colony to provide hosts for the parasitic wasps; and 4. A year-round *T. plannipennisi* colony to produce the thousands of wasps required for release during the field program.

The goal for 2017 is to produce enough wasps to augment the insects we receive from the USDA to establish at least six new release sites across Ontario and Quebec, requiring around 12,000 wasps. The made-in-Canada wasps can also be used for lab studies at GLFC into the parasitoid's ecology and behaviour. Once the wasps are released in an area they should naturally establish themselves on the landscape and successively have at least four generations a year. Adult wasps can fly away to find more EAB larvae to parasitize. During the winter, the wasp larvae survive within the EAB larvae and in the spring they emerge to start another year of control.

It will be several years before we will be able to measure whether these parasitoid releases are reducing the emerald ash borer populations enough to effectively protect ash trees. In the US, where trials have been underway for longer, a buildup of parasitized EAB has been reported, but no major impacts on EAB populations have been observed yet. It is hoped that parasitoids could become one of the tools available to help mitigate the spread of this devastating pest.

For more details on the parasitic wasp trials, refer to Frontline Express # 82 (coming out soon) or contact Krista Ryall.

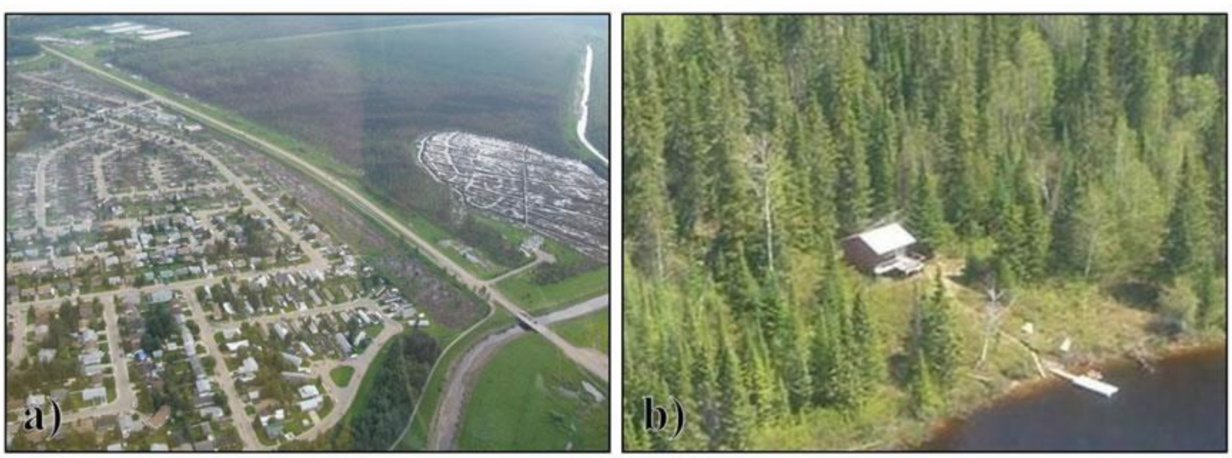
For more details on the *Tetrastichus* parasitic wasp captive breeding program contact John Dedes.

Mapping Canadian wildland fire interface areas

Lynn Johnston, a GLFC fire researcher, recently completed her M.Sc. through the University of Alberta. Her thesis focused on mapping Canadian wildland fire interface areas.

Although wildland fires are a beneficial ecosystem process, they can also cause destruction to human-built structures and infrastructure, as evidenced by disasters such as the Fort McMurray fire in 2016 and the Slave Lake fire in 2011. This type of destruction occurs in the "wildland-urban interface" (WUI), which is the area where homes or other burnable community structures meet with or are interspersed within wildland fuels.

The concept of the WUI can be expanded to industrial structures and infrastructure values. Here, the "wildland-industrial interface" is the interface of wildland fuels and industrial structures (e.g., oil and gas, or mining structures). The "infrastructure interface" is the interface of wildland fuels and infrastructure values (e.g. roads, powerlines, or railways). These industrial and infrastructure areas are not traditionally considered part of the WUI, but may require protection from fires and are important emerging issues.

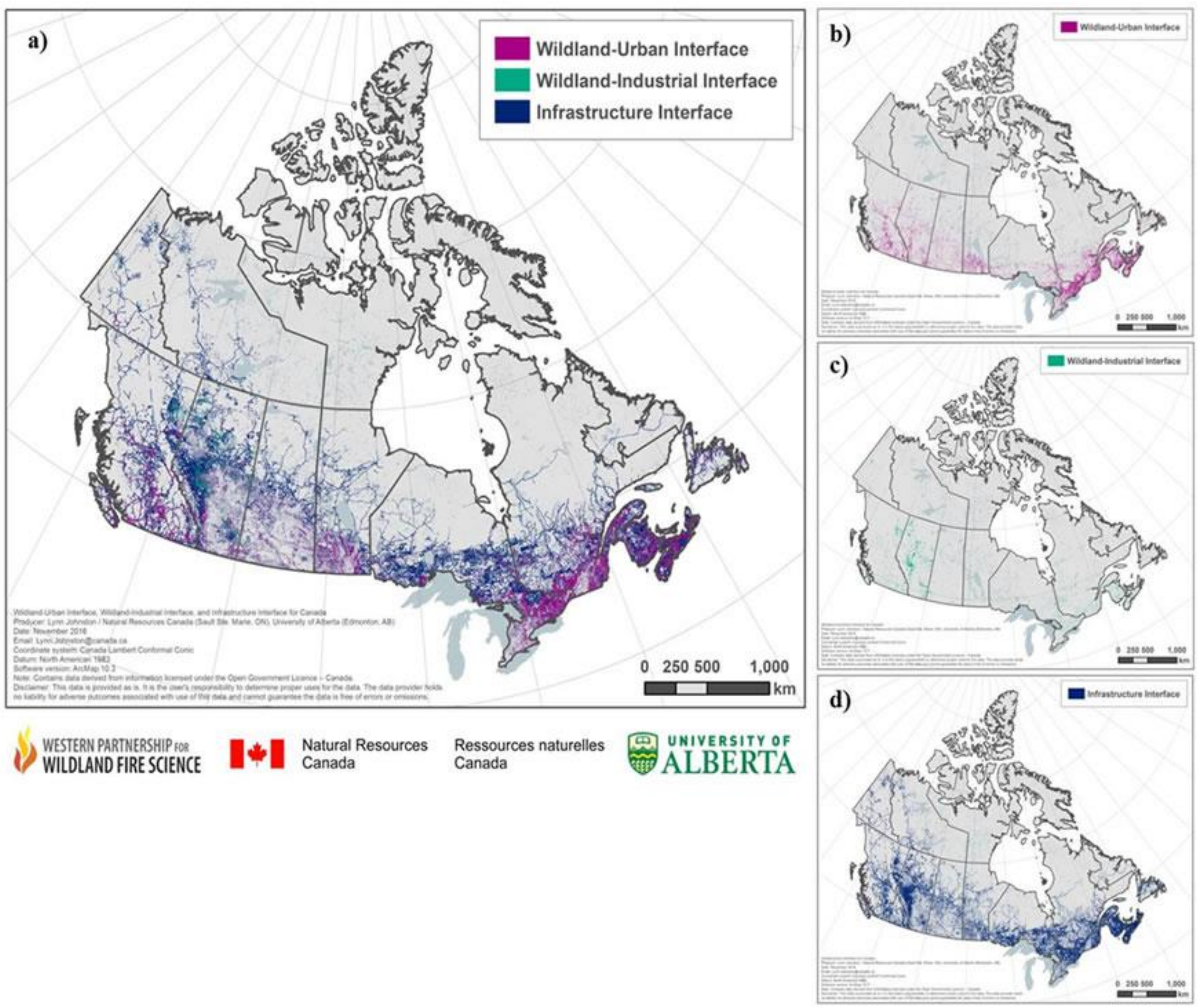


Photos showing typical wildland-urban interface areas: a) a community bordering a forested area, and b) an isolated cabin amongst a forested area. Photo: Mike Flannigan, University of Alberta (a), Jeremy Johnston, Ontario Ministry of Natural Resources and Forestry (b).

In order to mitigate destructive interface fires, basic information such as the location of these areas is required. Unfortunately, Canada does not have national scale, high-resolution interface maps for use in research or fire management, which hinders our ability to study and manage or mitigate fires in interface areas.

This study focused on defining and mapping the three interface types (i.e., WUI, wildland-industrial interface, and infrastructure interface) for the national area of Canada. All three interface types were defined as areas of wildland fuels which are within a variable-width buffer (maximum distance: 2400 m) from potentially vulnerable structures or infrastructure.

Nationally, it was found that Canada has 32.3 million ha of WUI (3.8% of total national land area), 10.5 million ha of wildland-industrial interface (1.2%), and 109.8 million ha of infrastructure interface (13.0%). The images below show the national maps.



Canadian national interface maps: a) all three interface "types" together, b) the wildland-urban interface (WUI), c) the wildland-industrial interface (WII), and d) the infrastructure interface.

The results of this study provide a baseline for future research, including fire risk mapping, change detection, and future predictions of interface areas. There are also a wide variety of practical applications, including various topics in wildfire mitigation (e.g., FireSmart and industrial fire regulations), long-term planning (e.g. city planning and insurance), and wildfire decision support (e.g., fire prioritization and risk modelling).

New approaches to phytosanitary treatment of export lumber

GLFC scientist, Chris MacQuarrie, is working in a collaborative effort to test the scientific rationale behind the systems approach for phytosanitary treatment of export lumber.

The systems approach to phytosanitary certification considers the effect of all stages of the lumber production process in reducing the risk of wood products spreading potentially-invasive insects. Until recently it has been challenging to obtain good estimates for the level of risk reduction for most wood boring pests in milled lumber because of relatively low densities of these organisms typical in wood. However, the large outbreak of the invasive emerald ash borer (EAB) in Ontario and Quebec provided an opportunity to do these experiments.

In the first experiment we are examining how many wood boring insects are removed at each stage of the milling process. We selected infested ash trees in southern Ontario and milled them into lumber at Townsend Lumber in Tillsonburg, Ontario. At each stage of the milling process (e.g., debarking, squaring, edging) we collected samples which were then placed into rearing. The number of EAB recovered from these samples will tell us how many insects were present in each raw log, and the number removed during each stage of lumber production. From these data we will be able to determine the precise contribution of the lumber production process to reducing risk from EAB and more importantly, estimate the reduction in potential risk from other wood boring insects in Canadian export lumber (e.g., bronze birch borer).

In the second experiment we are evaluating the effect of heat treatments on the viability of EAB in infested lumber. Presently, wood bound for export markets that is potentially infested with EAB must be heated to 72°C. However, if EAB adults can be rendered dead or unable to reproduce through heating at lower temperatures this would result in significant savings for Canadian lumber producers. In our experiment we heat-treat ash slabs infested with EAB to specific temperatures using kilns at FPInnovations in Quebec City. We will then collect any insects emerging from these slabs and evaluate their survival time, how many eggs they produce and count the number of insects that died. These data will show if heating at lower temperatures can reduce the risk from emerald ash borer by either killing EAB in the wood or rendering any surviving adults unable to reproduce.

These experiments are intended to provide valuable information for developing phytosanitary certification rules for Canadian export lumber. This is a joint research project with NRCan scientists at the Laurentian and Pacific Forestry Centres with our partners at the Canadian Food Inspection Agency, Ontario Wood, the Quebec Wood Export Bureau and technical support from FPInnovations and Townsend Lumber Inc.

Sirex woodwasp field trials

GLFC entomologist Jeremy Allison conducted field trials with Sirex woodwaps (S. noctilio) on Scots, red, jack and eastern white pine and observed its development.

In many, but not all, parts of the Southern Hemisphere where it has become established, *S. noctilio* can be an aggressive tree killer, particularly where natural enemies and competitors are absent and exotic pines are planted in monocultures and not well managed. In newly invaded habitats, natural controls (e.g., co-evolved host plants with effective resistance mechanisms, natural enemies, competitors) are often absent or ineffective at regulating introduced herbivores. Consequently, non-native insects sometimes become pests in the invaded habitat.

In North America the introduced range of *S. noctilio* overlaps with Scots, red, jack and eastern white pine. Scots pine is a host in the native range while the other three species are novel host associations for *S. noctilio*. To consider the potential risk for this insect to attack native species, we placed caged *S. noctilio* on freshly cut logs of Scots, red, jack and eastern white pine. We observed that oviposition, adult emergence and survivorship from egg to adult were highest on Scots and red pine. Interestingly, although white pine was a suitable larval host, female oviposition was low in these host trees and conversely, although jack pine was perceived as a suitable host by females, larval survival was lowest in these host trees.

Life-tables developed from experimentally-manipulated and natural cohorts of *S. noctilio* suggest that factors that act on early life stages (tree resistance or competition among fungal associates) have very strong effects on *S. noctilio* survival and likely contribute more than natural enemies in maintaining *S. noctilio* populations in North America below damaging levels.

We would like to acknowledge collaboration and co-funding from the USDA-FS Forest Health Protection.

Woodland caribou: Managing a threatened landscape species in the boreal forest

Scientist Ian Thompson recently gave webinars on woodland caribou management to both the Canadian Institute of Forestry and a Quebec audience at the Laurentian Forestry Centre.

The webinars focussed on the basic biology and ecology of woodland caribou in Canada, with a concluding section on how to manage these caribou. Ian explained that the caribou have a low rate of reproductivity and require high adult populations to persist on the landscape.

There are multi-factorial causes of woodland caribou decline across the country and Ian spoke to these. Key points were:

- forest management and climate change can change habitat;
- caribou are adapted to a cold climate with their large hooves for navigating through snow, thick coat and haired nostrils to handle cold temperatures, and ability to digest lichens which are found in northern climates;
- these animals experience heat stress at temperatures greater than 25° Celsius and since the 1950s climate has been one of the significant variables affecting caribou range;
- indirect effects of climate change result in more favourable climate conditions (warmer) for deer and moose populations which have attracted more predators into the caribou's range as well as an increase in parasites. The brain worm, a parasite of deer, kills caribou;
- human intervention in the forest (forest management, agriculture and mineral/oil exploration) increases corridors and fragments the forest which reduces suitable habitat and quality of habitat for the caribou as well as increasing opportunities for predators and parasites to affect the caribou.

The advice to ECCC (Environment and Climate Change Canada) from the Caribou Science Panel from 2011 was highlighted, noting the clear relationship between declines in caribou production and increasing disturbance, and pointing out the variance associated with the regression. This variance at national scale is explained by a host of issues such as: the boreal forest grows slowly and there is insufficient time to fully understand the effects of forest management; the lack of historical information on caribou populations and their movements; and caribou are long-lived so the effects are not readily apparent for many years. The large mammal ecosystems are also quite different across Canada and the predator-prey relationships can vary which increases the variance of the results. The conclusions of the webinar were that the burden of proof for any management regime must be judged by the effectiveness of measures to conserve caribou populations, and that the cumulative extent of disturbance must be limited and not just mitigated.

Ecologists and geneticists join forces to better understand forest adaptive capacity

The pan-national workshop of the Co-VITAS team, a collaborative project that examines species' adaptive capacity to climate change, was held this past February 22nd and 23rd in Mont St-Hilaire, Quebec.

Launched in 2013, the « Co-VITAS » project (a French acronym for "Intraspecific variability of aboveground and belowground plant traits") is a multidisciplinary and collaborative science initiative led by Dr. Isabelle Aubin (Canadian Forest Service) and Dr. Alison Munson (Laval University). The project is investigating the response to environmental changes of six widely distributed forest understory species by measuring a set of ecophysiological and genetic attributes throughout the species range. The group enlisted and coordinated the efforts of 23 research teams across Canada for field sampling of 81 sites from Newfoundland to Yukon. Its objective is to tease apart key aspects of Canadian forest adaptive capacity, particularly in the context of climate change. This work will inform management options to support forest adaptation in Canada, helping reduce vulnerability of forests to climate change.

Held under the auspices of the Forest Change initiative (CFS) and the Canadian Institute of Ecology and Evolution (CIEE), the workshop reunited for the first time participating scientists from across Canada to foster a national and transdisciplinary interpretation of results. Manuscripts in progress and new projects stemming from this initial collaboration were discussed. The unique pan-Canadian dataset will be available via TOPIC (Traits of Plants in Canada) after publication. The TOPIC network is composed of governmental, academic and industrial researchers interested in the development and application of the functional trait approach to Canadian issues.

Science Journal for Kids explores effects of climate change on forestry

GLFC researchers contributed to articles that will get students thinking about how conifer growth may change in a warming climate and the future costs of fighting forest fires.

The Science Journal for Kids (and their teachers), founded by a high school environmental science teacher in Texas, features articles based on the latest environmental science peer-reviewed research papers rewritten in age-appropriate language as a way to get young people engaged with science.

Dan McKenney and John Pedlar are contributing a piece based on their journal publication: "Assessing the anticipated growth response of northern conifer populations to a warming climate", published in *Nature/Scientific Reports*. Students are challenged with the question of whether conifers will grow faster in a warmer climate. The article is based on nearly 40-year growth results from black spruce and jack pine transplant (or provenance) experiments, in which seeds originating from a variety of locations (or populations) across the range of each species were planted at test sites in the northern US and Canada.

Trees that originated from warmer climates grew faster at colder temperatures than at their original location. The opposite was true for trees that came from colder climates – they grew faster when transplanted into warmer climates. These results demonstrate to students that answers to these questions are complex and in this case, depend on where the trees originate from within the species range.

Predictions based on the results from this study are that trees growing in the northern portion of their geographical range will probably grow faster when temperatures rise. This is because their optimal growing temperature is higher than at their current location. Conversely, trees growing in the southern portion of their range will likely exhibit growth reductions and/or mortality.

Dan and John, along with Emily Hope, have also contributed to an article on the anticipated wildfire suppression costs in a warming climate, based on a journal article published in PLOS One last year. They forecast wildfire area based on a climate metric projected into the future and generated estimates of wildfire suppression costs. They based the projections on historical provincial data from 1980 to 2009 and the climate moisture index (a measure of dryness based on temperature and precipitation data), which is typically a good gauge for drought-related impacts on trees. Results suggested that fire costs will increase dramatically over the coming century both as a result of increased areas burned and rising fixed costs. The students are challenged to learn more about the natural role of wildfire, and to consider the influence of their everyday actions on the environment.

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.

The Island Lake biomass harvest experiment: Early results

This report summarizes the results to date from the Island Lake Biomass Harvest Experiment, a collaborative research project situated near Chapleau, Ontario.

GLFC Information Report #16 published in two indigenous languages

For the first time, GLFC has published one of its information reports in both Ojibway and Cree: "The Island Lake Biomass Harvest Experiment: Early results".

Regulations and guidelines for the use of wood ash as a soil amendment in Canadian forests

This report presents information on the current guidance relevant to soil applications of wood ash for each province and territory in Canada.

Recent Publications

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