branchlines

Volume 26#3 Fall 2015

Inside:

forestry
university of british columbia

dean's message

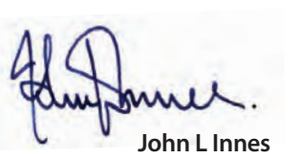
The Faculty of Forestry at UBC always has many different activities in progress, especially in September and October. Would-be employers are visiting earlier and earlier as the demand for graduates increases, and there is a growing realization amongst those employers that the "match-making" needs to be done in an efficient and timely manner, as the demand exceeds the supply, especially given that our students have the possibility of taking up employment anywhere in the world (and, increasingly, they do so). At the same time, students know that they need to stand out if they are to get the best jobs, and a major factor that employers look for is work experience.

In the past, work experience often came in the form of summer job placements, a tried and tested means of gaining experience and some financial support. However, over time, a new type of experience has grown in popularity, and it is a trend that we are actively encouraging. This takes the form of co-op placements. Well-developed in the Wood Science Program, the Faculty's co-op program has seen remarkable growth across the rest of the faculty in the past 2 years, as described on page 6. Co-op placements are a win-win situation for employers and students. Students gain highly valued work experience, and employers have the opportunity to screen potential future employees under workplace conditions. At the Faculty's co-op evening, it was evident that many employers are taking this a step further, and assigning students to solving complex problems that the companies are encountering. This not only provides students with a real taste of what a particular type of job may involve, but can be of considerable benefit to a company. I am reliably informed that one student's solution to a particularly pressing problem has already saved the company millions of dollars! This illustrates to me the huge mutual benefits that can be gained from co-op placements, and I hope that the program will continue to grow.

Another report features the "Open Doors" project. This is a unique partnership between the Aboriginal Program at FPInnovations, the Emily Carr University of Art + Design, the Freda Diesing School of Northwest Coast Art and the Centre for Advanced Wood Processing (CAWP) at UBC. I had the pleasure of attending the opening of the exhibition and was stunned by the quality of the work on display. The carved door panels were exquisite, but the real opportunity lies in the possibilities of their replication as limited edition reproductions using the computer-numerical-control router technology available in CAWP. The innovative approach adopted by this project has the potential to create numerous small-scale Aboriginal businesses up and down British Columbia's coast, and will ensure that economic benefits flow back to the communities. Partnerships of this nature are difficult and time-consuming to establish, but the benefits are obvious.

This September saw the start of a new undergraduate program, in urban forestry, and a new graduate program, in international forestry. The timing of both could not have been better. The demand for an urban forestry program in Canada has been huge, and considerable interest has been expressed in what we are doing. We expect the program to develop rapidly over the next few years, and know that its graduates will make a major contribution to the quality of life of those of us who live in cities. Obesity already affects 1 in 4 Canadians, and is expected to affect half of the population by 2031. Providing outdoor recreation opportunities in and around cities will be an important step in combatting this alarming trend, and will also contribute to reducing related health issues such as diabetes and cardio-vascular disease, as well as mental health disorders. Globally, more and more people are moving to cities: in China alone, 400 million people will move to cities in the next 30 years, and the health disorders associated with more sedentary lifestyles seen today will only continue to increase. Urban forestry is clearly here to stay.

The World Forestry Congress, held in Durban, South Africa, in early September, illustrated just how badly our Master's program in International Forestry (MIF) is needed. While there were many excellent talks, it was clear that many of the distinguished panellists had minimal knowledge of even the basics of forestry. The MIF program is intended to train those already in or planning to enter careers involving national and international negotiations about the fate of the world's forests. I hope that they will be able to utilize fully the knowledge that they gain.



John L Innes
Professor and Dean

forestrynews

Faculty and staff awards

Gayle Kosh, our manager of graduate programs in the Faculty of Forestry for the past 8 years, has received the 2015 UBC President's Service Award for Excellence, for outstanding achievement and excellence within the UBC community. The Award is the top award presented to UBC staff in recognition of excellence in personal achievements and contributions to UBC and to the vision and goals of the University.

Scott Hinch has been named as "Fellow of the Society" at the 145th annual general meeting of the American Fisheries Society in Portland Oregon in August 2015. Less than 8 other Canadians have received this honour and Scott is the youngest. Fellows of the Society are individuals who have made outstanding or meritorious contributions to efforts in leadership, research, teaching, mentoring, resource management and/or conservation, and outreach/interaction with the public.

John Innes has received the 2015 CIF International Forestry Achievement Award, for unique and outstanding contributions or achievements in international forestry. The Award recognizes that Canada is a world leader in the practice of forestry and appreciates the actions of individuals who have shared this leadership with other nations. It can also recognize the actions of an individual to bring nations together to better forestry practices globally.

Bruce Larson is the 2015 recipient of the CIF Canadian Forestry Achievement Award, for unique and outstanding achievements in the field of forestry. The Award appreciates the value of consistent exceptional contributions made over a lifetime to the field of forestry in addition to singular momentous achievements. Congratulations Gayle Scott, John and Bruce.

National Forest Week celebrations

As part of National Forest Week (September 21-25), and the theme of Wildland Fires, the Faculty of Forestry organized several highly successful public events. Our largest event was on Friday September 25 when "Beyond the Inferno" drew crowds of people to our building. The afternoon began with a live demonstration by a Rapattack crew from the BC Wildfire Service. At precisely 4pm, a helicopter hovered over the grass area directly outside our Forest Sciences Centre building. Three Rapattack crew members quickly rappelled from the helicopter onto a small (and well-contained) demonstration bonfire that had been ignited on the grass area directly outside the building. Ground crew members were on hand to extinguish our small "fire". Following this spectacular event, Rapattack crew members, and many of the individuals who had gathered to view the event, joined our evening session of short talks dedicated to the topic of wildfires. The evening's speakers were Lori Daniels (UBC Forest and Conservation Sciences), Lyle Gawalko (Ministry of Forests, Lands and Natural Resource Operations), Jed Cochrane (Parks Canada), Bruce Blackwell (BA Blackwell and Associates) and Stephen Sheppard (UBC Forest Resources Management). Videos of the evening talks can be viewed on our youtube channel http://bit.ly/BeyondInfernoVideos.

Finally, the evening events culminated with the official launch of our new Bachelor of Urban Forestry (BUF) degree program. This program is the first undergraduate degree in urban forestry to be offered in Canada. See page 4 of this newsletter for further information on this new program.

New Urban Forestry program

With more than half the world's population living in urban areas, increasing urbanization, and rising public expectations for livable, sustainable and greener communities, cities all over the world will need urban forestry professionals who can deal with these complex, multi-disciplinary challenges.

To help meet this growing demand, UBC's Faculty of Forestry has launched a new undergraduate degree, the Bachelor of Urban Forestry (BUF), in collaboration with the School of Architecture and Landscape Architecture. This new degree program, directed by Dr Stephen Sheppard, is dedicated to the planning and management of urban greenspaces and is the first of its kind in Canada. Below are 5 reasons why students might consider a career in urban forestry:

Helping people: By greening the concrete jungle, urban foresters deliver happiness to city dwellers. Many research studies have shown that green environments improve physical and psychological health, encourage active recreation, and reduce crime. Just by viewing natural scenery outside a window, people recover faster from stress and illness. Trees can raise property values and commercial revenues. UBC Forestry graduate student Lorien Nesbitt is studying how to improve "green equity" in poorer neighbourhoods in Vancouver and other cities, where people have little access to the benefits of a mature tree canopy such as shade, filtered air, and aesthetics.

"We all deserve to live in communities that support our health and well-being. Trees are an important part of creating healthy and productive communities. Trees make life better."

– Lorien Nesbitt

Saving our communities by climate proofing cities: Urban forests and ecosystems play an important role in moderating the extremes of climate change. There is an urgent need to conserve, manage and expand our canopy and green infrastructure, the parts of urban nature that quietly and effectively shelter and moderate our environment against increasing heat waves, flash floods, forest fires, and air pollution, all at very little cost. In 2015, residents of the Pacific Northwest faced one of the hottest and driest summers in decades, and found themselves in the midst of water shortages, raging forest fires, and smoke-filled skies. When rain finally came, a powerful windstorm swept communities, causing substantial damage to trees and cutting off power to well over 1 million homes. It is vital that we keep our urban forests in a healthy and resilient state in order to support sustainable and livable cities of the future.

Expanding job prospects: Most cities are gearing up to confront the challenges facing their urban forests and communities. This means growing job opportunities in local government, consulting firms, education, and research. In some parts of Canada, there are more jobs in urban forestry than in conventional forestry. In China alone, urbanization demands thousands of professionals skilled in design, installation and maintenance of parks and green spaces. Throughout UBC's urban forestry program, students will meet practitioners and potential employers in arboriculture, landscape architecture, urban planning, engineering, and nursery operations, through lectures, field trips, and co-op/internship programs.

Developing transferable skills: Urban forestry is a truly interdisciplinary field. We encourage our students to incorporate various skillsets, including systems thinking, gamification, people skills (such as community engagement and communications), design and planning of greenspaces, geographic information systems, and governance. These skillsets will prepare our graduates for a range of public and private sector careers in urban forestry and related fields. Our graduates will also be well-equipped to pursue post-graduate education and research in various disciplines.

Doing cool stuff: Where else can you learn from leading researchers in fields as diverse as geomatics and remote sensing, urban ecology, landscape architecture, urban planning, and visual communications? UBC offers students opportunities to explore regional parks, botanical gardens, nature reserves, indigenous communities, coastal forests, and scenic recreational backdrops to our cities. UBC provides international networks that can connect students with case studies and contacts in countries around the world. Where better than in Vancouver, British Columbia – the "Greenest City" – to learn and apply innovative and practical skills in urban forestry!

For further information on this new program including admission requirements and deadlines, visit www.forestry.ubc.ca/students/undergraduate/prospective/.

New course-based graduate program

The Faculty of Forestry is offering a new 9 month course-based Master of Geomatics for Environmental Management (MGEM) beginning August 2016 (subject to final government approval). The program is designed for foresters, ecologists, conservation managers and other practitioners seeking to improve their understanding of geospatial theory, methods and application.

There is an increasing need for geospatial scientists in environmental management. This program prepares students for a range of careers in geomatics services, consulting, engineering, conservation management and planning and development in both the public and private sectors.

The program begins with an intensive landscape ecology course introducing modelling around the core ecological themes of the program.

- Resilience
- Carbon and Biomass
- Ecological Goods and Services
- Landscape Pattern, Heterogeneity and Change
- Social-Ecological Perspectives for Environmental Management

Other courses cover a mix of ecology-based theory and hands-on practice to provide students with a well-rounded education in quantitative skills such as statistics, programming, GIS and remote sensing/image processing within an environmental management context. Students will be exposed to industry, government and NGO professionals to gain an understanding of the vast opportunities available within this emergent field.

Students will meet local professionals from both internationally recognized companies as well as startup companies allowing them to see the vast range of possibilities a degree in the MGEM program offers.

For more information about the MGEM graduate program, visit www.ubc.ca/grad/mgem.

Innovation in the bio-economy – a training program

As Chile's bio-economy is gaining momentum, a large government-sponsored program to develop innovative capabilities among Chilean universities (the Chilean Performance Agreement) has provided funding to the Universidad de Concepción (UdeC) to enhance their bio-economy program. The Faculty of Forestry at UBC was approached to help in this process and subsequently organized a UBC-based training program for 12 bio-economy experts from the UdeC this past July.

The program was designed to showcase UBC's latest research and innovation strategies in the bio-economy through a series of lectures, lab visits, group discussions and workshops. The main areas covered were:

- Best practices in technology transfer, including coordinating between bio-economy researchers and technology managers/business developers.
- Identifying, developing and financing effective linkages between researchers and industry, and effectively identifying market opportunities.
- Fostering bio-economy technology entrepreneurship

Lectures were given by our faculty members Drs Jack Saddler, Phil Evans, Scott Renneckar, David Cohen and Ian De La Roche. In addition Dr Frank Ko (Department of Materials Engineering), Dr Mark MacLachlan (Department of Chemistry) and Dr Mark Martinez (UBC Pulp and Paper Centre) participated in the training program. One of our most active collaborators was FP Innovations, who offered a tour of their installations and shared their expertise in bio-economy strategy. One-on-one and small group meetings were held with Dr Yousry El-Kassaby (UBC Forestry), Dr Harry Brumer (Michael Smith Laboratory) and members of the Entrepreneurship@UBC Accelerator Program.

A workshop on strategy and visioning gave the Chilean delegation the opportunity to question the organizational structure and culture of their bio-economy program at UdeC. Net-Map, an innovative influential network mapping group interview tool developed by Dr Eva Schiffer (World Bank) was used to identify key influential actors and networks in the bio-economy sector of the Bío Bío Region of Chile. These exercises, led by Ana Elia R Hidalgo, a PhD candidate at UBC's Faculty of Forestry and co-facilitator of the training, were useful to reflect on knowledge gained from the training, current group dynamics within the networks and to help define the next steps towards the creation of a university-industry collaboration network in the Bío Bío Region of Chile.

Wenchang He receives Harry Earl Award

When Wenchang (Will) He enrolled in a doctoral program in the Faculty of Forestry straight out of an undergraduate program at Beijing Forestry University he couldn't imagine that a few years later he'd be sharing the stage at an international conference with Europe's leading experts in wood composites science. "Looking back I can see how inexperienced I was", said Will, "but thanks to the support of my supervisor, Professor Evans, staff in the Dean's office and my fellow students I feel I've come a long way, in the past 4 years, both as a person and as a researcher", said Will. "The first few years were tough as I was exploring some new concepts in wood composites science ". "But little by little I made progress and now I'm ready to tell the world about what I've been doing (and pass on some of my exciting findings)". "I'm very fortunate that my paper secured the inaugural Harry Earl Award as the best student paper submitted to the conference". "The award means that I'll be able to attend the conference and make my first trip to Europe". Afterwards Will intends to visit his family in Chengdu. "I'm sure my family will notice many changes in me". "Living in Vancouver for the past 4 years has really shaped me into becoming a much more mature and independent individual". "Since I came to Vancouver I've been actively involved in lots of group activities (hiking, beach volleyball and team-Frisbee) as well as community service. "I've made many great friends with different backgrounds and developed new interests such as snowboarding and biking". "As much as I enjoy the great outdoors that Vancouver has to offer, above all I am very grateful for the opportunity I've been given to study in the Faculty of Forestry at UBC". "The past 4 years have been a tough but rewarding journey". "I am proud to say that I have received the highest quality education that I could ever have hoped for". "I am glad to see our research has been recognized on the international stage".

Wenchang He is supported by China Scholarship Council Student Scholarship and the Mary and David Macaree Fellowship. He received the Harry Earl Award and presented his paper on 'Reducing the thickness swelling of wood composites by creating a 3-dimensional adhesive network' at the International Panel Products Symposium in Llandudno, Wales, UK on 8th of October 2015.

Co-op reaches new heights

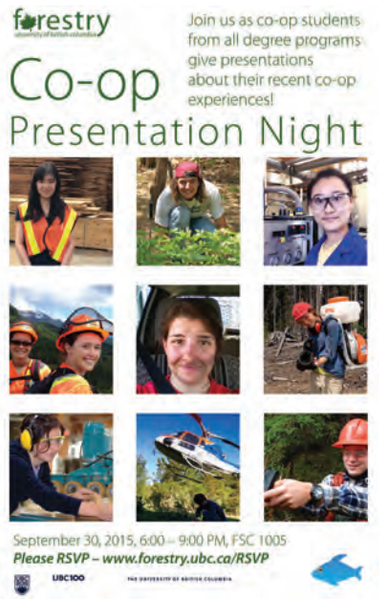
Co-op Presentation Night occurs twice a year, showcasing selected students who have recently completed their co-op work terms. Over the years, this event has grown from a handful of people in a classroom to a major networking event with more than 200 guests including employers, faculty members, parents and students.

The success of our most recent Co-op Presentation Night, was due in large part to the student presenters, who shared their insights and achievements in workplaces across BC and around the world. Stories of holistic forestry practices in Finland were dovetailed with quality control experiments using video cameras to solve complex production problems. Each student revealed a unique perspective on the field of forestry, giving the audience a chance to see distinct industry practices from multiple viewpoints.

During the intermission guests interacted with junior co-op students as they presented their poster assignments from their first work terms. More than 35 posters were displayed from work terms in India, Chile, China, Japan, Nicaragua, the USA and across Canada.

The past 2 years have been a period of rapid growth for our co-op program – from launching an employment website, producing a new newsletter, coordinating marketing initiatives and doubling the number of student applicants – co-op is larger and more organized than ever before.

Our next Co-op Presentation Night will be in January of 2016, with a new batch of recently returning co-op students sharing their experiences in presentations and posters. If you would like to receive an invitation to this event, please contact Tony Loring, Co-op Coordinator, at tony.loring@ubc.ca or 604.827.5196.



Forest-related conflict in the Monks' Community Forest, Cambodia

In Cambodia, forest resources are a vital part of many families' livelihoods, with the poorest people depending upon them most heavily for food, firewood, medicinal plants, and building materials. However, increasing demand for agricultural lands and valuable hardwoods is contributing to deforestation and forest degradation in the region, reducing the resources available for families in need and contributing to the destruction of delicate ecosystems. In response, the international development community has promoted Community Forestry (CF) projects with the aim of empowering local people to manage their own forests more sustainably.

Hollie Grant is a doctoral candidate in UBC's Forests and Communities in Transition (FACT) Lab, co-supervised by Drs Rob Kozak and Philippe Le Billon (Geography). She has been studying the Monks' Community Forest in the northwest of Cambodia. Established in 2002, the CF gained recognition from the Ministry of Environment in 2008, becoming the first CF in Cambodia to complete the complex registration process. It is one of the few remaining places in the country where endangered tree species, such as *Dalbergia oliveri* (Burmese Rosewood) and *Afzelia xylocarpa* (locally known as 'beng'), can be found. The forest is also home to several endangered species of animals, including banteng (*Bos javanicus*), pileated gibbons (*Hylobates pileatus*), and pangolins (*Manis javanica*).

Like other forests in Cambodia, it faces degradation due to illegal logging. Additionally, the rare wildlife attracts poachers. Elsewhere in Cambodia, Community Forest patrol groups often 'lose' to the loggers and poachers, watching helplessly as timber or animals are carted away by organised groups armed with guns or machetes; the threat of violence is often too great for patrol groups to intervene. However, in the Monks' Community Forest, the monks have been particularly effective at reducing the frequency of conflicts and resolving those that do occur. This is related to both their unique management of the CF and the monks' position in Cambodian society.

Firstly, the monks are able to organise patrols of the forest at least once a day and twice during the dry season. Without rice fields to attend to or paying jobs to go to, they have more time to dedicate to forest protection than most Cambodians. This constant vigilance increases the likelihood that potential loggers and poachers will be deterred before conflict arises.

Furthermore, monks are highly respected within Cambodian society and many would-be loggers are reticent to disobey monks for fear of bad luck. To commit violence against a monk is one of the worst offenses in Cambodian culture and, consequently, monks can confront illegal loggers and poachers with less fear of retaliation than other CF members.

Monks also hold significant political power in Cambodian society. This means that local authorities are more likely to enforce punishments for offenders at the request of the monks. This is a significant advantage over other CF groups in Cambodia, where state authorities are often uncooperative and understaffed, if not outright corrupt.

However, while the monks have been able to reduce some forms of conflict among local forest users, other forms of conflict are harder to contest. One of the most pressing issues is the threat of losing 3,000 hectares to a reservoir, which will provide irrigation for a largescale economic land concession in the neighbouring province. Such disruptions divert the monks' attention away from the day-to-day tasks of forest protection and community capacity building. However, the Monks' Community Forest demonstrates that by building networks among conservation actors, progress can be made in protecting Cambodia's forests.

For further information contact Hollie Grant at grant.vhe@gmail.com or Dr Rob Kozak at rob.kozak@ubc.ca.

Beyond the dam: Sockeye salmon migration through a regulated watershed

On a mid-August afternoon, from high up on a bluff above the small town of Lillooet, British Columbia, staring out into the sunbaked canyon that cuts north and south as far as the eye can see, you can't help but be in awe of the scorched and ruggedly beautiful landscape falling into the turbid waters of the mighty Fraser River below. And the heat – man it's hot.

Gazing south through the hazy, sweltering air down toward the river, the great plume of brilliant blue water that intersects The Fraser directly from the west is hard to miss. Its path immediately swept southward by the massive murky flows so it looks like a stroke of azure watercolour on brown canvas. Peering harder and further south, a nondescript grey building on the western bank of The Fraser takes shape. Barely visible to the eye are a few low-slung power lines emanating from the structure, and the stark, angled lines of a concrete canal filled with blue water that disappears into the building. On the riverbank side, the blue water that vanished into the building is visible again, discharged into a swirling, frothy vortex before being swallowed by The Fraser and completing the painting down the river's western bank.

It's a beautiful picture really; save for a bit of infrastructure and a small town, it's probably not too far removed from the view Simon Fraser could have had when he first paddled this section of his river in 1809. However, to the knowing eye, this is also a view that bears all the hallmarks of a complex hydroelectric system tapped into the potential of BC's rugged geography.

But there's something else down there, swimming back and forth in that blue watercolour. Something that's been a part of the river here for millennia. If you had eyes like the Osprey riding up high on the thermals, you'd see them too. Crimson red against the azure, thousands of migrating adult sockeye salmon, using only their noses and memory to guide them home, where – if all the stars align – they'll find a mate, spawn, and complete their life's journey.

Adult sockeye salmon (*Oncorhynchus nerka*) have historically returned in great numbers to the Fraser River watershed and are hugely important culturally, economically, and ecologically in British Columbia. However, for more than the past decade, some populations have exhibited marked declines in returns, with migration mortality exceeding 90% in some cases. While a degree of mortality is expected given the single reproductive cycle of these fish and the gauntlet of natural and anthropogenic challenges they run during their migration, enroute loss exceeding 90% for more than a few years in a row is considered unprecedented and unsustainable by many. Researchers, managers, and First Nations alike have all recognized the necessity to better understand these trends if this iconic species is to persist.

One arena where stakeholders are working together to better understand the causes of these trends is within the context of watersheds regulated for hydroelectric power production. There are no dams on the mainstem Fraser River, making it unique in the Pacific Northwest for a river of its size – the Columbia River has 14 dams on its mainstem. However, a few of the Fraser's tributaries have indeed been regulated for hydropower. In the context of understanding trends in migration mortality and success, a hydrosystem can be used as a model to examine how migrating adult sockeye salmon are affected by their interactions with changing environmen-

The Fraser River and town of Lillooet. The plume of blue Seton River water, and migration route for the Gates and Portage Creek sockeye, is visible flowing southward with The Fraser.

A place where sockeye salmon migration delays are known to occur, the Seton Powerhouse discharges natal lake water into a tailrace directly adjacent to the Fraser River.

tal conditions and fixed hydroelectric infrastructure.

Completed in 1956 in a beautiful pocket of the Interior Fraser Canyon, 350 km from the Fraser River mouth, the Seton hydrosystem produces 42 megawatts of power for the provincial grid, and comprises one third of BC Hydro's greater Bridge-Seton hydroelectric network in the Seton-Anderson watershed. This area is also the final migration corridor for the Gates and Portage Creek populations of sockeye salmon that must pass from the Fraser River and ascend Seton Dam to reach their natal spawning sites in the upper reaches of the watershed. Here, for more than 10 years, UBC researchers from the Pacific Salmon Ecology and Conservation Laboratory led by Dr Scott Hinch (Department of Forest and Conservation Sciences) have been exploring the effects of hydropower infrastructure on sockeye salmon migrations in collaboration with BC Hydro and the St'át'imc (STAH-tleum) First Nation.

"If we are to sustain populations of wild salmon and meet the demand for energy in BC, a delicate balance between nature, industry, culture, and research is required."

To date, the bulk of the research conducted here by Hinch's lab has focused on the direct and indirect effects of the Seton Dam and fishway on migrating adult salmon physiology, energetics, and behaviour. However, until recently, no researchers had taken a step back from the dam to examine how the 2 different populations of sockeye salmon migrate through the entire hydrosystem. So, for part of his MSc work under the supervision of Dr Hinch, Collin Middleton (a graduate of UBC Forestry's Natural Resources Conservation undergrad program) set out to do just this: explore how adult sockeye salmon migration behaviour and success is shaped by the physiological status of individuals and the environmental conditions they experience within a regulated migration corridor.

From early August to late October in 2013 and 2014, Collin and a dedicated crew of Hinch Lab members and St'át'imc technicians, endured blazing sun and blowing sleet to radio tag and blood sample over 500 adult sockeye salmon from the Gates and Portage Creek populations. Using a series of fixed radio-telemetry receivers, they tracked and tagged individuals as they migrated up the Fraser River and entered the Seton River, passed the Seton Dam, and continued all the way to their natal spawning grounds, a distance of 30 or 50 km from the dam for the Portage and Gates Creek populations, respectively. Although this route sounds straightforward enough, natural variation in river temperatures, discharge at the Seton Powerhouse on the Fraser River bank, and mixing of water sources in the Seton River, can create conditions that delay fish migration and negatively affect their physiology. Because these fish are senescing and relatively close to their natal sites where they will die shortly after spawning, any delay that occurs prior to this can have negative consequences on migration. Indeed, delays of even a few days have been linked to failure in reaching spawning sites.

For the past year, Collin has been busy piecing together and analyzing individual migration histories from a mountain of telemetry data. The Seton Powerhouse tailrace on the western bank of the Fraser River is a well-known locale where migrations can be unusually delayed. However, preliminary results indicate that delay here has no effect on individuals passing the Seton Dam or surviving to spawning grounds. There is, however, strong evidence to support that increased delay migrating through the entire Seton hydrosystem reduces an individual's odds of surviving all the way to natal spawning sites. Furthermore, and consistent with trends from throughout the watershed, the highest levels of migration mortality in this system occurred in females; concerning because the number of females on spawning grounds limits the number of juveniles produced each year. Overall, mortality trends in both sexes were exacerbated by the effects of elevated river temperatures.

If we are to sustain populations of wild salmon and meet the demand for energy in BC, a delicate balance between nature, industry, culture, and research is required. For example, at times when both energy demand and temperatures are high, and mortality is inevitable, perhaps shifting power generation to other sites and reducing fishing efforts could ensure more fish reach spawning grounds. This project demonstrates how partnerships between academic groups, resource agencies, and First Nations can be highly beneficial working toward understanding more about and protecting natural resources in this rapidly changing world.

For more information contact Collin Middleton at collin.t.middleton@gmail.com or Dr Scott Hinch at scott.hinch@ubc.ca.

Climate change disrupts an ancient evolutionary arms-race

Pine trees and their insect pests have engaged in an evolutionary arms-race spanning many millennia. Trees have evolved physical and chemical repellents (such as resin) to help deter colonization and consumption by insects. Most insects that live under the bark avoid these barriers by colonizing defensively compromised, or dead, host material. Some species of bark beetles have evolved effective counter-measures, such as pheromone-mediated mass-attack, that overwhelm host defenses, and allow occupation of otherwise healthy trees. Trees under this threat respond in turn and develop resistance, and those that are safe, either due to host specificity in the insect or some geophysical barrier, do not develop resistance. Rapidly increasing climatic temperatures affect the 2 sides of this war of survival in significantly different ways however, and the advantage goes to the insects. Trees have long lifespans and are stationary, and therefore cannot migrate or quickly adapt to a changing climate. Insects are ectothermic (regulation of body temperature depends on external sources), highly mobile, and enjoy very high reproductive potential; even slight increases in temperature lead to an exponential rise in population size.

The traits that allow for rapid adaptation to changing climate also make insects adept at invasion of novel habitats. Many species of forest insect pests have rapidly colonized naïve ecosystems on distant continents after arriving via international shipping. The emerald ash borer (*Agrilus planipennis*) and the redbay ambrosia beetle (*Xyleborus glabratus*) currently threaten to exterminate ash and redbay populations across North America. In both cases, these insects are relatively unknown and do little damage in their native ranges in Asia, where ecosystems have inherent restraints to population growth. These restraints are often numerous and interactive, and include host defenses, predation/parasitism, and inter- and intra-specific competition. The invaded forests are most often on a wholly different continent and share no species in common with the native system, making it difficult to conduct controlled experiments.

The recent outbreak of mountain pine beetles (*Dendroctonus ponderosae*) in British Columbia presents an opportunity for discovery. Rapidly declining minimum winter temperatures in more northern and high-elevation lodgepole pine forests, and homogenization of the forest landscape across BC, have led to an unprecedented expansion in range by this destructive native pest. Recent research shows that lodgepole pine trees in the expanded range, both in BC and Alberta, are more susceptible to colonization and subsequent mortality. Naïve populations of lodgepole pines experience higher attack densities, and female beetles produce more eggs. These phenomena work in concert and the insects produce more individuals per year, leading to longer and more severe outbreaks. When the individuals perform better, so does the team.

Jordan Burke is a doctoral candidate working with Dr Allan Carroll in the Forest Insect Disturbance Ecology Lab at UBC. Jordan's research suggests that elevated susceptibility in the invaded forests is due to a lack of coevolution of the induced

"The recent outbreak of mountain pine beetles (*Dendroctonus ponderosae*) in British Columbia presents an opportunity for discovery."

resinosis (resin production) response in the trees, similar to what might drive an exotic insect introduction. The mountain pine beetle system allows researchers to control for factors that would otherwise be impossible; naïve and experienced forests contain nearly the same species complex of hosts and competitors, allowing scientists to isolate the role of host defenses. Comparisons of the induced resinosis response between populations of lodgepole pine and other host species, reveal that coevolved populations react more strongly to simulated attack than do those with weaker co-evolutionary relationships. However, it is expected that different host species will react differently to attack simulation treatments, and this information alone is insufficient evidence to conclude that evolution is, or was, taking place.

Jordan and Allan Carroll, along with Dr Jorg Bohlmann, have developed a method of comparing the induced resinosis response of trees in a way that takes into account the inherent variation that arises when comparing distant forests. Each tree is treated with a mountain pine beetle attack simulation (using a symbiotic fungal species), and the phytohormone methyl jasmonate, at the same time. Methyl jasmonate induces a defensive reaction in all plants, and serves as a type of control treatment, providing a "baseline" measurement for each tree. The researchers compare the expression of monoterpenes (volatile defensive chemicals) in the induced resin in response to each treatment. Comparison with historical climate modeling reveals that lodgepole pine trees that reside well within the historic range of the beetles will react more vigorously to the beetle simulation. This differential was absent in other regions of western Canada, where past climate was likely to be too cold for beetle epidemics. The researchers consider this to be evidence that these coevolved populations have adapted to "recognize" a significant threat to their safety. In the dry lodgepole pine forests of British Columbia, an attack by mountain pine beetles almost always results in mortality; trees with insufficient induced defensive expression will be selected against. At the same time, the induced resinosis response is energetically costly, and so in the absence of outbreaks, it is advantageous for the tree not to over-do it.

The hypothesized story of the evolutionary interaction between lodgepole pine and mountain pine beetles in western Canada begins at the end of the last ice age. Around 12,000 years ago, as kilometers-thick glacial ice receded, lodgepole pine trees migrated north, and their pests came with them. At some point, the trees were able to outstretch the beetles in range, as the insects cannot withstand extremely cold winters, and suffer immensely in reproductive potential during cool summers. In these newly ice-free northern and high elevation sites, the growing season is colder and short, and so the trees must invest all they can to above-ground growth in order to earn canopy dominance. In these relatively insect-free landscapes, the biggest enemy to an individual tree is its neighbor. There is a tradeoff for resources between growth and defense, and so trees in a relatively beetle-free environment will be under immense selection pressure to drop the tools developed during the ancient arms-race, and focus on growing. What we observe now are divergent defensive strategies between populations in the presence or absence of periodic, high mortality events caused by the beetle.

Now, enter the humans. Excessive atmospheric carbon has raised the climate temperature so rapidly that mountain pine beetles have spilled into this devolved defense-free space faster than the trees have been able to adapt. These shifts happen naturally, but usually take many millennia to play out, allowing plants to adapt and continue the arms-race. Here, humanity has rapidly tipped the balance, and the advantage goes to the insect, which is already a destructive pest in the coevolved range; the Canadian government has estimated BC will lose 58% of the merchantable pine on the landscape by 2017. This type of research gives us the opportunity to point to an economic consequence of climate change, which is the result of a disruption of a complex ecological interaction that evolved over millennia. Recently, the southern pine beetle, a related species that is already destructive in southern North America, has been discovered killing trees in the Long Island region of New York, a region once too cold for this insect. It is reasonable to think we will see other eruptive herbivore expansions throughout the Holarctic biogeographic region, where forests often extend into climates previously too cold for massive populations of insects.

For more information contact Jordan Burke at jordan.lewis.burke@gmail.com or Dr Allan Carroll at allan.carroll@ubc.ca.

Mule deer habitat management and natural disturbance

Photo CC3.0 Terry Spivey, USDA Forest Service, Bugwood.org

Mule deer winter habitat management is an integral part of forestry in British Columbia's interior, predominantly in the Cariboo. Mule deer require a clumpy canopy distribution for shelter and food. The abrasion from the canopy causes branches from the top to break off, making needles and lichen more accessible and available for the deer. The canopy also offers areas of reduced snow pack for the deer to lie and facilitate their travel.

Staff at UBC's Alex Fraser Research Forest in Williams Lake began a single-tree selection harvest regime to help create mule deer habitat at the Knife Creek block in the early eighties. Now, 30 years later, they are re-examining the same 3 blocks. Under the supervision of Drs Lori Daniels and Allan Carroll (Department of Forest and Conservation Sciences), 2 graduate students, Marc-Antoine Leclerc and Wesley Brookes have set up plots within the treated areas and collected data pre and post harvest to further investigate the impacts of this type of management on the stand.

The master's candidates are hoping to recreate the stands' disturbance history, focusing on fire and western spruce budworm. Additionally, they wish to compare the risk potential for abiotic and biotic disturbances resulting from the single-tree selection harvest. To do so, they embarked on a 2-summer adventure to collect data from the treated areas before and after harvest.

In 2014, their first summer of data collection, Marc-Antoine and Wesley assessed the stand's structure and vigour. They determined the 10 closest canopy and sub-canopy trees and measured their diameters. They also photographed the canopy at each plot to determine canopy cover, working closely with Drs Daniels and Carroll to ensure proper data collection. They collected the bulk of their data in the summer of 2015.

This past June, the 2 graduate students along with 2 undergraduate students working in UBC's Tree Ring Lab, set out for Williams Lake to collect the remainder of their data. They received additional help in the form of 3 extra crew members from the Tree Ring Lab at the beginning of July. Once more, they assessed the stand's structure and vigour and in addition to this, the trees were examined for beetle attacks and any other signs of disturbance. They assessed the plot's fuel load with fuel transects and estimated vegetation cover. A regeneration count was done. Moreover, cores were taken from the selected sub-canopy and canopy trees and finally, tree cookies with fire scars were cut for further analysis in the lab.

The susceptibility of the stand to budworm attacks will be determined based on the vigour of the stand, which will be analyzed with the tree cores and the observed growth. The stand's fire risk will be examined with the spatial distribution of trees and fuel along the forest floor. The stand's disturbance history will focus on western spruce budworm outbreaks and fires. These will be analyzed using the tree cores and the fire scars.

At this point it is too early to determine the effects of mule deer winter habitat management on a stand's natural disturbance regime. But the outcomes of this research could very well create a paradigm shift in how mule deer habitat is managed for years to come.

For further information on this project, contact Marc-Antoine Leclerc (leclercmarcantoine@gmail.com), Wesley Brookes (wesleybrookes@hotmail.com), Lori Daniels (lori.daniels@ubc.ca) or Allan Carroll (allan.carroll@ubc.ca).

Opening doors – capacity building for Aboriginal communities

BC Coast Aboriginal art is widely known for its traditions, sophisticated design, and unmatched craftsmanship. With a history spanning thousands of years, artisans have formed a pillar of coastal Aboriginal culture, often depicting traditional myths, beliefs, histories and customs. Both historic and contemporary pieces have impacted the art community, and today are highly coveted by museums and collectors.

A unique educational program was launched this past summer to promote the artistry and design of traditional art. Artisans representing 10 Aboriginal communities, mostly on the BC Coast, participated in celebrating the story-telling nature of traditional BC Aboriginal art while also promoting coastal communities and their unique talents. This initiative was led by the Aboriginal Program at FPInnovations and was a cooperative project involving Emily Carr University of Art + Design, the Freda Diesing School of Northwest Coast Art and the Centre for Advanced Wood Processing at UBC.

The BC Coast Aboriginal Doors Program completed a 4-week intensive carving course this past summer, held at both Emily Carr University of Art + Design Aboriginal Gathering Place in Vancouver and the Freda Diesing School of Northwest Coast Aboriginal Art in Terrace. This intermediate program offered students training and instruction by established Aboriginal carvers.

The 10 completed carvings were exhibited at the Yaletown Roundhouse in Vancouver in early October, including a panel of presentations by the artists, the schools and the project leaders. The door panels were manufactured from BC Coastal red and yellow cedar, where possible sourced from Aboriginal lands, and certified as sustainable.

Project managers Dr Chris Gaston (Associate Professor at the Faculty of Forestry and University Liaison at FPInnovations) and Brenda Crabtree (Aboriginal Program Manager at Emily Carr University of Art + Design) collaborated to make this project a reality, involving a large number of champions from the schools, funders, and of course the individual Aboriginal artists and their communities.

The next step will be to work with interested artists on seeking out joint venture opportunities with established door manufacturers for markets in North America and abroad. This will involve modern scanning and computer-numerical-control (CNC) router technologies to facilitate the creation of artist-owned limited edition carving copies. The limited-edition-print concept is key, insuring that the artists and their communities maintain ownership and credit for their designs and for their work. As is the case with limited edition reproductions by print-media artists, the CNC technology will allow for increased artist productivity, and for increased affordably of the signed copies to a wider audience of collectors, and in the case of these doors, home/commercial building designers.

There are a number of possibilities being considered for the application of the CNC technology. These range from very high resolution router carvings where little finishing is required by the artists, to low resolution where the artists will still do a lot of the work. For the latter, the technology helps with the original rough carving of a design that is scanned from an original or from a drawing, allowing the artist to essentially create a pseudo-original. The advantage is time saving for the less skilled portion of the process. The choice of process belongs to the artist / manufacturing joint venture, and will be driven by their marketing strategy. Ultimately, it is hoped that the training and application of machining technologies will lead to capacity building and added wealth to Aboriginal communities.

FPInnovations and Emily Carr University of Art + Design are looking forward to recreating this program for other communities in BC and the rest of Canada. For further information contact Dr Chris Gaston at chris.gaston@ubc.ca.

research lab profiles

The Integrated Remote Sensing Studio

First in a new series to take you on an inside tour of some of the Faculty of Forestry's research labs

The Integrated Remote Sensing Studio (IRSS) is housed in the Forest Resources Management Department in the Faculty of Forestry at UBC. IRSS lab members conduct research using remote sensing and geospatial information to study forest related issues and conservation. Their research covers a wide-range of topics, including use of remote sensing to assist forest inventory, map long-term land-cover change, assessing species habitat, understanding wildfire impacts, mapping urban greenness and linking changes in forest structure to disturbance. Research is conducted at a variety of spatial scales, from the entire Canadian Boreal forest, to the scale of individual trees. The diversity of the IRSS lab attracts individuals from all over the world and creates a unique collaborative environment.

The lab is run by Nicholas Coops, a faculty member in the department of Forest Resources Management who holds a Canada Research Chair in remote sensing and obtained his PhD from the Royal Melbourne Institute of Technology in Melbourne Australia. Nicholas teaches remote sensing in the Faculty of Forestry's undergraduate program, as well as a graduate level advanced remote sensing class. He is also teaching a new course, "Observing the Earth from Space", which is aimed at introducing geospatial technologies to first year students. His efforts extend beyond his lab; Nicholas is the editor-in-chief of the Canadian Journal of Remote Sensing, which covers a wide breadth of remote sensing topics and research.

Who works in the IRSS lab?

The IRSS consists of postdoctoral fellows and graduate students, both PhD and Master's candidates. The lab also employs a number of undergraduate students through UBC's annual Work Learn program. These students assist both the researchers and graduate students and learn to participate in the research process. In addition, the IRSS hosts Canadian and international visitors who wish to learn more about how remote sensing imagery can be applied to their individual projects. Visitors have come from China, Brazil, Quebec, Italy, to name a few.

The IRSS is a diverse community of researchers in terms of student educational backgrounds and nationalities. Graduate students and PDFs come from a range of experiences, including forestry and ecology to geomatics and computer programming. Approximately 50% of the lab consists

of international students from countries such as Spain, China, Poland, Italy and the United States and 50% are from Canada.

What does the work entail?

Most of the research undertaken within the lab is computer based, using remote sensing and geographic information systems. Students and PDFs also write their own programs to process the remote sensing data. As the data is often very large the students need fast workstations and high resolution screens. Occasionally, fieldwork is required to help validate and build relationships between remote sensing data and variables of interest. Many lab members deliver their results and techniques at international conferences, providing an opportunity for lab members to discuss with individuals both in academia and industry. The IRSS also publishes an impressive number of peer-reviewed papers every year; in the past 5 years an average of 30 publications have come out of the lab every year.

What is currently going on at the IRSS?

Research within the IRSS uses spatial datasets obtained from various remote sensing technologies such as Light Detection and Ranging (LiDAR), Landsat, MODIS, SPOT, aerial photography, and hyperspectral sensors. Here is a flavour of some of the work being conducted in the IRSS:

Amanda Mathys' research involves mapping the distribution of tree species in the Pacific Northwest using a process-based model (3-PG). She is particularly interested in how tree species distribution may be altered in response to extreme events such as drought and frequency of frost.

Curtis Chance and **Andrew Plowright** are working with the City of Surrey to determine tree condition and to map the distribution of invasive species across the city using a combination of hyperspectral imagery and LiDAR.

Doug Bolton and **Ryan Frazier** are using a combination of Landsat time-series and LiDAR data to understand the effects of fire and recovery across the boreal forest of Canada.

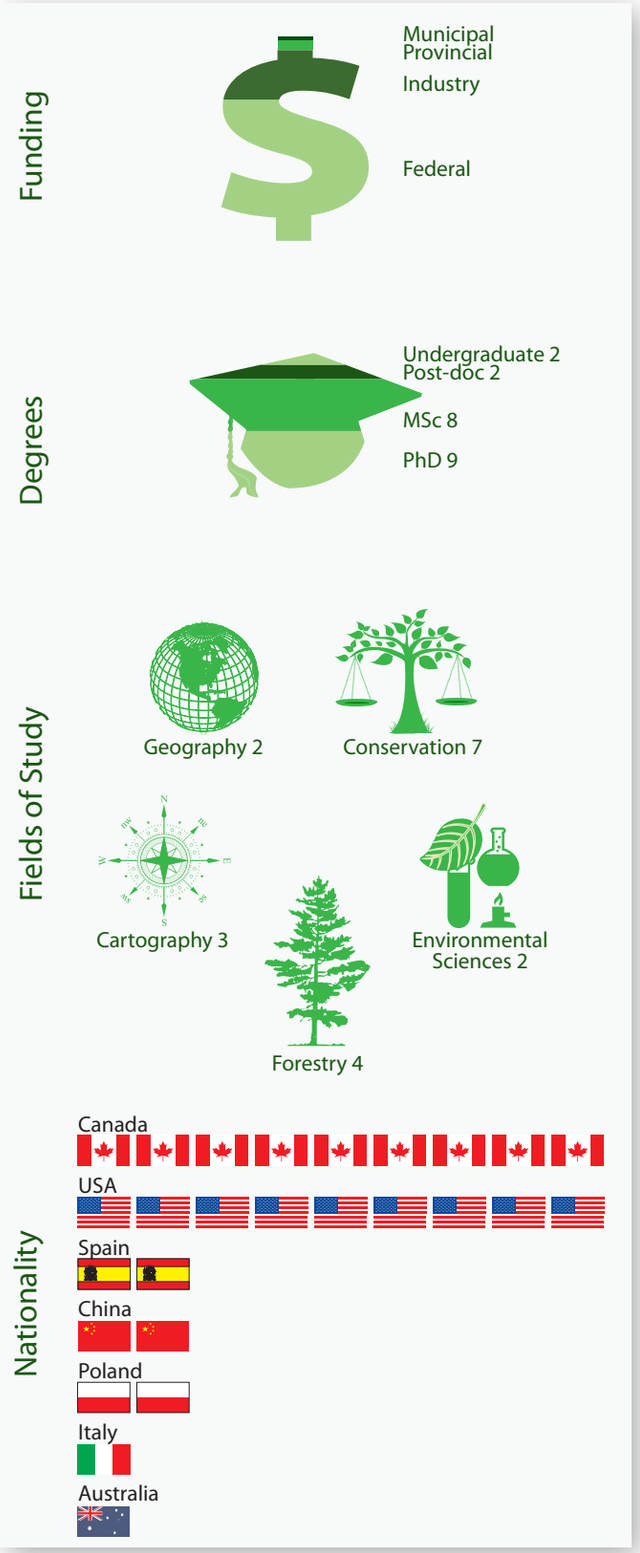
Gregory Rickbeil is using telemetry data to study how changing arctic conditions are affecting barren ground caribou across their range in the Canadian continental arctic. He is inferring behaviour from caribou movement patterns and linking it to remotely sensed environmental conditions both spatially and temporally.

Piotr Tompalski, **Anna Yuil** and **Lorraine Campbell** are assessing the capacity of LiDAR data to provide information on forest productivity, terrestrial ecosystem mapping and ecosystem goods and services in BC and Alberta.

Yuhao Lu is integrating urban development models and long term Landsat imagery to further understand urban environments. He is exploring how urban land cover and vegetation change, at regional scales, over time and space.

Who funds the work in the IRSS?

Research in the lab is funded by many different organizations through various grants, partnerships and investments. Many of the individuals within the lab work on projects funded by government organizations such as the Canadian Forest Service and BC Ministry of Forests, Lands and Natural Resource Operations, as well as international government agencies such as the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation and NASA, while others have obtained funding through grants and fellowships, such as Natural Science and Engineering Research Council of Canada and Affiliated Fellowships.



How can you can contact the IRSS?

The IRSS is a unique place with a community of individuals who like to explore and discover the world through remote sensing. If you would like to learn more about the group, visit them at: irsslab.forestry.ubc.ca or follow them on Twitter @ IRSS_UBC. Dr Nicholas Coops can be reached at nicholas.coops@ubc.ca.

Gap size, mycorrhizal networks and seedling survival

The interior Douglas-fir forests are of cultural and economic significance to British Columbia because of their location near major rivers where human populations flourish. In the interior dry belt, these forests grade from hot, dry grasslands in the valley bottoms to cooler and wetter pine and spruce forests at higher elevations, thus representing a major climatic transition and biodiversity hotspot. The interior Douglas-fir forests have had a long and varied management history, including First Nations stewardship, extraction of timber and gold and the recent ranching industry.

Forest management today generally emulates the natural disturbance regime through partial cutting and reliance on natural regeneration. However, natural regeneration success has been unreliable because of the arid climate and recent drought conditions which are expected to increase. Natural disturbances in the interior Douglas-fir forests are caused by fire, insects and pathogens, which kill select trees at varying scales, and create disturbance patches of various sizes. This leads to a complex forest structure of canopy gaps that increase light and soil moisture availability for new germinants. By creating a wide range of natural disturbances, we can learn how to initiate conditions that native tree species are best adapted to regenerate in.

Recent research has highlighted the crucial role belowground fungal symbionts play in forest regeneration. Myco: meaning mushroom, and rhiza: meaning root, refers to the symbiotic association between belowground fungi and plant roots, where fungi trade nutrients and water they acquire from the soil for photosynthate from the plant. These mycorrhizae can form networks linking different trees together, and the links can serve as conduits of moisture and nutrients from mature trees to new seedlings. At threshold distances from an established tree, a seedling can benefit from resources supplied by the mycorrhizal network while escaping the competitive effects of the surrounding trees and plants.

After a 3-year study, Matt Zustovic, a master's student working with Dr Suzanne Simard in the Department of Forest and Conservation Sciences, found that forest gaps larger than 300 m^2 were too hot and dry to support the moisture demands of the new seedlings in the dry, cool interior Douglas-fir forests near Kamloops, BC. Many studies have shown that an increase in gap sizes leads to an increase in light and soil moisture, and therefore increased survival; however, this study suggests that there is an upper threshold where gaps can be too large to ameliorate harsh climatic conditions and meet the moisture demands of the seedlings. Gap size also heavily influenced mycorrhizal fungal communities on the regenerating seedlings, likely through its effect on soil moisture availability.

Survival of seedlings in the dry, cool interior Douglas-fir gaps of Matt's study averaged 46%, which is considered a success in these forests. However, in a drier and hotter interior Douglas-fir forest at lower elevation, seedlings growing in similar-sized gaps met 98% regeneration failure. These results suggest that, what once were resilient forests that interfaced grasslands at lower elevations, now have very low regenerative capacity in today's climate. These kinds of failures are likely to become more and more commonplace as climate becomes increasingly arid in this region.

If we are to continue harvesting these forests, Matt's study suggests, for the higher elevation dry, cool interior Douglas-fir forests, partial cuts that emulate moderate sized disturbances, usually under 0.5 ha promote access to mycorrhizal networks and increased survival. With all the services these forests already provide to us, we need to find alternative economic services that promote healthy reforestation and move our high production forestry practices to areas that can more readily accommodate our timber demands.

For further information on this research contact Matt Zustovic at mattzustovic@gmail.com or Dr Suzanne Simard at suzanne.simard@ubc.ca.

Landscape sustainability in Kyrgyzstan

Progress in sustainability science increasingly requires collaborations between natural and social scientists. Furthermore, examining social-ecological systems (SES) over the long-term is fundamental to truly understanding SES dynamics. Such ideas are a core component of a trans-disciplinary Central Asia project led by Hisham Zerriffi, a sabbatical visitor at the Faculty of Forestry. The project examines sustainability and resilience of agro-pastoral systems in the face of both social and ecological changes since the collapse of the Soviet Union. With UBC Forestry faculty members Drs Shannon Hagerman and Sarah Gergel, and researchers at the University of Central Asia's Mountain Societies Research Institute (MSRI), the project combines archival remote sensing and interviews to assess long-term change. Together, this integrative approach will better characterize ecological change as well as perspectives of local people dependent upon pastoral resources. Because grazing is the most extensive land use in the entire world, this research has global implications for sustainable land management.

The Naryn region of Kyrgyzstan is largely agro-pastoral. Most households engage in livestock husbandry for their primary livelihood and 85% of agricultural land is pasture. The latest estimates (2007) suggest that at least 30% of pastures in Kyrgyzstan are substantially degraded. The social-ecological dynamics of Kyrgyzstan have evolved from a system of nomadic herding (as part of Soviet collectivism) to a communally-governed, more decentralized, management approach. Challenges in implementing communal governance may be contributing to over-grazing, confounded by drought conditions which are potentially indicative of future climatological stressors.

This summer the team visited the region's pastures to test and implement a set of interlinked research protocols to assess pasture health. Long-term remote sensing can help track annual and seasonal dynamics of vegetation. Thus, Ian Eddy (MSc student) is mapping pasture vegetation using decades of historical MODIS imagery to differentiate among climatic, topographic and anthropogenic factors that impact pasture condition.

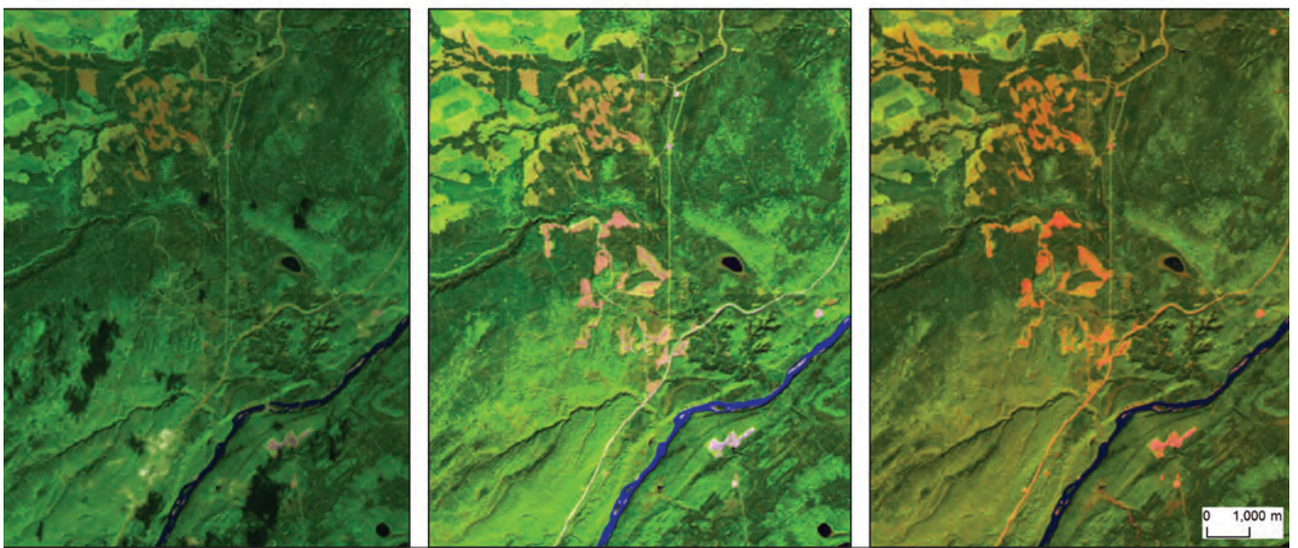
Interviews with Kyrgyz herders, livestock owners and pasture managers are helping elicit their perspectives on pasture health. Led by Jordan Levine (PDF at UBC's Liu Institute), in collaboration with MSRI researchers, this research explores how local stakeholders assess pasture health and consider pasture use decisions and uncover human cognitive and behavioural factors influencing landscape change. When combined with remote sensing and vegetation sampling, our multi-pronged approach provides a more comprehensive understanding of how and why sustainability of pastures may be changing over the long-term.

University of Central Asia scholars visited UBC last spring to co-develop an integrative social-ecological framework for investigating governance and management challenges in these agro-pastoral systems. We created a historical profile of commons governance in the region to understand historical and emerging drivers of change and the legacies of past governance regimes.

This project opens new doors for us. We aim to develop a long-term, participatory social-ecological monitoring and research programs with MSRI and the University of Central Asia. These programs leverage UBC Forestry's research and teaching expertise to help understand SES in a dynamic challenging part of the world.

For further information contact Dr Sarah Gergel (sarah.gergel@ubc.ca) or Dr Hisham Zerriffi (hisham.zerriffi@ubc.ca).

Remote sensing helps to assess forest productivity



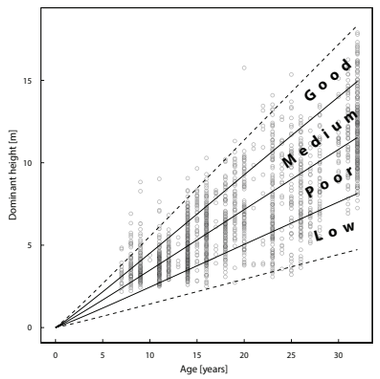
A subset of 3 images acquired with Landsat in 1999, 2000 and 2001 respectively, near Port Hardy, Vancouver Island. Forest disturbances occur as pink or red patches.

Sustainable forest management requires accurate information on a range of forest stand attributes. This information, collected during forest inventories, is crucial for evaluating the current and projected conditions of a forest, as well as being critical for assessing the consequences of management decisions. Among all possible forest attributes, forest site productivity, which describes the potential of a site to produce biomass, remains one of the most important attributes. This information is fundamental for decisions regarding optimal species composition, rotation age, allowable cut, and most importantly, to forecast future timber yield.

The most common approach for measuring forest site productivity is site index (SI), which describes a forest stand as a relation between tree age and height. Site index or height age curves have conventionally been constructed by modeling the height growth of a subset of the largest trees at a given location and for a given species, according to the concept that stand dominant height is correlated with stand volume. The projected height of the stand at 50 years is then used as an index of potential site productivity, allowing estimates to be compared across sites and across stands of different ages.

Remotely sensed data can be used to estimate both stand age and dominant height, the 2 attributes used to characterize site productivity. A demonstrated technology for the accurate estimation of stand height is airborne laser scanning (ALS), which allows for the collection of highly accurate, 3-dimensional point clouds using light detection and ranging (LiDAR) measurements acquired from an aircraft. Additional equipment installed on the aircraft (global navigation satellite systems receiver and inertial measurement unit), allows the precise recording of the coordinates of the laser beam reflections from objects on the ground. Single laser beams can penetrate through canopy cover, and multiple reflections can be recorded. ALS has proven to be an excellent data source to characterize forest stands, providing capability to generate accurate terrain models, estimates of tree and stand height, basal area, or stem volume. It has progressed to an operational technology that provides reliable estimates of crucial forest characteristics, and it has become a common tool used in forest inventories. Most of the ALS-based methods that allow for the estimation of stand biomass, volume, or basal area are based on various height metrics, including height percentiles, proportions, and descriptive statistics such as maximum, mean, or standard deviation of point height values. As LiDAR pulses can penetrate through the forest canopy, it is also possible to assess vertical forest structure or detect understory vegetation. The accurate tree and stand height estimates provided by ALS data are the foundation of these methods.

Stand age can be assessed using time series of satellite imagery. The available archive of Landsat data



Developed forest site productivity model with productivity divided into 4 classes. Points represent input age and dominant height values of sample units used during model development. Age values obtained using Landsat time series; dominant height estimated using airborne laser scanning point clouds.

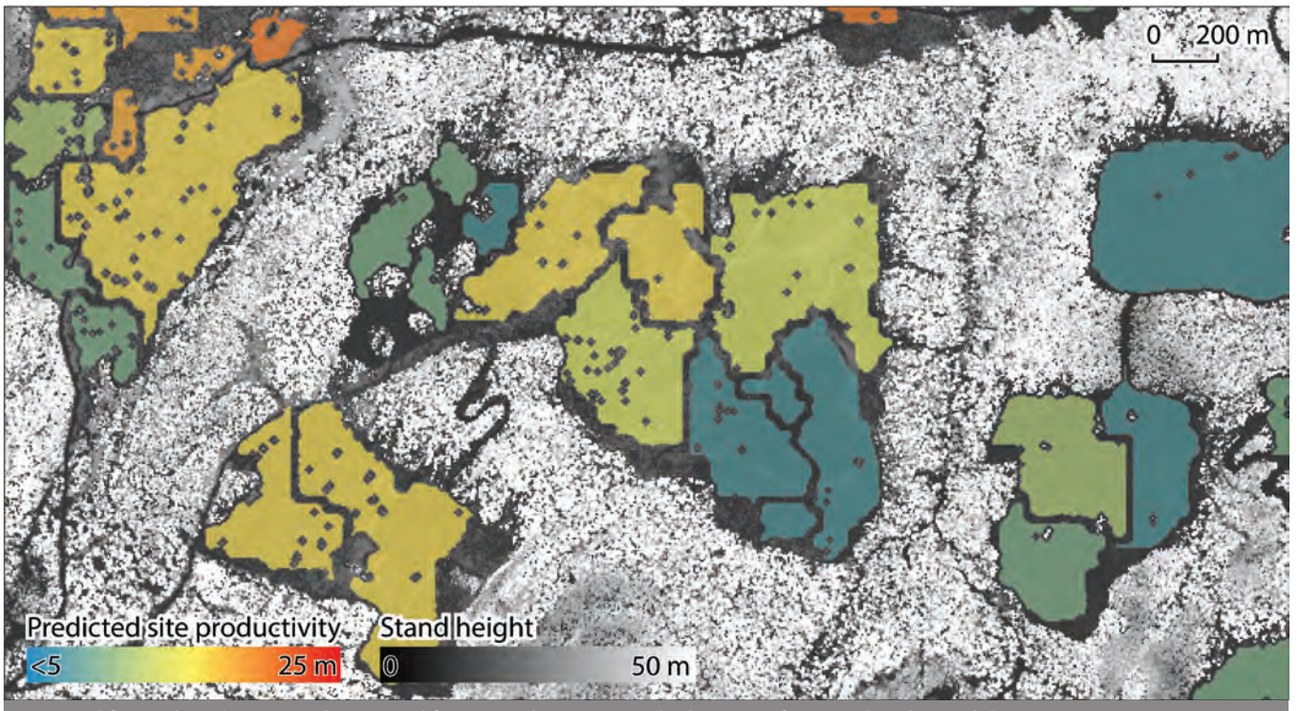
represents more than 40 years of observations and, since 1984, has been acquired at 30 m spatial resolution with consistent spectral resolutions across multiple sensors, all systematically calibrated to promote interoperability. Time series analyses of annual Landsat imagery enables detection and mapping of stand replacing disturbances and their attributes such as spatial location, extent, and date, which is often based on analyzing the spectral trajectories (see photographs). Time since disturbance can then be used as a proxy for estimating stand age.

Dr Piotr Tompalski is a post-doctoral fellow working with Dr Nicholas Coops in the Department of Forest Resources Management. Using the LiDAR-based estimates of stand height, and the Landsat-based estimates of stand age, Piotr's research team has developed a site productivity model for young stands dominated by western hemlock at a study site on northern Vancouver Island. He utilized Landsat imagery to detect areas of forest disturbance and estimate time since disturbance as a proxy for age, as well as the LiDAR point clouds to estimate stand dominant height. Piotr used a chronosequence of sample units to obtain a good approximation of stand growth to develop a model of site productivity (see graph). The model was based on the Chapman-Richards equation, with a base age equal to 32 years.

Conventionally, site productivity curves are derived via field measures and destructive sampling, enabling very accurate estimates of both tree age (via core samples) and tree height (via direct measurement). Stand dominant height, or top height, is commonly estimated in the field as the average height of the largest 100 trees (by diameter) per ha or by an analogous definition of the largest diameter site tree (tree selected for the dominant height measurement) in a 0.01 ha plot. The method Piotr used for estimating dominant height from the ALS data seeks to emulate this approach, and has been shown to produce heights that more closely correspond to field measurements and operational definitions of top height.

Piotr's approach will be useful for assessing forest site productivity in any location with available LiDAR point clouds and a historic record of Landsat images. His model is based on a large number of sample units that cover a broad range of site productivity, which is the main advantage of the approach, particularly when compared to conventional methods whereby models are often developed from a limited number of samples. However, a chronosequence built on stand-replacing disturbances detected with Landsat imagery will be limited by the availability of 30-m resolution Landsat data (ie, circa 1984) and therefore is applicable only to younger stands.

This research was supported by the Canadian Wood Fibre Centre of the Canadian Forest Service and Western Forest Products Inc. Research was done in collaboration with Joanne White, Michael Wulder (Canadian Forest Service, Pacific Forestry Centre) and Nicholas Coops (UBC). *For further information, contact Dr Piotr Tompalski at piotr.tompalski@ubc.ca or Dr Nicholas Coops at nicholas.coops@ubc.ca.*



Detected forest disturbances with assigned forest productivity, overlaid on top of canopy height model

Time studies and forest harvesting in South Africa

By Chloe Williams

Timer in hand, pen at the ready, fingers hovering over the "record" button, our team of 5 forestry students watches with anticipation as the harvester approaches the first of a bunch of trees that we had numbered the previous day. The bright orange numbers are barely visible as the morning sunlight penetrates the plantation in the Storms River region of South Africa, an area renowned for its natural beauty and its potential to grow trees. As a UBC Natural Resources Conservation undergraduate student, this harvesting business is all new to me. Nonetheless, I have been asked to lead a productivity study by the Department of Forest and Wood Sciences at Stellenbosch University, where I am spending the year to complete my final UBC co-op work terms. Past work terms have given me snapshots of the inner workings of the forestry industry, but, with the dust of dropping trees gusting into my eyes, this work term stands out as a unique application of what I have learned in class. While the immediate objective of this time study is to measure the productivity of a mechanized cut-to-length saw timber system, the ultimate goal is to help increase harvesting efficiency within these stands. Not an easy task in a culture accustomed to disregarding efficiency and timeliness, commonly referred to as doing things on "Africa time".

At the moment, South Africa is experiencing an increase in use of mechanized harvesting systems, one of which is the cut-to-length system. Understanding their productivity is therefore an important step towards maximizing the output from forests, which could benefit the South African forestry industry and, ultimately the nation's economy. Although cut-to-length systems have been extensively studied in other parts of the world, the productivity of these systems in South Africa are limited, especially for pine saw timber. Our study focuses on exploring the time distribution of the work elements for both a harvester and a forwarder, modelling their productivities, estimating fuel consumption as well as CO_2 emissions, and finally, assessing the harvester's cross cutting accuracy along with the associated fibre waste.

Preliminary results show processing to be the most time-consuming element in the harvester's work cycle, although time spent fixing mechanical issues also reduced productivity. In modelling productivity, tree volume and the average moving distance were found to be significant and acceptable predictors. The harvester's cross-cutting accuracy was high – only contributing 0.28% of utilizable wood to waste. The forwarder's productivity was modelled based on load size and the distance it moved in field. We also calculated estimates for both machines' fuel consumptions and emissions, amounting to approximately 23.29 litres of diesel per hour for the harvester and 15.54 litres per hour for the forwarder.

Although this study only presents a preliminary exploration of the productivity of a pine saw timber cut-to-length system, we hope that further studies will help advance the overall goal of maximizing productivity in harvesting South African forests. Even though "Africa time" applies to many aspects of life here, there is a drive and a need within the forestry industry to increase efficiency. I hope that, throughout my work, I can do a small part to enrich the industry's database on this kind of information. I will be returning to complete my final 4 months of studies in January 2016, enriched from my experience on this side of the world.

Since 2007 UBC Forestry's Co-op Program has supported 12 students on co-op terms in Stellenbosch University. For further information contact Tony Loring (Co-op Coordinator) at tony.loring@ubc.ca.

development & alumni news

Alumnus donates $350,000 to support Forestry students

"You need to be resourceful when living on a farm," says Henry David Currey, a UBC alumnus who graduated with a BASC (Agricultural Engineering) in 1950. "When things break down, you have to fix them, and that's how it was with me."

This combined background in engineering and agriculture allowed Henry, better known as Dave, to flourish as an entrepreneur. As the former President of Ronco Pole Structures Ltd, Ronco Fencing Ltd and Princeton Wood Preservers Ltd, he has made a generous gift to support student awards and bursaries at UBC. A portion of that gift will benefit Forestry students for many years to come.

Born in 1926, Dave grew up on a mixed wheat and dairy farm in rural Alberta, and spent 9 years learning in a 1-room schoolhouse. Although no one in Dave's family had previously attended university, he met a classmate who planned to enrol at UBC and was intrigued by the idea.

Dave recalls his time at UBC as "a working relationship." He lived in a trailer at the corner of Wesbrook and Agronomy and cooked all his meals over a single hotplate. He studied hard, and during the summers he had to work to ensure he had enough money to return the next year.

After graduating, Dave became a franchisee with a small company, which he eventually bought out. By applying what he learned at UBC, he was able to build up successful businesses that thrived for over 40 years.

Dave's generosity and willingness to pay it forward has allowed UBC to establish new student awards. The Dave Currey Award in Forestry recognizes students who demonstrate a combination of academic merit and community leadership. Preference is given to those with demonstrated financial need, and recipients are chosen by the Faculty.

"The support provided from these funds is intended to help deserving and committed students continue with their education," says Dave. "This is important for people to contribute and grow. The ability to earn enough to allow continuous study no longer exists. This was a way to help."

The help is much appreciated. David Williams, BSc (Natural Resources Conservation) 2015, says, "This award is helping me get through the end of my degree with less debt, more options, and not a small sense of pride that maybe some of the hard academic work of the last few years has been noticed, somehow, by someone."

Ruby Carrico is interested in how industry and environmentalists can work together to create a sustainable future. "To this end I am going to Haida Gwaii to attend an intensive field school," she says. "This award will help support me through this coming semester and it encourages me to continue to work hard in my studies and my future career."

Jesse Way's background is much like Dave's. "I grew up on a dairy farm, and many people from back home don't further their education for financial reasons. Scholarships such as the one you have donated go a long way in reducing the financial stress of having moved away from home to go to university," he says.

Patrik Friesen is a third-year Conservation Science and Management student who plans to become a Registered Professional Biologist. "I have a keen fascination for natural history and the human role within it," he says. "This donation will help me to further my education and allow me the opportunity to explore these interests."

The Faculty is deeply grateful to Dave for his tremendous support that is truly making a difference in the lives of students. To learn more about this award, or to learn how you can support students, please contact Emma Tully, at 604.822.8716 or emma.tully@ubc.ca.

Alumni in action

Often our alumni ask "What happened to my classmates after graduation?" while our students wonder "What can I do with my degree?" To answer these questions, this column features stories from our alumni highlighting the various career paths they followed.

Emily Sunter, BSc (Forest Sciences) candidate '15

In honour of the beginning of the school year and the next round of November graduations, this piece focuses on Emily Sunter, one of our students expected to graduate this November.

This past Forestry Undergraduate Society (FUS) president did not choose Forestry initially, but growing up with forests and animals playing a large role in her life, it was a natural fit. Born and raised in the Comox Valley on Vancouver Island, the forests were her backyard and having spent a large amount of time with animals, working and volunteering for the SPCA for almost 12 years and working for vet clinics, she always knew she wanted her career to focus on them. While most of her work had been with domestic animals, she hoped to work with wildlife.

Emily applied to UBC with the intention of going into wildlife biology, but found out that that her grades were not quite high enough to get into the Faculty of Science. She ended up being accepted instead to her second option, Forestry. However, in her first semester after sitting in Forestry professor Peter Arcese's class for just an hour once a week, she realized she was having more fun and was more interested in it than anything she'd ever done before in school. After a long conversation with Peter, she decided to stay in Forestry and focus on forest sciences and wildlife ecology, a decision she is very glad she made. She found the classes and research interesting and flexible, and is very grateful for the amount and type of practical skills she now has. Emily also appreciated the variety of students that she met while in Forestry, who were diverse in culture, age, maturity and interests.

Starting as the Forest Sciences Representative for the FUS, she held the role of president last year and she found it to be an incredible experience. If professors, staff or students had questions, they often came to her first as she was the face that everybody seemed to know in the building. It was also a humbling experience, both to have a lot of people hope that you can help them, and to be able to make an impact. During her year, they started a bursary to help send students to the CIF Ring Ceremony. Also, with the help of Student Services staff, they organized more events geared towards first year students to build a feeling of community.

Outside of Emily's role as FUS president, her accomplishments include receiving the Gerry Burch Scholarship in her second year, being nominated for the "Just Desserts" award and this year, receiving the Student Leader Recognition award, Forest Sciences Award and Gold Medal Award at the CIF 2015 Ring Ceremony.

Her fondest memory of her time at UBC Forestry is the people. "Students and professors here are very together, understanding and open. We all have similar interests. It has something to do with the outdoors, wanting to know more and wanting to make a difference." Emily's biggest influences at Forestry include Allan Carroll, her thesis supervisor, along with professors Peter Arcese, Sally Aitken and Student Services Director Chiara Longhi. Their support and guidance all contributed to her figuring out her direction in forestry.

As for Emily's plans, she just returned from a trip to South America and her future is full of options. She'd love to end up in a smaller town, perhaps working in industry or environmental consulting. Her passion is human/wildlife interactions, and she would love to work towards helping people understand the things we share this earth with, perhaps eventually going back to do research on it as a Master's degree.

As she approaches graduation, Emily's final thought before leaving UBC Forestry is a huge thank you! "I will be eternally grateful for the respect and education I received, the conversations I've had, and the fun. It has been a long but amazing time in UBC Forestry!"

Upcoming and recent alumni events

Event Recaps:

Class of 1975 40th Reunion

Submitted by Ron Judd, BSF'74

On a sunny August 2nd, 2015 the class of 1975 met for their 40th reunion on the shore of Becher Bay in East Sooke. The event was held at the home of Ron Bellamy and his partner Lisa, in a setting that was totally West Coast.

Nineteen class mates and spouses travelled from around BC and New Zealand to meet and greet, share stories long forgotten by many and renew friendships that have spanned 40 plus years. Conversations began as if they had never ended, even though some of the class hadn't seen each other in those 40 years. It demonstrated how close knit our class was. This was the class that Dean Gardner was happy to see leave - we played hard, but also worked and studied harder, and built an esprit du corps that probably hasn't been seen at UBC since 1975.

A tribute was held for the classmates that couldn't attend, either due to previous commitments or are no longer with us.

An election was also held using the RAILROAD method and the next reunion will be in New Zealand in March, 2018. Bill Dyck has volunteered to be the reunion committee of one with help from this side of the pond. Start saving your money for a winter get away.

The class of 1985 30th reunion

On behalf of the organizing committee I would like thank everyone for attending and a special thank you to Ron and Lisa for hosting the event.

Class of 1956 59th Reunion

The class of 1956 celebrated their 59th reunion on Wednesday, June 17th and Thursday, June 18th, 2015 in Sydney, BC. The events kicked off on Wednesday evening with an ice breaker at the hotel. Thursday's started with a breakfast, followed by a tour of the Butcharts Garden in the afternoon. The reunion finished with an evening BBQ at the home of the daughter of one of the classmates.

This class has been holding reunions since at least the mid-70s, mostly on a 5-year cycle, though they recently increased the frequency to a 3-year cycle. Next year they will be celebrating their 60th reunion!


The class of 1975 40th reunion

Class of 1985 30th Reunion

On the weekend of May 29th, the class of 1985 celebrated their 30th reunion. Starting off with a reception on the Friday night at the UBC Forest Sciences Centre, many classmates reunited after not seeing each other for years.

The next morning, the energetic group hiked the Grouse Grind. In the evening they met up at Koerner's Pub on campus for dinner and dancing. Music was provided by Swayed Band, which included the class' own Steve Hardy.

Congratulations to the class of 1985!

Mark your Calendars for the following events:

- Career and Networking Evening, UBC Forest Sciences Centre, November 4th, 2015. Meet our students and prospective employers. For further information contact Debbie at debbie.mcpherson@ubc.ca.
- Alumni Social at the ABCFP Conference in Vancouver – February 25th, 2016.

Public lecture and annual research evening

Dr Hugh Possingham, Australian Laureate Fellow and professor of mathematics and professor of ecology at the University of Queensland will be giving a free public lecture in the Faculty of Forestry on Friday November 27, 2015 at 4:30 pm in the Forest Sciences Centre room 1005. The title of Hugh's talk is "Six common mistakes in how goverments allocate funds to conservation research".

Dr Possingham is also director of the ARC Centre of Excellence for Environmental Decisions (CEED) and the National Environmental Research hub for Environmental Decisions, 2 global leaders in the field. In 2103 he was awarded a 5-year Australian Research Council Laureate Fellowship. Hugh and his students are global leaders in conservation planning and the originators of MARXAN, a marine and terrestrial reserve design tool used around the world to optimize conservation successes given economic and social constraint.

Abstract: Conservation researchers almost all want to have an impact on the real world, not just in the scientific world. They would like their research to change management practices and policy, which will in turn lead to fewer extinctions and more resilient ecosystems. In this talk Dr Possingham will tell stories about successes and failures in translating research into practice. Every story is very different, but they are all predictably unpredictable.

We will also be holding our annual research evening in conjunction with this lecture and hosting a reception from 5:30 to 6:30 (following Dr Possingham's talk). The posters will display current research by our graduate students, post docs and faculty members. For further information visit www.forestry.ubc.ca/calendar-of-events/.

In Memorium

Karel Klinka (June 18, 1937 – September 15, 2015), Professor Emeritus of the Forest and Conservation Sciences Department.

Dr Karel Klinka was an outstanding supervisor, forester, mentor, collaborator and friend.

Karel was born in Prague, Czechoslovakia, where he earned his Forest Engineering degree. He immigrated to Canada in 1969 and earned his PhD in the Faculty of Forestry, UBC in 1976 under the mentorship of renowned botanist Vladimir Josef Krajina. Karel had a distinguished career with the BC Ministry of Forests and the UBC Faculty of Forestry.

Karel's knowledge of plant ecology was encyclopedic and his ability to recall Latin names was legendary. His field trips on site classification by assessing soils and indicator plants are permanently etched in the memories of hundreds of Forestry students. Over his 20 years as a professor, he was an outstanding mentor for 22 graduate students and 4 post-doctoral fellows. He was recognized for his many achievements: he was the recipient of the 1977 Distinguished Forester Award from the Association of BC Professional Foresters, the 1989 BC Science and Engineering Gold Medal, and a 1993 Killam Teaching Prize in Forestry.

Karel's internationally renowned research on plant ecology and biogeoclimatic ecosystem classification is an enduring legacy that guides sustainable management and conservation of BC's forests. In honour of Karel's contributions to student learning and his lifelong commitment to sustainable management of forest ecosystems, the Faculty is working to establish the Karel Klinka Scholarship in Forest Ecology with the support of alumni, friends, colleagues and organisations. The scholarship will be awarded to outstanding graduate students focusing their research on sustainable forest management and conservation. To contribute to this scholarship, please contact Emma Tully at emma.tully@ubc.ca or 604.822.8716.

Newsletter production

branchlines is produced in-house by the Faculty of Forestry at the University of British Columbia.
Editor: Susan B Watts, PhD, RPF, susan.watts@ubc.ca
Designer: Jamie Myers, jamie.myers@ubc.ca

ISSN 1181-9936

Questions concerning **branch**lines or requests for mailing list updates, deletions or additions should be directed to sue.watts@ubc.ca.

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Faculty of Forestry
University of British Columbia
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