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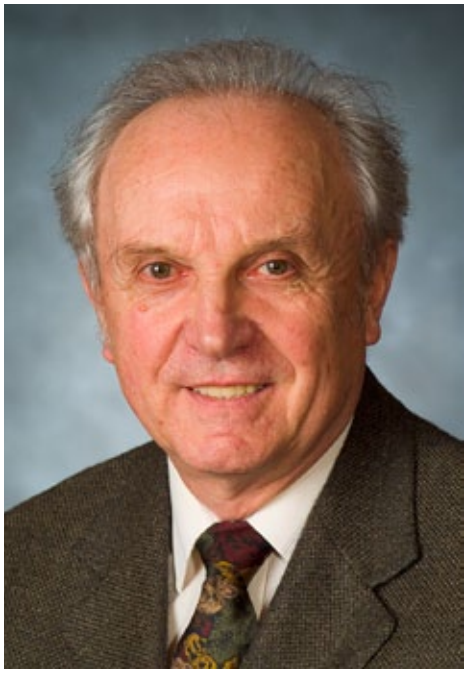
An interview with retired forest entomologist Dr. Imre Otv



Barb Crawford: Can you give us an overview of your career?
Imre Otvos: I worked at Pacific Forestry Centre (PFC) from April of 1980 to November of 2009. Prior to that, I was at the Newfoundland Forest Research Centre for 11 years. I guess I can say I served Canada from coast to coast. Maybe it's appropriate that I am retiring here on Vancouver Island—my first job was setting chokers in the summer of 1957 in Gold River, for the Tahsis Logging Company.

I arrived in Canada on January 6, 1957 and was part of the Sopron group that Les Safranyik so well described (see August 2011 issue). I opted to do my graduate work in the United States. At first I went to Oregon State University, in Corvallis, then to the University of California at Berkeley where I received my Masters and PhD degrees. I majored in biological control, ecology, and forest entomology, with a minor in statistics.

I wanted to come back to Canada, so I accepted a job offer from the Canadian Forest Service, which was expanding in the 1960s. I felt that Canada gave me a country when I and other Hungarian refugees had none so I should give something back to this country. So that's how I ended up in St John's, Newfoundland.

In July of 1969 my wife and I drove across Canada, and I visited each of the Canadian Forest Service research labs to network. I figured this would be a good opportunity to meet colleagues whom I knew by name, but hadn't met in person. It ended up generating many opportunities for co-operation and long-term friendship.

BC: What fuels the passion you have for your work?
IO: Nature. From my early childhood I have been interested in nature. When I was 10 or 11 years old, I saw a stag beetle (one of the insects that attack dying oak trees). I quickly took off my shoes and socks, and up the tree I went. I was reaching for the beetle when it let go and fell to the ground. I tried to come down quickly, backwards, at the same time keeping an eye on the beetle, when I saw that it was raising its wings ready to fly. I jumped off, and managed to catch it and put it in my sock for safe keeping. But I ended up with a strained ankle.

I figured if we could learn about what happens in nature, maybe we could apply or mimic it. I became passionate about it.

Imre Otvos at the base of an old-growth tree that was logged at Gold River Muchlat, 1957.

os: Giving back

Working for the Tahsis Logging Company, Gold River Muchlat, 1957. Imre Otvos far right and fellow CFS researcher and Sopron colleague, Les Safranyik, second from the left.

Anyway, it was nature, and how nature works. I was interested in biology in high school, and later in university I became more interested in how insect populations are kept in check. There's a natural tendency for insect populations to increase without natural enemies, and the natural enemies keep insect populations in check or balance most of the time. I figured if we could learn about what happens in nature, maybe we could mimic it. I became passionate about it.

BC: What contribution or achievement that you've made over the course of your career are you most proud of?

IO: Actually there are several. While I was in Newfoundland, I showed for the first time that a fungal disease is one of the major factors in controlling the eastern hemlock looper.

I have also shown that one can initiate an epizootic (large-scale larval mortality) and speed up the outbreak of a disease. To the best of my knowledge, I was the first to show this in Canada. Pathogens, including fungi, occur naturally, so one is not modifying or creating anything new or artificial, just using what is already in nature. This is why I thought that by looking at what's happening in nature, what control mechanisms (be that parasite, predators, or pathogens) are important, maybe we could manipulate them to reduce damage to our forests.

For the Douglas-fir tussock moth, a forest defoliator of coniferous trees on the west coast, there are two viruses that cause an epizootic naturally. By the time they cause the spread of the disease among the larvae, considerable damage to trees has already occurred. So my logic was, if we can put the virus out before it occurs there naturally, maybe we can suppress the population so the insect would not cause damage to the trees, or cause less damage. **Dr. Roy Shepherd**—he was my mentor here at PFC—agreed that it was worth trying.

We showed that, yes, we can cause an epizootic. In those areas that we treated with the virus, the outbreak did not develop, and little or no damage was caused by the insect, both at low as well as high insect density. This was the first hint that we had a promising control mechanism. We discovered we could reduce the dosage to about one third of the registered dose.

The province of BC then applied this operationally starting in the mid-1980s. This was the first operational use of a naturally occurring virus against a native forest defoliator.

Select publications

An integrated management system for the Douglas-fir tussock moth in southern British Columbia. 2009. Maclauchlan, L.E.; Hall, P.M.; Otvos, I.S.; Brooks, J.E. BC Journal of Ecosystems and Management 10(2):22–36.

Safety of *Bacillus thuringiensis* var. *kurstaki* applications for insect control to humans and large mammals. 2007. Otvos, I.S.; Armstrong, H.; Conder, N. Pages 45–60 *in* J.-C. Côté, I.S. Otvos, J-L. Schwartz, and C. Vincent, editors. Proceedings of the 6th Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis* and its Environmental Impact, October 30–November 3, 2005, Victoria, BC. Érudit, Montréal, Québec.

Pest management of the Douglas-fir tussock moth (Lepidoptera: Lymantriidae): Prevention of a Douglas-fir tussock moth outbreak through early treatment with a nuclear polyhedrosis virus by ground and aerial applications. 1984. Shepherd, R.F.; Otvos, I.S.; Chorney, R.J.; Cunningham, J.C. Canadian Journal of Entomology 116:1533–1542.

On the cover

Logging trucks at Gold River Muchlat, 1957.

Select publications

Does aerial spraying of *Bacillus thuringiensis* subsp. *kurstaki* (Btk) pose a risk to nontarget soil microarthropods? 2006. Addison, J.A.; Otvos, I.S.; Battigelli, J.P.; Conder, N. Canadian Journal of Forest Research 36:1610–1620.

Preliminary hazard rating for forest tent caterpillar in British Columbia. 2010. Otvos, I.S.; Omendja, K.; Foord, S.; Conder, N.; Borecky, N.; Nevill, R.J. The Forestry Chronicle 86(5):636–648.

Management implications of forest defoliators: An interview with Dr. Imre Otvos. 2007. Schivatcheva, T. Link (9)2:22–24.

Dr. Shepherd and I co-developed the Douglas-fir tussock moth management system (see sidebar). We have received tremendous support and co-operation from the Forest Protection Branch of the BC Forest Service over the years.

The last year that I worked (in fact, that's why I delayed my retirement), we wanted to prove conclusively that by releasing the virus, we were causing considerably more larval mortality than what would have occurred naturally. We applied a unique strain, and from the dead insects, using DNA fingerprinting, we identified whether the death of the individual larva was caused by the virus that occurs there naturally or by the unique strain that we sprayed. By spraying, we increased the mortality rate by about 35–40%. We still have two other unique strains left, so this work could be repeated to refine this estimate. We have proved beyond a shadow of a doubt that we can significantly increase larval mortality if we apply the registered virus early. We did this last project co-operatively with the BC Forest Service and the US Forest Service.

We also looked at the side effects of Btk (*Bacillus thuringiensis* subsp. *kurstaki*, a naturally occurring bacterium widely used as a microbial insecticide) on birds and mammals (for which there are really none), and parasitoids of the target insect, and we looked at side effects on earthworms with **Jan Addison** (see sidebar). We followed the classical biological control of the winter moth with introduced parasitoids. We also looked at the impact of all outbreaks caused by three forest defoliators to determine if this damage impact might affect the Allowable Annual Cut. The first was the forest tent caterpillar and that work is being done by **Kangakola Omendja** (see sidebar). Now I am retired, but luckily **Dr. Brian Van Hezewijk** is interested in the project and he is helping us to revise a second manuscript on this topic. The other two are black-headed budworm and western hemlock looper.

Of course I did not accomplish all these things by myself. Over the years well over 100 people worked with me. In particular, **Nicholas Conder** must be mentioned because over the years he became my right-hand-man and helped tremendously with the various projects, meeting deadlines, and trying to keep me realistic in my plans.

"Pathogens, including fungi, occur naturally, so one is not modifying or creating anything new or artificial, just using what is already in nature. This is why I thought that by looking at what's happening in nature, what control mechanisms …are important, maybe we could manipulate them to reduce damage to our forests."

Events

National Electronic Lecture Series: Boreal Mixedwoods
Canadian Institute of Forestry
Effects of partial cutting in aspen-dominated stands on the eastern edge of the boreal mixedwood
August 3, 2012 • Dr. Brian Harvey

Are mixtures of white spruce and trembling aspen more productive than pure stands?
August 15, 2012 • Dr. Art Groot

Natural and inexpensive means of regenerating boreal mixedwood forests
August 22, 2012 • Dr. Vic Lieffers

White spruce understory protection: From planning to growth & yield implications
September 5, 2012 • Dr. Brigitte Grover

Early vegetation control for the regeneration of a single-cohort, intimate mixture of white spruce and trembling aspen on upland boreal sites—7 year results
September 12, 2012 • Dr. Doug Pitt

Modelling juvenile aspen–spruce growth dynamics: Preliminary results from the Dynamic Aspen Density Experiment (DADE)
September 26, 2012 • Willi Fast

Canada's Forest Sector at a Turning Point
Canadian Institute of Forestry AGM and 104th Annual Conference
September 17–20, 2012 • Québec, QC
http://democonference.cwfcof.org

National Forest Week 2012
Canadian Forestry Association
September 23–29, 2012 • Nationwide
http://www.canadianforestry.com/html/outreach/forest_week_e.html

An individual tree approach to forest inventory

From local to national and global levels, improvements to the precision, accuracy, timeliness, completeness, and cost-effectiveness of forest information are needed. In Canada, the most detailed forest inventories are done by the provinces and forest companies. Even though some provinces have migrated from black and white aerial photos to multispectral digital cameras, forest inventories are still largely produced through human image interpretation anchored by field surveys, a very tedious and costly process. As Pacific Forestry Centre (PFC) scientist **Dr. Francois Gougeon** is fond of saying: "Wouldn't it be nice if we could get computers to do the bulk of the work?"

With the advent of higher resolution satellite and aerial sensors as well as his background in computer image analysis, Gougeon realized that a paradigm shift was needed. Instead of delineating large ensembles like forest stands and then assessing their content, he recognised that it would be more useful if computers could delineate individual tree crowns (ITCs), assess their species, and then regroup them into forest stands. Forest interpreters are still an important part of this approach, first by providing sample areas or trees with which to train the computer in species recognition, and then by doing a quality assessment of the results and refining them.

Gougeon and **Dr. Don Leckie**, also a research scientist at PFC, have explored this concept for the past 20 years. This has led to a sophisticated suite of about 35 computer programs (known as the ITC Suite) that is used by a dozen research groups world-wide along with Canadian forestry consulting firms and provincial governments.

The ITC Suite is presently being tested in Ontario as part of the AFRIT (Advanced Forest Resources Inventory Technologies) Project, which is led by the Canadian Wood Fibre Centre (CWFC) (Natural Resources Canada) and the Ontario Ministry of Natural Resources, in collaboration with Tembec Inc., the Ontario Forest Research Partnership, and Queens University. This large technology transfer and demonstration project examines the capabilities of the ITC Suite on an operational scale by analysing some of the 1.3 million ha of the Hearst forest. Another goal of this joint project is to produce a full ITC-based forest inventory of the Canadian Forest Service's (CFS) Petawawa Research Forest (PRF).

Using multispectral aerial data, flight lines must be normalized to each other in order for the computer to consistently recognize more than a dozen species over the full 10 000 ha PRF area. First, the non-forested areas are masked; then individual tree crowns are delineated in all of the images, classified into species, and regrouped into typical forest stands (Figure 1). Precise species composition and other forest information is produced for each stand in a format directly transferable to Geographic Information Systems (Figure 2). Aerial LiDAR data or stereo image autocorrelation are used to produce a Digital Canopy Model, which can be used to assess forest stand or ITC heights. Wood volumes can be calculated—using more precise species composition—the conventional way, or on a stand or ITC basis as a function of species, crown area, and height. As part of AFRIT (and within other CFS and CWFC projects), work is also underway to assess volume, biomass, and fibre quality using a combination of LiDAR and multispectral data.

This ITC-based forest analysis can also be done with images from the current generation of high-resolution (better than 1 m/pixel) satellites. Already, stand-leading species and heights have been inferred from ITC parameters extracted

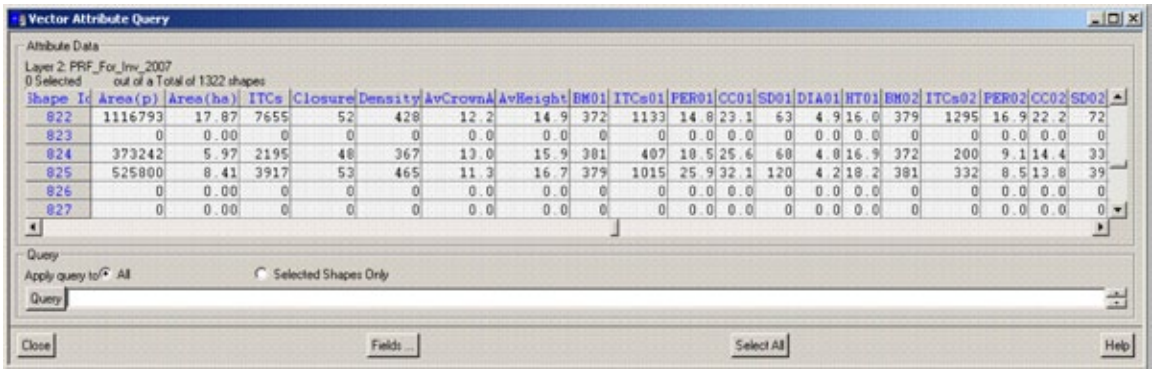


Figure 1. ITC-based forest inventory of part of the Petawawa Research Forest, Ontario.

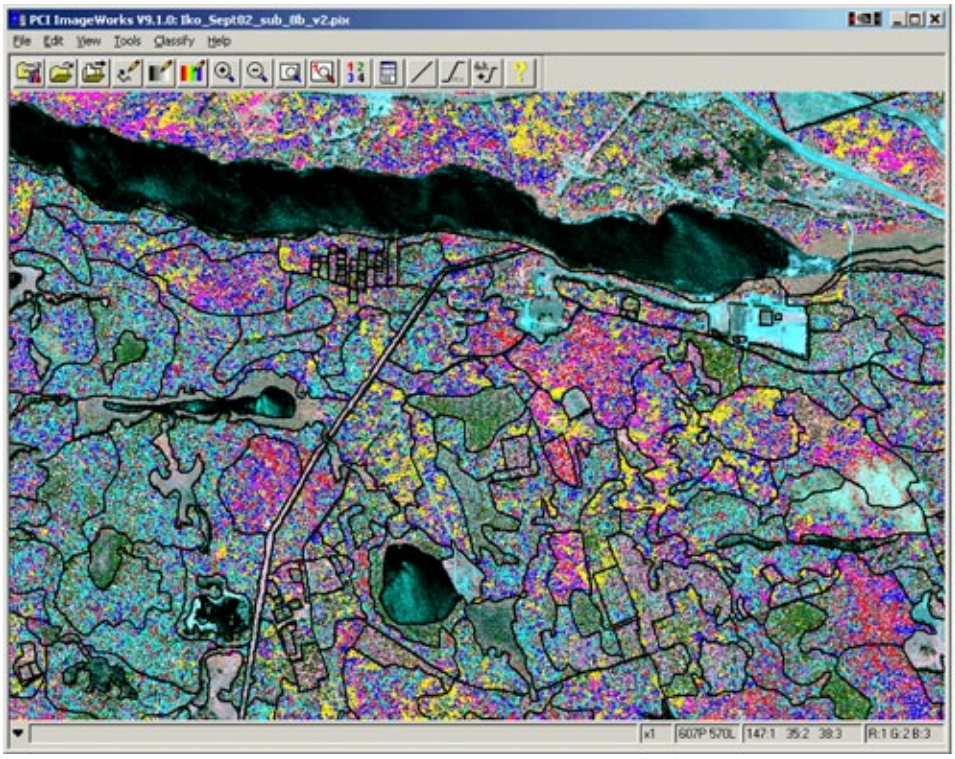


Figure 2. ITC-based stand information typically transferred to Geographic Information Systems.

from satellite panchromatic images and used to estimate volume and biomass in some northern sections of Canada for the National Forest Inventory. Other studies have shown comparable species composition results for satellite and aerial multispectral images of the same area. The ITC Suite has been used for a variety of specialized inventories (e.g., single species or snag detection, damage and health issues, gap assessments) and has specialized modules for regeneration assessment.

Precise, accurate, and timely semi-automatic ITC-based forest inventories are within our reach with the use of high resolution (<1 m/pixel) satellite or aerial images. Although the ITC information is currently regrouped at the forest stand level, in the near future individual tree crown information will be gathered and used directly for forest management and operation planning.

For further information, Dr. Gougeon can be contacted at fgougeon@nrcan.gc.ca

Accolades

Congratulations to the Canadian Wood Fibre Centre (CWFC) who received the 2011 Canadian Forest Management Group Achievement Award from the Canadian Institute of Forestry (CIF) in recognition of its contributions to forestry. The award was accepted by CSFC Executive Director George Bruemmer at the CIF annual banquet in Ottawa last September.

The award is presented for "outstanding achievement by teams and groups of natural resource managers, researchers, and NGO groups in the field in forest resource-related activities in Canada." In the letter formally announcing the CWFC's nomination for the award, the CIF highlighted the many skills and talents of NRCan researchers, as well as their ability to collaborate with each other and with other partners in the forestry sector. The CIF recognised CWFC contributions to various projects, specifically in the fields of genetics, silviculture, and forest inventory.

On January 19, 2012, Assistant Deputy Minister Tom Rosser presented the 2011 CFS Merit Awards to scientists and staff at the PFC. The awards, presented for both individual and group achievements, were awarded in recognition success in the areas of:

Collaboration, presented to the PFC Sustainable Development Committee for their commitment to facilitating a conducive work environment for all employees and staff at the PFC. Committee members include **Shelley Church, Antoine Lalumière, Andrea Schiller, Grace Sumampong, Sharon Sutherland, Holly Williams, Brad Yarmie,** and **Arezoo Zamany.**

Innovation in Operations, presented to the Voice-over Internet Protocol (VoIP) Team with members at both the GLFC and the PFC; members at the PFC include **Lee Boychuk; Dave Harrison, Glen Roy, Jim Whybra,** and **Bill Yu.**

Management Excellence, presented to **Jim Wood** for his exemplary management skills and record of success es with the CFS over the past 30 years. Of particular note are Jim's success in securing funding and his leadership role in taking on and implementing new initiatives within the CFS.

Outstanding Achievement, presented to **Dr. Doug Maynard** in recognition of his 30 years of service in the CFS, and in particular, his commitment to sustainable resource management and the reduction of emissions by Canada's Oil and Gas Sector.

Long-term service at PFC: 10 years **(Morgan Cranny, Werner Kurz, Jun-Jun Liu, Gurp Thandi, Kiri Westnedge);** 15 years **(Terry Holmes);** 20 years **(Kevin Pellow, Gary J. Roke);** 25 years **(Brian D. Titus),** and 30 years **(Nicholas Humphreys, Doug Maynard, Bill Wilson, Jim Wood).**

Conference Notes

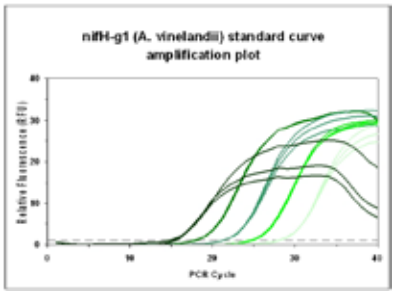
Biotechnology and its environmental applications

Biotechnology is a term that embraces many approaches to problem-solving, ranging from molecular biology and genomics to bioremediation, biological control, and the use of bio-based materials in new energy technologies… the list is extensive. Many of these technologies can be employed to solve global environmental challenges relating to environmental impacts influenced by pollution, climate change, and the sustainability of human presence and activity on the landscape.

To further discussions in this topic area, the *First World Congress on Environmental Biotechnology* (WCEB) was held from 19–22 October 2011 in Dalian, China. It occurred in conjunction with the Low Carbon Earth Summit 2011, and promoted the theme "Healthier, Safer, and Environment Friendly." The conference, hosted by the International Talent Information Research Center (China State Administration of Foreign Expert Affairs) and by the China Council for the Promotion of International Trade (Dalian Sub-Council), offered a forum for the exchange of ideas between professionals, activists, and decision-makers in this topic area. The event focused on the contributions of participants involved in policy, markets, science and technology, business, and innovation.

Richard Winder, a microbial ecologist studying the impacts of forest practices on forest soils at the Pacific Forestry Centre, was invited to the Dalian conference to speak about his research on the use of advanced molecular biology methods to understand the dynamics of nitrogen-fixing and denitrifying bacteria in forests soils. Because soil microbes are extremely diverse and most cannot be cultured, molecular tools are needed for this work. Winder discussed his use of these methods to study microbial populations in the Levels-of-Growing-Stock Study (LOGS) sites on Vancouver Island. By using these methods, he has uncovered the importance of free-living N-fixers, and how they vary dramatically with soil carbon levels, understorey plant composition, woody debris levels, and other environmental conditions. The study shows, Winder explained, that forest management practices that affect these parameters could have significant impacts on soil fertility and sustainable tree growth.

These two conferences brought together more than 700 participants from 58 countries. "The meetings were an excellent opportunity to network with other important international figures in the topic area," Winder said of this first WCEB meeting. The second annual WCBE meeting will be held this fall from September 24–26 in Taiyuan, China.



In quantitative PCR (Polymerase Chain Reaction), a series of DNA samples (from soils) can be used at different dilutions to build a standard curve. These curves can then be used to quantify the DNA "signal" corresponding to particular microbes in the soil environment.

Conference centre in Dalian, China.

Collecting soil samples at the LOGS (Levels-of-Growing-Stock) plots in the forest near Sayward, BC. DNA will be extracted from the soil and used to quantify populations of key species of nitrogen-cycling bacteria.

New Publications from Pacific Forestry Centre

Information Reports

Peter, B.; Benskin, H. 2012. One hundred years of BCFS–CFS collaboration. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC. Information Report BC-X-432.

Journal Articles

Fitterer, J.L.; Nelson, T.A.; Coops, N.C.; Wulder, M.A. 2012. Modelling the ecosystem indicators of British Columbia using Earth observation data and terrain indices. Ecological Indicators 20:151–162.

Otvos, I.S.; Mills, D.A.; Conder, N. 2012. Within-crown distribution, attack, and germination of *Curculio occidentis*-damaged and *Cydia latiferreana*-damaged Garry oak acorns in Victoria, British Columbia, Canada. The Canadian Entomologist 144:419–434.

Ramsfield, T.D.; Shamoun, S.F.; van der Kamp, B.J. 2012. Histopathology of the endophytic system and aerial shoots of *Arceuthobium americanum* infected by *Colletotrichum gloeosporioides*. Botany 90(1):43–49.

Chen, G.; Wulder, M.A.; White, J.C.; Hilker, T.H.; Coops, N.C. 2012. Lidar calibration and validation for geometric-optical modelling with Landsat imagery. Remote Sensing of Environment. In press. doi: 10.1016/j.rse.2012.05.026

Magnussen, S.; Wulder, M.A. 2012. Post-fire canopy height recovery in Canada's boreal forests using airborne laser scanner (ALS). Remote Sensing 4(6):1600–1616.

Verma, S.S.; Yajima, W.R.; Rahman, M.H.; Shah, S.; Liu, J.-J.; Ekramoddoullah, A.K.M.; Kav, N.N.V. 2012. A cysteine-rich antimicrobial peptide from *Pinus monticola* (PmAMP1) confers resistance to multiple fungal pathogens in canola (*Brassica napus*). Plant Molecular Biology 79:61–74.

Liu, J.-J. 2012. Ectopic expression of a truncated *Pinus radiata* AGAMOUS homolog (PrAG1) causes alteration of inflorescence architecture and male sterility in *Nicotiana tabacum*. Molecular Breeding 30(1):453–467.

Niquidet, K.; Stennes, B.; van Kooten, G.C. 2012. Bioenergy from mountain pine beetle timber and forest residuals: A cost analysis. Canadian Journal of Agricultural Economics 60(2):195–210.

Niquidet, K.; Sun, L. 2012. Do forest products prices display long memory? Canadian Journal of Agricultural Economics 60(2):239–261.

Kaal, J. Nierop, K.G.J.; Kraal, P. Preston, C.M. 2012. A first step towards identification of tannin-derived black carbon: Conventional pyrolysis (Py–GC–MS) and thermally assisted hydrolysis and methylation (THM–GC–MS) of charred condensed tannins. Organic Geochemistry 47:99–108.

Wulder, M.A.; White, J.C.; Coggins, S.; Ortlepp, S.M.; Coops, N.C.; Heath, J.; Mora, B. 2012. Digital high spatial resolution aerial imagery to support forest health monitoring: the mountain pine beetle context. Journal of Applied Remote Sensing 6:062527.

Stewart, B.P.; Nelson, T.A.; Wulder, M.A.; Nielsen, S.E.; Stenhouse, G. 2012. Impact of disturbance characteristics and age on grizzly bear habitat selection. Applied Geography 34:614–625.

Fajardo, A. and McIntire, E.J.B. 2012. Reversal of multicentury tree growth improvements and loss of synchrony at mountain tree lines point to changes in key drivers. Journal of Ecology 100:782–794

Magnussen, S.; Næsset, E.; Gobakken, T.; Frazer, G. 2012. A fine-scale model for area-based predictions of tree-size-related attributes derived from LiDAR canopy heights. Scandinavian Journal of Forest Research 27(3):312–322.

Magnussen, S. 2012. A new composite k-tree estimator of stem density. European Journal of Forest Research. doi: 10.1007/s10342-012-0619-4

Gralewicz, N.J.; Nelson, T.A.; Wulder, M.A. 2012. Spatial and temporal patterns of wildfire ignitions in Canada from 1980 to 2006. International Journal of Wildland Fire 21(3):230–242.

Maghsoudi, Y.; Collins, M.J.; Leckie, D.G. 2012. Speckle reduction for the forest mapping analysis of multi-temporal Radarsat-1 images. International Journal of Remote Sensing 33(5):1349–1359.

Ørka, H.O.; Wulder, M.A.; Gobakken, T.; Naesset, E. 2012. Subalpine zone delineation using LiDAR and Landsat imagery. Remote Sensing of Environment 119:11–20.

Chen, G.; Hay, G.J.; Carvalho, L.M.T.; Wulder, M.A. 2012. Object-based change detection. International Journal of Remote Sensing 33(14):4434–4457.

Coops, N.C.; Hilker, T.; Bater, C.W.; Wulder, M.A.; Nielsen, S.E.; McDermid, G.J.; Stenhouse, G.B. 2012. Linking ground-based to satellite-derived phenological metrics in support of habitat assessment. Remote Sensing Letters 3(3):191–200.

Michaud, J.-S.; Coops, N.C.; Andrew, M.E.; Wulder, M.A. 2012. Characterising spatiotemporal environmental and natural variation using a dynamic habitat index throughout the province of Ontario. Ecological Indicators 18:303–311.

Hilker, T.; Coops, N.C.; Culvenor, D.S.; Newnham, G.J.; Wulder, M.A.; Bater, C.W.; Siggins, A. 2012. A simple technique for co-registration of terrestrial LiDAR observations for forestry applications. Remote Sensing Letters 3(3):239–247.

Cloude, S.R.; Goodenough, D.G.; Chen, H. 2012. Compact Decomposition Theory. IEEE Geoscience and Remote Sensing Letters 9(1):28–32.

Haughian, S.R.; Burton, P.J.; Taylor, S.W.; Curry, C.L. 2012. Expected effects of climate change on forest disturbance regimes in British Columbia. BC Journal of Ecosystems and Management 13(1):1–24.

Filipescu, C.N.; Groot, A.; MacIsaac, D.A.; Cruickshank, M.G.; Stewart, J.D. 2012. Prediction of diameter using height and crown attributes: A case study. Western Journal of Applied Forestry 27(1):30–35.

Gómez, C.; Wulder, M.A.; Montes, F.; Delgado, J.A. 2012. Modelling forest structural parameters in the Mediterranean pines of central Spain using QuickBird-2 imagery and classification and regression tree analysis (CART). Remote Sensing 4(1):135–159.

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