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Small is beautiful: grassroots projects feed global data synthesis

Scientist Dr. Aubin and colleagues recently published a paper on how collaboration in local data management can help answer global ecological questions.

The paper addresses the important but overlooked role of small "grassroots" teams of scientists to bring people into a collaborative environment to share data. Ecologists are increasingly challenged to answer large scale or broad scope questions that require vast and transdisciplinary datasets to effectively address them.

Grassroots projects can play an important role in making ecological data available. They are building blocks for global research. They can foster best practices in data management and provide tangible rewards to researchers who choose to invest time in sound data stewardship. By connecting data generators with data users, these initiatives improve the ability of data users to accurately interpret the available data while also providing appropriate acknowledgement to data generators.

The paper gives examples of three grassroots initiatives the authors were involved with, varying in their objectives, extent of area studied, study duration and disciplines. The TOPIC network (Traits of Plants in Canada database) is a hub for Canadian researchers to integrate small datasets and make them available locally, and to the international scientific community via its collaboration with the international trait database (TRY). In the Co-VITAS project, 23 research groups across Canada collaborate to study intraspecific trait variability at a subcontinental scale. This initiative involves systematic sampling of several traits across a species' range, a task well beyond the capabilities of a single laboratory. In the Island Lake biomass harvest experiment, which focused on the ecological impacts of different levels of forest biomass removal, the challenge was to foster data exchange among scientists from diverse disciplines to tackle transdisciplinary questions. Yes, small is beautiful, and grassroots efforts are well-grounded.

For more information contact Isabelle Aubin or read the full article, Managing data locally to answer questions globally: the role of collaborative science in ecology.

20-year results of biomass removal: What can it tell us about full tree logging?

The Canadian Forest Service and the Ontario Ministry of Natural Resources and Forestry jointly established a series of biomass removal trials in the early 1990s on sites deemed most sensitive to increased nutrient removals.

GLFC researchers Paul Hazlett and Rob Fleming co-authored a paper that reported on 20-year post-harvest soil carbon and nutrient reserves from 14 biomass removal trials. The experiment was established on coarse-textured, nutrient-poor sites in northern Ontario as part of the North American Long-Term Soil Productivity (LTSP) experiment and evaluated conditions in the forest floor and upper 20 cm of mineral soil. The three harvest treatments included: stem only (delimbed at the stump), full-tree (the entire trees with boles and branches removed), and full-tree with forest floor removal (full-tree harvest followed by blading off the forest floor and approximately the upper 5 cm of mineral soil). In general, there was no difference in soil carbon and nutrient reserves between stem only and full-tree treatments after 20 years. The results suggest there is no need for restrictions on full-tree harvesting for traditional wood products on nutrient poor sites. However, from a cautionary perspective, it seems prudent at this time to restrict more intensive bioenergy harvests (where even greater amounts of logging residues are removed) to deep, finer-textured sites that have larger soil carbon and nutrient reserves. The stands evaluated here were just reaching the crown closure development period where nutrient limitations are likely to occur. Thus, continued monitoring is needed to determine if tree growth and foliar nutrition will be affected over the next couple of decades.

A related paper with scientist Rob Fleming as the primary author evaluated the 20-year stand growth response in these trials, and examined the effects of disc trenching, soil compaction following blading and repeated glyphosate applications as well as the treatments listed above. Key findings were: 1) complete forest floor removal slightly increased planted tree survival but reduced longer-term stand productivity; 2) vegetation control markedly increased stand growth initially but effects lessened substantially over time; 3) whole-tree harvesting had similar effects on stand development as stem-only harvesting; 4) compaction following forest floor removal had no additional effects on stand development; and 5) ingress of natural regeneration was greater with harvest/site preparation treatments that maintained cone-bearing logging slash on-site, but was not significantly affected by vegetation control. The importance of this publication lies in the longer-term (20 yr.) responses it reports. Forest floor removal on similar sites is likely to have substantial negative impacts on longer-term stand productivity despite showing little evidence of this in the short term. By contrast, positive vegetation control effects on future stand productivity of similar site types can be substantially overestimated when based on short-term results. At this point there is also no strong evidence that operational whole-tree harvesting, as was practiced on these sites, reduces stand productivity compared with stem-only harvesting.

The information derived from this research has informed Ontario's policies related to the sustainable level of harvesting of forests for biomass energy. The results supported a review and revision of the full-tree logging direction within Ontario's forest management guidelines. It was concluded that full-tree logging was unlikely to have a long-term impact on soil nutrients for typical rotation lengths in Ontario, and therefore the "Not Recommended" and "Conditionally Recommended" restrictions for very shallow soils and coarse textured, sandy sites were removed in Ontario's revised Forest Management Guide to Silviculture.

Both the soil effects and growth response articles are available on our publications website.

What motivates people to plant trees?

Government programs to encourage tree planting are particularly effective in counties with marginal agricultural land. Private land owners' concern for wildlife is another major factor.

For the past three years, Heather MacDonald, Dan McKenney, Emily Hope and others from GLFC have been working together with Forests Ontario to understand why private land owners plant trees. Forests Ontario is the lead delivery agent for the 50 Million Tree Program and has recently received funding from the federal government. In a 2018 paper, Adoption influences in Ontario's 50 Million Tree Program, Heather and her co-authors found that land with lower agricultural value showed larger increases in tree cover, demonstrating potential for tree planting in Canada on marginal cropland. A second paper, soon to be published in *Landscape Online* , which surveyed private land owners up to ten years after participating in a Forests Ontario tree planting program, found that a concern for wildlife was a major motivator for planting trees through afforestation programs. As a result, motivating private land owners to plant trees can benefit from emphasizing planting trees for wildlife. The survey also found a high level of satisfaction with Forest Ontario tree planting programs, with 67% of respondents reporting enhanced well-being and enjoyment of their property since planting trees.

Heather MacDonald, GLFC Forest Research Social Scientist, looks at human influences in resource management.

Ensuring pest free lumber for export

Wood from trees infested with emerald ash borer (EAB) was used to test the effects of both milling and heat treatment on pest risk reduction in sawn wood.

As part of a collaborative effort with federal, provincial, and industry contributors, research scientist Chris MacQuarrie and forest entomology assistant, Meghan Gray tested a systems approach for the phytosanitary treatment of lumber from trees infested with EAB. This approach considers how all the steps in a production process act to reduce the risk of a living pest existing in the final product. Infested green ash trees were used to: 1) quantify the change in EAB density as a log was turned into sawn wood; and 2) quantify the effect of heat treatment on mortality of EAB pupae present in the lumber.

Results showed that greater than 90% of EAB were removed during debarking. More than 99% of EAB were removed by the time a log was turned into sawn wood. Heat was effective at killing beetles in the wood at lower temperatures than present regulations require. All life stages of EAB were killed at 56°C and above; current regulations require that wood potentially infested with EAB and bound for export markets be heated to 72°C. 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.

These experiments provide a valuable scientific basis for developing phytosanitary certification rules for Canadian industry to export lumber that may come from trees potentially infested with EAB. The same principles and standards could also be applicable to other wood boring insects. Addressing the likelihood of pests being present in wood and wood products destined for international trade is an essential step towards minimizing the risk that Canadian wood exports could result in the movement, introduction and establishment of invasive species.

This was a joint research project with NRCan scientists at the Laurentian (Robert Lavallée) and Pacific Forestry Centres (Meghan Noseworthy) with our partners at the Canadian Food Inspection Agency, Ontario Wood, the Quebec Wood Export Bureau and technical support from FPInnovations (Marc Savard) and Townsend Lumber Inc. of Tillsonburg, ON.

Modelling and mapping Canada's Climate to support climate change mitigation and adaptation studies: a university lecture

Scientist Dan McKenney gave a talk at the University of Winnipeg in early January, where he provided a general overview and history of climate mapping work he and his team have been involved with over the last 25 years.

Dan McKenney works in collaboration with Environment and Climate Change Canada, the US National Oceanic and Atmospheric Administration, and The Australian National University. Some of these models are part of the Prairie Climate Centre's Climate Atlas of Canada hosted at the University of Winnipeg; see also ClimateData.ca). These two web portals are part of ECCC's efforts to mainstream considerations of climate change into Canadian society. The climate mapping makes use of "ANUSPLIN", a widely used and leading edge tool for mapping climate with origins in Australia. You can also see some of this work on NRCan's web site: Regional, national and international climate modeling. Dan also discussed some of the opportunities this work has provided in support of climate change mitigation and adaptation studies. Examples are as wide-ranging as updates to Canada's plant hardiness zones (Plant Hardiness of Canada), (wildfire suppression costs under a changing climate) under a changing climate, and modelling changing risks/threats to human health due to shifts in insect species, including mosquitoes and ticks.

The talk was well attended with students, faculty members, other federal government departments as well as Manitoba Hydro and Manitoba's Forestry Branch.

GLFC launches 75th anniversary celebrations: a look at some of the pioneering scientists

Dr. Basil Arif reflected on the work of some of the first federal forestry scientists in Sault Ste. Marie and their significant contributions to advancements in insect biocontrol.

Research in forest entomology in Sault Ste. Marie started in 1945 in response to a massive outbreak of spruce budworm that was causing major defoliation of forests. Scientists having global recognition in their fields were brought in to start research in the developing area of insect biocontrol. This endeavour was based on the knowledge that a polyhedrosis virus was responsible for the collapse of an infestation of European spruce sawfly.

The internationally renowned virologist, Dr. Gernot Bergold, was recruited from Tübingen University, Germany in 1950 to start research in insect viruses. This was quite a feat considering it was the post-war years. The advanced equipment at the laboratory allowed him to do impressive and innovative research on viruses and his publications and research are considered to be fundamental to baculoviruses and insect virology.

Dr. Ted Bird, considered a pioneer in the field of insect pathology, was also recruited to the lab in 1950. He was one of the scientists that provided evidence that a polyhedrosis virus was responsible for the collapse of the European spruce sawfly infestation.

Another important scientist was Dr. Gerry Wyatt, who came from Cambridge University in 1952 and was highly trained in the field of nucleic acid biochemistry. His observations on base pairing in DNA from the research he did with insect viruses provided a critical piece of evidence to support the double helix structure of DNA that was proposed by Watson and Crick in 1953. Wyatt's research paper was cited in the famous paper in Nature that won them the Nobel Prize in medicine in 1962.

In the late 1960s, Dr. John Cunningham, from Oxford University in England, was hired to study the potential application of insect viruses in the control of lepidopteran and hymenopteran forest insect pests. His work led to the first virus product registered in Canada as a biological control agent in 1983. The product, Lecontvirus, is highly effective against redheaded pine sawfly.

Dr. Tom Angus was recognized for his work on the delta endotoxin of the bacterium *Bacillus thuringiensis*. *B.t.* is the most extensively used biocontrol agent today in the world against forest and agricultural insect pests.

We can thank Dr. Sardar Sohi for the development of insect cell lines, which are crucial to studying viruses and toxins in tissue culture systems and are still in use today.

Dr. Basil Arif himself began working in Sault Ste. Marie in 1972 and became a world leader in the molecular biology and genomics of insect baculoviruses and entomopoxviruses. Dr. Arif and his team developed a genetically modified spruce budworm virus that has a faster mode of action.

All of these scientists played an important role in the field of insect biocontrol. The early research that they pioneered has had significant and positive outcomes in forestry and pest management in Canada. Many of the journal articles of these scientists can be found on the Canadian Forest Service's publications website.

Recent Publications

Aubin, I.; Cardou, F.; Boisvert-Marsh, L.; Garnier, E.; Strukelj, M.; Munson, A.D.; Gachet, S. 2020. Managing data locally to answer questions globally: the role of collaborative science in ecology. Journal of Vegetative Science: https://doi.org/10.1111/jvs.12864.

Blackburn, G.S.; Bilodeau, P.; Cooke, T.; Cui, M.; Cusson, M.; Hamelin, R.C.; Keena, M.A.; Picq, S.; Roe, A.D.; Shi, J.; Wu, Y.; Porth, I. 2020. An Applied Empirical Framework for Invasion Science: Confronting Biological Invasion Through Collaborative Research Aimed at Tool Production. Annas of the Entomological Society of American 229: https://doi.org/10.1093/aesa/saz072.

Bouwer, M.C.; MacQuarrie,C.J.K.; Gil, O.J.; Slippers, B.; Allison, J.D. 2020. Impact of intercept trap type on plume structure: a potential mechanism for differential performance of intercept trap designs for Monochamus species. Journal of Pest Science: https://doi.org/10.1007/s10340-020-01204-y.

Bush, A.; Compson, Z.; Monk, W.; Porter, T.M.; Steeves, R.; Emilson, E.; Gagne, N.; Hajibabaei, M.; Roy, M.; Baird, D.J. 2019. Studying ecosystems with DNA metabarcoding: lessons from aquatic biomonitoring. Methods in Ecology and Evolution.

Cardou, F.; Aubin, I.; Bergeron, A.; Shipley, B. 2020. Functional markers to predict forest ecosystem properties along a rural-to-urban gradient. Journal of Vegetation Science 31(3): 416-428.

Carleton, R.D.; Owens, E.; Blaquière, H.; Bourassa, S.; Bowden, J.J.; Candau, J.-N.; DeMerchant, I.; Edwards, S.; Heustis, A.; James, P.M.A.; Kanoti, A.M.; MacQuarrie, C.J.K.; Martel, V.; Moise, E.R.D.; Pureswaran, D.S.; Shanks, E.; Johns, R.C. 2020. Tracking insect outbreaks: a case study of community-assisted moth monitoring using sex pheromone traps. FACETS 5: 91–104.

Edge, C.B.; Baker, L.F.; Lancot, C.M.; Melvin, S.D.; Gahl, M.K.; Kurban, M.; Navarro-Martin, L.; Kidd, K.A.; Trudeau, V.L.; Thompson, D.G.; Mudge, J.F.; Houlahan, J.E. 2020. Compensatory indirect effects of an herbicide on wetland communities. Science of the Total Environment 718: 137254.

Emilson, C.E.; Bélanger, N.; Brais, S.; Chisholm,C.E.; Diochon, A.S.; Joseph, R.; Markham, J.; Morris,D.; Van Rees, K.; Rutherford, M.; Venier, L.A.; Hazlett, P.W. 2020. Short-term growth response of jack pine and spruce spp. to wood ash amendment across Canada. GCB Bioenergy 12(2): 158-167.

Erbilgin, N.; Klusch, J.G.; Najeeb, H.; Cale, J.A.; Ishangulyyeva, G.; Rajabzadeh, R.; Boone, C.; Bozic, T.; Jansson, G.; Haapanen, M.; Hughes. C.; MacQuarrie, C.J.K.; Schroeder, M.; Seppo, R. 2020. Chemical similarity between introduced and native populations of Scots pine can facilitate transcontinental expansion of mountain pine beetle in North America. Biological Invasions 22: 1067-1083.

Erni, S.; Wang, X.; Taylor,S.; Boulanger, Y.; Swystun,T.; Flannigan,M.; Parisien,M.-A. 2020. Developing a two-level fire regime zonation system for Canada. Journal of Forest Research 50(3): 259-273.

Hope, E.; Gagnon, B.; Avdi´c, V. 2020. Assessment of the Impact of Climate Change Policies on the Market for Forest Industrial Residues. MDPI: Sustainability 12(5): 1787.

Johnston, L.M.; Wang, X.; Erni, S.; Taylor, S.W.; McFayden, C.B.; Oliver, J.A.; Stockdale, C.; Christianson,A.; Boulanger, Y.; Gauthier, S.; Arsenault, D.; Wotton, M.; Parisien, M.-A.; Flannigan, M.D. 2020. Wildland fire risk research in Canada. Environmental Reviews: https://doi.org/10.1139/er-2019-0046.

Kattge, J. et al. 2020. TRY plant trait database – enhanced coverage and open access. Global Change Biology 26(1): 119-188.

Lupardus, R.C.; Azeria, E.T.; Santala,K.; Aubin, I.; McIntosh, A.C.S. 2020. Uncovering traits and recovering grasslands: A functional assessment of oil and gas well pad reclamation. Ecological Engineering: X 5: 100016.

MacDonald, H.; McKenney, D.W.; McLaven, K.; Perry, S. 2020. Realizing Expectations from Planting Trees on Private Land in Ontario,Canada. Landscape Online 78: https://doi.org/10.3097/LO.202078.

MacQuarrie, C.J.K.; Gray, M.; Lavallée, R.; Noseworthy, M.K.; Savard, M.; Humble,L.M. 2019. Assessment of the Systems Approach for the Phytosanitary Treatment of Wood Infested With Wood-Boring Insects. Journal of Economic Entomology 113(2): 679-694.

Morris, D.M.; Fleming, R.L.; Hazlett, P.W.2020. Ontario, Canada's LTSP experience: Forging Lasting Research Partnerships and the Adaptive Management cycle in Action. Journal of Forestry: fvaa002.

Musetta-Lambert, J.L.; Kreutzweiser, D.P.; Sibley, P.K. 2020. Assessing the influence of wildfire on leaf decomposition and macroinvertebrate communities in boreal streams using mixed-species leaf packs. Freshwater Biology: https://doi.org/10.1111/fwb.13488.

Parker, K.; Ryall, K.; Auema, B.H.; Silk, P. 2020. Early detection of *Agrilus planipennis*: investigations into the attractive range of the sex pheromone (3*Z*)-lactone. Entomologica Experimentalis et Applicata 168(2): 166-173.

SamkovÁ, A.; Jansta, P.; Huber,J.T. 2020. Illustrated key to European genera, subgenera and species groups of Mymaridae (Hymenoptera), with new records for the Czech Republic. Zootaxa 4722(3): 201-233.

Tanentzap, A.J. Fitch, A.; Orland, C.; Emilson, E.J.S.; Yakimovich, K.M.; Osterholz, H.; Dittmar, T. 2019. Chemical and microbial diversity covary in fresh water to influence ecosystem functioning. Proceedings of the National Academy of Sciences of the United States of America 116(49): 24689-24695.

Watt, G.A.; Stocks, B.J.; Fleming, R.A.; Smith, S.M. 2020. Stand breakdown and surface fuel accumulation due to spruce budworm (*Choristoneura fumiferana*) defoliation in the boreal mixedwood forest of central Canada. Canadian Journal of Forest Research: https://doi.org/10.1139/cjfr-2019-0076.

Weigand, A.; Abrahamczyk, S.; Aubin, I.; Bita-Nicolae, C.; Bruelheide, H.; Carvajal-Hernández, C.I.; Cicuzza, D.; Nascimento da Costa, L.E.; Csiky, J.; Dengler, J.; de Gasper, A.L.; Guerin, G.R.; Haider, S.; Hernández-Rojas, A.; Jandt, U.; Reyes-Chávez, J.; Karger, D.N.; Khine, P.K.; Kluge, J.; Krömer, T.; Lehnert, M.; Lenoir, J.; Moulatlet, G.M.; Aros-Mualin, D.; Noben, S.; Olivares, I.; Quintanilla, L.G.; Reich, P.B.; Salazar, L.; Silva-Mijangos, Tuomisto, H.; Weigelt, P.; Zuquim, G.; Kreft, H.; Kessler, M. 2019. Global fern and lycophyte richness explained: How regional and local factors shape plot richness. Journal of Biogeography 47(1): 59-71.