branchlines

Volume 28#3 Fall 2017

Inside:

forestry
university of british columbia

dean'smessage

The summer of 2017 will be remembered for a long time in our Research Forests. A number of fires were ignited in the Alex Fraser Research Forest by a lightning storm, at the same time as multiple fires were ignited in many parts of the Cariboo-Chilcotin region. At the time of writing, many fires are still burning in British Columbia, and mop up operations are continuing in the Research Forest. Overall, we lost about 1,000 ha, or 10% of the Research Forest, despite the incredible efforts made by the Research Forest manager, Ken Day, and his team working under exceptionally difficult conditions. Thanks are also due to the staff at Malcolm Knapp Research Forest who came to the aid of Ken, and the many volunteers who also were involved in fighting the fires. Many experiments and long-term trials were destroyed, but at the same time there are new opportunities for research on, for example, the effects of different silvicultural prescriptions on fire intensity. Our timber supply from the forest has been disrupted and we can expect the financial ramifications to continue for some time. The immediate reaction would be to salvage as much as possible as quickly as possible, but science has indicated that salvage needs to be done thoughtfully and with care – another research opportunity. Unfortunately, for some time, wildfire research has not been a priority for the provincial government, so funding may be hard to come by.

Lori Daniels provides an interesting analysis of the 2017 wildfires in this issue. The management of wildfire hazard is costly, and not always consistent with the many other objectives of forest management. Past management practices, especially fire suppression, have created serious problems in some areas, exacerbating the threat. As she says: "Transformative changes to management are essential to achieve forest and community resilience to contemporary and future wildfires". It will be interesting to see whether the 2017 wildfires, and the change of government, will provide sufficient impetus to initiate a change away from the *status quo* that the government and licensees have become so accustomed to.

This issue contains an article by Rob Kozak about his late father, long-term faculty member Tony Kozak. Having been asked to prepare a presentation about the Sopron Division of the Faculty of Forestry at UBC for the upcoming Canadian Institute of Forestry conference, I am struck by the parallels between 1956 and 2016, when Canada again accepted significant numbers of refugees. This link is reinforced by the following article about the 'Refuge' concert. The group from Sopron faced many problems, and it is rather disappointing to realize that some of those problems still exist today. In particular, many coming from Hungary felt that their European forestry education wasn't recognized in Canada. The emphasis on engineering, which is still present in some European forestry schools, wasn't fully appreciated in Canada. Nor was the European emphasis on the development of management plans (as opposed to harvesting plans), although that has thankfully changed in most of Canada.

While wildfires have pre-occupied the forest sector west of the Rockies, the issue of caribou conservation has become increasingly important across much of Canada. The federal government has issued a *Summary of the Action Plan for the Woodland Caribou* that refers to provincial caribou range plans, and provinces are moving ahead with these. There are concerns in the forest sector that if the principle of a 65/35 non-disturbance/disturbance threshold is adopted by the provinces, it will adversely affect the industry and the economies of many communities dependent on the forest sector. The work of Greg Rickbeil on barren-ground caribou (a different sub-species to the woodland caribou) describes some of the complexities involved with the management of caribou and the difficulties that decision-makers will face when establishing habitat management and protection prescriptions. This requires sound science covering both the habitat needs of the woodland caribou and the needs of the communities that could be impacted by the decisions.

John L Innes
Professor and Dean

forestrynews

Announcements

Dr Sally Aitken, Professor in the Department of Forest and Conservation Sciences and Associate Dean – Research and Innovation, has been named a Fellow of the Royal Society of Canada – Life Science Division. Sally is an internationally recognized authority on the genetic adaptation of forest trees to climate. Her research links genomics, ecology and climatology to understand adaptation and the capacity of trees to adapt to new conditions. She is helping re-shape forest management, conservation, and reforestation decisions for new climates. You can read about the work of Sally's research group on page 18.

Congratulations Sally.

Dr Rob Guy has started his leadership as Head of the Department of Forest and Conservation Sciences.

Dr Gary Bull has taken on the role of Head of the Department of Forest Resources Management.

Both Rob and Gary commenced these roles on July 1, 2017.

Congratulations Rob and Gary.

Enrolment milestones

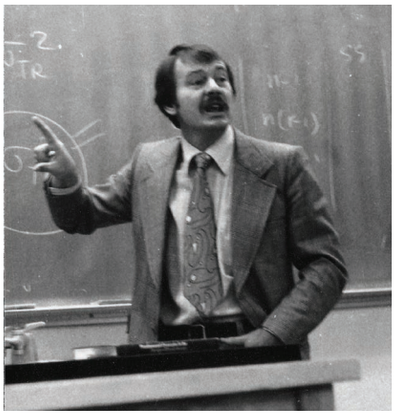
We are still growing! Our total count of students now registered in Faculty of Forestry's undergraduate and graduate programs is 1,441. Of these, 1,126 are students enrolled in one of our 6 bachelor programs and 315 are students studying for graduate degrees. These enrolment numbers represent record highs for both undergraduate and graduate programs in the Faculty.

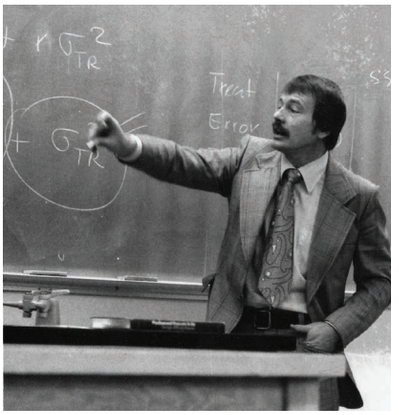
After hitting a milestone of more than 1,000 students last year, our undergraduate enrolment continues to track upward, growing by 10% in 2017. Through ongoing promotional campaigns aimed at redefining how the public perceives forestry and targeted recruitment activities increasing awareness of our breadth of course offerings, we have been able to attract stellar students from all over the world – 60% are domestic, and 40% are international, mostly from China and the United States. Student numbers are up in all of our programs, but our Urban Forestry program, now in its third year, continues to make impressive strides, with nearly 150 students and growing. Plans are underway to create a new specialization in Natural Resources Conservation (in partnership with the Department of Wood Science) for 2018 tentatively called the Bioeconomy Sciences and Technology (BEST) major. The focus of this program will be on the industrial utilization of plant and forest-based resources to provide society with chemicals, materials, and fuel, while reducing our environmental footprint. The hope is to attract business-oriented students who are interested in careers related to managing our natural environment to provide for societal needs, while balancing environmental, social, economic, cultural, and aesthetic values. Despite the unprecedented growth in the number of undergraduate students, our graduates are still able to find meaningful employment in their chosen fields. One of the reasons for this revolves around the effectiveness of the co-operative education program (co-op) to link classroom knowledge with practical skills needed by employers in the workplace. In today's post-secondary education landscape, where a degree does not equal a career anymore, co-op is a critical tool in establishing not only the relevance of PSE institutions, but ensuring that graduates have the connections and the skills that they need to work successfully in their chosen field. Over the past 4 years, we have seen co-op enrolment increase by 350% and we anticipate the upward swing to continue.

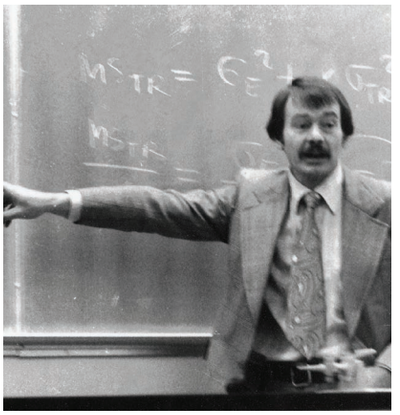
This September saw 67 new graduate students joining the Faculty – an increase of 46% over last year's numbers and the largest cohort of new graduate students in our history. We attribute much of this increase to our relatively new, and highly popular, suite of professional course-based masters programs now available to prospective students. We launched the Master of Sustainable Forest Management (MSFM) program 5 years ago and have seen 83 students graduate to date. Two years ago, we introduced a Master of International Forestry (MIF) degree and have seen this program almost double in size over the past year. Just last month we introduced our newest professional degree the Master of Geomatics for Environmental Management (MGEM) with 29 students registered in its inaugural class. We plan to introduce a Master of Urban Forestry degree to our suite of professional course-based masters programs by 2019.

A warm welcome to all of our new students!

Remembering Tony Kozak







On the tennis courts, at the card table, in the classroom, or at the IBM punch card machine, Tony Kozak was a force to be reckoned with.

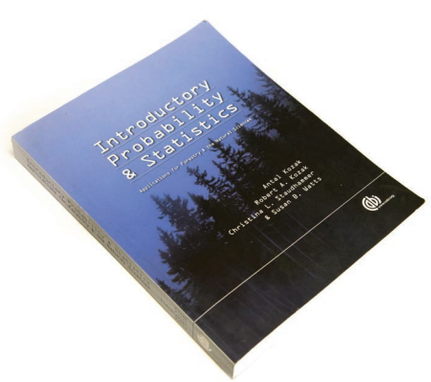
Born in Tiszapüspöki, a small hamlet on the plains of Hungary, Tony always had a knack for numbers. By the time he was in his teens, he was gainfully employed as the bookkeeper at the local wine cellar. Despite a misspent youth on the soccer pitch and almost being expelled from school for refusing to acknowledge Stalin's birthday, Tony did well academically. Well enough, in fact, that he was streamed into a university track, no small feat in Soviet Hungary. After a conscripted stint in the army, Tony settled on the Hungarian Forestry School (now the University of West Hungary), located in Sopron.

It is here that he met his classmates, his brothers and sisters in arms, his fellow travelers. It is here that he said goodbye to his life and family in Hungary to become a political refugee. It is here where bonds that remain unbroken after 60 years were forged. It is the story of the Sopron Division of the Faculty of Forestry at UBC.

Like many other uprisings, the Hungarian Revolution of 1956 precipitated student action across the country. In Sopron, the Student Revolutionary Committee took charge of the municipality, orchestrating runs of supplies and munitions to the capital, Budapest, where most of the fighting was taking place. Indeed, for two weeks in October, it looked as though the Hungarian freedom fighters would emerge victorious. But in early November, masses of Soviet troops were mobilized across Hungary, including in western Hungary. As their tank divisions barreled down the road to Sopron, there was only one option left.

Some 250 forestry students, as well as 50 professors and their families, fled across the border to Austria. While there, Dean Kalman Roller put out a call to several countries to see who might accept this group of refugees. The Government of Canada's interest was most definitely piqued and they hastily made arrangements with the Faculty of Forestry at UBC to continue providing the Sopron students with a forestry education, first in Hungarian, then gradually transitioning to English. This was an offer that could not be refused. The Sopron Division of the Faculty of Forestry at UBC was born.

At first, life in Canada was very challenging, and took a great deal of adjustment for a group of kids in their early twenties – learning a new language, navigating a foreign culture, studying new ecosystems, working part-time to make ends meet, and so on. Tony started life here with nothing more than a leather coat from The Hudson's Bay, a crisp five dollar bill, and a pack of smokes. But he loved Canada – not just its majestic landscapes and the opportunities it afforded – he loved the very idea of Canada. One of the people he admired most was Jack Pickersgill, Canada's Minister of Citizenship and Immigration during and after the Hungarian Revolution. That he had the wherewithal to broker a deal which brought an entire school of foresters to UBC in a manner of days is nothing short of a miracle. But the fact that he had the foresight to understand the long term benefits that Canada would reap – not the least being the adoption of European sustainable forest management practices – can only be described as visionary. Under Pickersgill's watch, some 38,000 Hungarian refugees sought asylum in Canada immediately after the uprising, an unprecedented migration and one that has forever changed both immigration policy and the multicultural mosaic that is Canada. His actions were a shining example of just how easy it is to solve a humanitarian crisis with a little bit of generosity, some imagination, and a whole lot of compassion. For Tony, this left an indelible mark, and helped shape his



worldview as a caring, kind, honourable, and unflinchingly honest person. More importantly though, it motivated him to become, in the true spirit of the word, a *citizen* of Canada.

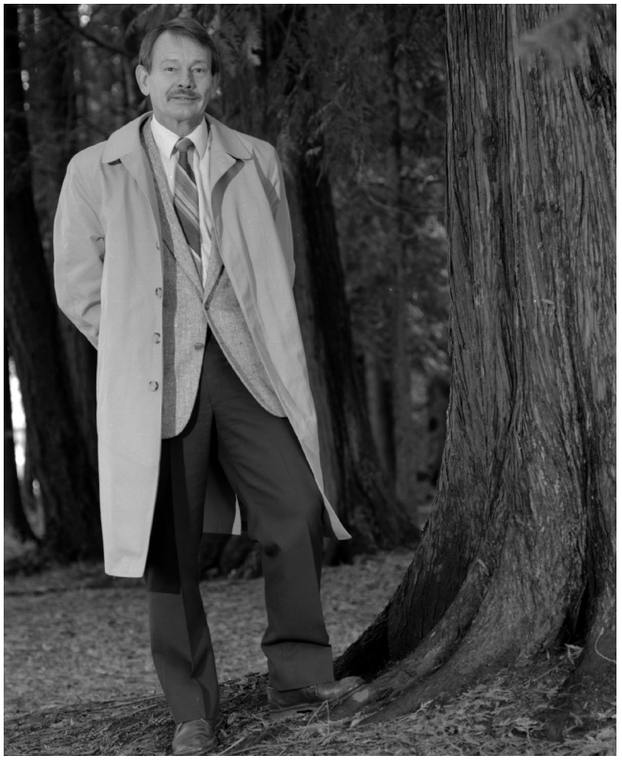
And it shaped him in all facets of his life. It inspired him to succeed. Tony worked relentlessly as a student at UBC, completing his BSF in 1959 and his PhD in 1963. Shortly after finalizing his doctorate, he was hired on as a Professor in the Department of Forest Resources Management, one of only two Sopron alumni to achieve this distinction. He spent 36 years as a faculty member and took pride in serving the longest combined term as an Associate and Acting Dean between 1977 and 1998. Through it all, he found time to play a ferocious game of tennis several times a week and regularly partake in epic sessions of ulti, the national card game of Hungary. But nothing gave Tony more satisfaction than raising a family and watching his two children grow up and succeed in his adopted homeland. His son followed in his academic footsteps, while his daughter works in Vancouver's theatre community, something that he never fully comprehended, but always respected. Tony retired in 2001, but continued to come in to the Forest Sciences Centre – his home away from home – several times a week, advising graduate students on statistical issues until as recently as last year and routinely enjoying coffee and maple-glazed doughnuts with staff and faculty.

An influential and always dogged scientist, Tony is best known for his pioneering forest mensuration work on developing tree taper volume models, which have been fitted in many countries and for many tree species around the world and have now come to be generically known as "Kozak Taper Equations". He began work in this domain in the late-1960s as one of UBC's first computer programmers (remember FORTRAN?), and continued until 2004, when he wrote the aptly titled article, "My Last Words on Taper Equations" (he wasn't kidding). As a graduate supervisor, his legacy includes four generations of biometricians whose analytical chops have been heavily influenced by his expertise in modelling and experimental design, as well as his philosophies underlying the careful use of data. Tony capped his research career off as the lead author of a book entitled, "Introductory Probability and Statistics: Applications for Forestry and the Natural Sciences". While this experience proved rewarding in the end, writing it was a long, drawn-out affair, so much so that Tony asked that a copy of the book accompany him to the grave (it did).

But it was teaching that Tony loved the most, and he was much adored by generations of forestry students. Scores of students will recall his atrocious jokes, his inability to pronounce the word "variable", and his wicked exams. Some will remember (and perhaps even use) the lessons on statistics that he imparted. Others will reminisce that he was always the first Professor to show up at the undergraduate social events, and not averse to buying you a beer if you asked. But none will forget the dedication and respect and passion that he showed for students. As Associate Dean, students knew that his office was a safe space, a place where anything could be discussed discretely and confidentially, and where problems – no matter how big or how small – could be resolved. For his efforts, in 1992, he was awarded the Killam Teaching Prize in recognition of his commitment to teaching and mentorship excellence. This was Tony's proudest career achievement.

Dr Antal (Tony) Kozak, Professor Emeritus, died peacefully and surrounded by family on June 22, 2017 at the age of 81 after a short illness. He will be dearly missed by colleagues, friends, family, and the generations of students that he cared for so deeply. Those who wish to honour Tony's memory can donate to the Tony Kozak Scholarship in Forest Measurement at UBC (https://memorial.support.ubc.ca/tony-kozak/) or raise a glass of mediocre Scotch to the last Soproner to exit the building.

Story by Robert Antal Kozak, who inherited his father's good looks and, as Associate Dean, Academic in the UBC Faculty of Forestry, currently resides in the position that was first held by Tony. A celebration of Tony's life will be held later this fall at UBC.



The art of being rooted

By Jason Hall

The idea of Forest haunts my perception of UBC's Sopron Refugees. The forest is where you go in times of uncertainty; it's also a refuge from that uncertainty. For the Sopron refugees – Hungarian forestry faculty and students caught up in the Hungarian Revolution in 1956 who found refuge in UBC's Faculty of Forestry – the recurring theme of the forest is everywhere. So it was with "Refuge" the concert performed in April at St Philip's Anglican Church. With music and stories, *Refuge* celebrated Vancouver's refugee heritage with a 60th anniversary all-Hungarian concert based on 3 recurring themes: forest, pilgrimage, refuge.

Forest

The concert opened innocently with a patriotic anthem *Rákoczi Siralma*, which I performed on tárogató – that most Hungarian of instruments. Even though I'm not Hungarian, the tárogató's haunting wildness has re-ignited my passion for playing music, and St Philip's stellar acoustics allowed listeners to appreciate its haunting beauty.

It was a great pleasure to have a *bona fide* Hungarian visitor, Gergö Péter Éles, perform on his pásztorfurulya – a wooden flute played by shepherds in the hilly meadows of Transylvania. Éles is a cultural emissary sent to Vancouver as part of the Hungarian government's *Körösi Csoma Sándor Program*, which assesses the needs of overseas Hungarian communities. "My job is to lend assistance in organizing events, helping Hungarian schools preserve our language, and supporting culture in as many ways as possible", said Éles.

Béla Bartók's *Tíz magya dal* (Ten Hungarian Songs) formed the transition from folk music to concert music. Before tenor Erik Kallo sang, he read the words to the second song with its strong resonance to the plight of refugees:

"Forests, valleys, tight groves,
For a long time I was hiding among you;
I was a fugitive with the wild game,
I wept with the little birds."

Pilgrimage

Audience members listened to Sopron alumnus Laszlo Retfalvi speak about his experiences during the Revolution He spoke of tense days as the Revolution spun out of control, their escape into Austria, and their eventual arrival in Canada. Laszlo encouraged the audience to visit Les Jozsa's Sopron Gate at UBC, which looms as a daily reminder of the Faculty of Forestry's Hungarian connection but is otherwise largely unknown to most Vancouverites.

Next, Vancouver composer Jeffrey Ryan bridged Old World and New with a piece for tárogató and piano. He titled it *Arbutus* to reflect a tree "common in British Columbia, but not native to Hungary" and his writing capitalized on the tárogató's folk traditions by drawing out the glissandi and ornaments of traditional tárogató, which he described as the instrument's "wildness".

Corey Hamm (UBC School of Music) performed Franz Liszt's *Vallée d'Obermann* from the work, *Années de Pèlerinage* (Years of Pilgrimage). This highly meditative work for solo piano guides the listener through many complicated emotions ultimately asking such questions as "What do I want? Who am I? What do I ask of nature?"

Refuge

The Liszt buttressed a new work by Vancouver composer Adam Hill. *I Will Stay Here* (for solo tárogató and electronic soundscape) switched the focus to the contemporary plight of Syria's refugees traversing the world in search of a new home. Hill's work was by far the most confronting for the audience, so I devised some light choreography with the acoustic tárogató physically making the journey up the nave of the church culminating at the altar to the recorded witness saying "They're just people like you…interrupted."

At this point, the church played a more active role as Mary Lymburner described the church's role in the sponsoring the resettlement of a family from Damascus in Vancouver. The concert concluded with an arrangement of Zoltan Kodaly's *Esti Dal* (Evening Song) for tárogató, women's chorus, and organ.

"Oh, my Lord, give me a place to sleep,
I am weary with wandering,
With walking around and hiding,
With living on foreign land."

Getting the story out about the Sopron Alumni through music and stories helped bring awareness to the emerging refugee crises while giving many people a stronger sense of Vancouver's heritage of helping people in need.

On hearing of the concert UBC president Santa J Ono commented, "This legacy is something that UBC is very proud of and one that we cherish and celebrate."

Native American and Indigenous Studies conference

NAISA
xʷməθkʷəy̓əm
Vancouver 2017

From June 22 - 24, 2017, UBC co-hosted the 9th annual Native American and Indigenous Studies Association (NAISA) conference. NAISA is the largest interdisciplinary scholarly organization dedicated to Indigenous issues and research. Two forestry undergraduate students, Devon Campbell and Kristin Smart, share their impressions of the conference, and offer reflections on how this experience relates to their studies and future career plans. For more information, see www.naisa.org.

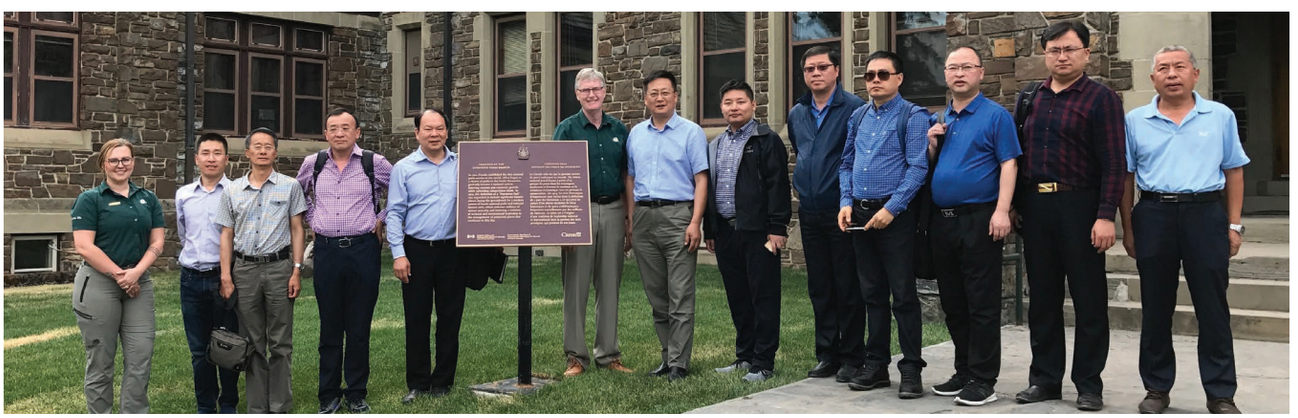
Devon Campbell – NAISA provided opportunity for individuals from diverse backgrounds to share their unique ideas on similar problems. I chose to attend panel discussions focusing on land management, traditional ecological knowledge, and asserting indigenous rights and title. A recurring message from these discussions is that economic prosperity is not necessarily an indicator of community well-being. Resource managers must look beyond financial gains of development and consider community uses of landscapes. Recognizing First Nation's rights to make decisions on their traditional territories gives them the opportunity to choose what is best for their community. After centuries of control by colonial powers, a changing tide of thought led by Indigenous peoples is becoming more significant across the globe. NAISA allows this force to grow stronger by facilitating the exchange of knowledge between groups that would have otherwise been isolated. I look forward to a future where Indigenous rights to traditional territory are fully recognized on a global scale.

Kristin Smart – I found the NAISA conference to be particularly rewarding. It allowed me the opportunity to step outside more familiar academic areas and discover new realms of research. As a Metis person raised in rural Saskatchewan, I have always had strong ties to Indigenous customs and issues as well as an awareness of segregation. Highlights for me included presentations related to neoliberalism and Indigenous struggles, the panel discussion on Metis territoriality, relationality and identity as well as many presentations and discussions on Indigenous education. As I look into my future as a Forester, I see the issues surrounding Indigenous forestry as a focal point. The conference was inspirational and synergetic, and I hope to play a role in creating similar open communications and collaborations in my studies and my future professional career.

Symposium on Stated-owned Forest Resources Management

A symposium "Stated-owned Forest Resources Management: Lessons Learnt from China and Canada" was co-hosted by UBC Forestry and the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet) on 3-9 July, 2017. The Chinese delegation was led by Mr Shuqing Feng, Deputy Director General, Department of Forest Resources Management, State Forestry Administration of China. Other members of the delegation included representation from the State Forestry Administration, the Ministry of Finance, the APFNet, the Forestry Bureau of Inner Mongolia Autonomous Region, and the Jilin Forest Industry Corporation.

The symposium focused on sustainable forest management, state-owned forest resources management, climate change and park management. Field trips provided the delegation an opportunity to meet with the BC Ministry of Forests, Lands and Natural Resource Operations in Victoria to deepen their knowledge of forest policy; foresters from Interfor in Campbell River to observe sustainable forest management in practices; and the director and the manager of Banff National Park, to understand Parks Canada's roles in environmental protection.



Invasion of boreal forests by the mountain pine beetle

After nearly 2 decades of destruction, the mountain pine beetle is notorious in western Canada. Due to the adverse effects of climate change and historical land-use, this insect is in the midst of an enormous outbreak, having devastated just under 20 million hectares of lodgepole pine forests in British Columbia to date. Recently, the outbreak has also expanded over the Rocky Mountains and into the boreal jack pine forests of Alberta. Forest entomologists in Canada worry that the beetles could expand throughout the boreal all the way to the eastern seaboard. Scientists at the University of British Columbia, and across Canada and the United States, are working together to better understand and predict how the mountain pine beetle might march across the continent.

Since the description of the mountain pine beetle by Andrew D Hopkins in 1905 (he originally called it the "Black Hills beetle" after where he found it in South Dakota), scientists have studied their physiology and population processes with vigor. The mountain pine beetle is an eruptive species, which means that the population periodically transforms from an innocuous, minor part of the forest into a widespread outbreak that can affect millions of hectares of forest. Regular changes in the climate trigger this transition, and positive feedbacks in the beetle's own behavior and physiology drive it to outbreak. The positive feedback works like this: the more beetles there are, the more trees they can kill, which in turn leads to more beetles and even more dead trees until finally the population boils over into a major outbreak. But eventually, the trees run out -- and then the beetle population must collapse back to its low-density state or face local extinction. After nearly a century of research, the forest entomology community understands quite well how this works in the beetle's native range. But these processes will likely change in the newly invaded boreal forests. This insect has caused irreparable damage to local economies in BC, and predicting potential changes to their population processes in invaded habitats is critically important to preventing further harm to our communities.

The Forest Insect Disturbance Ecology Laboratory at UBC (led by Dr Allan Carroll) conducts valuable research to tackle this pressing issue. During the past 5 years, researchers discovered that many characteristics of the boreal host tree species, jack pine, are amenable to mountain pine beetle outbreaks. This may mean that invasion of the boreal forests could enhance the mountain pine beetle's outbreak potential. For example, during his PhD research, postdoctoral researcher Dr Jordan Burke, along with his supervisor Dr Carroll, demonstrated that the chemistry of host trees heavily influences the development of outbreaks,

and that jack pine chemistry specifically may enhance beetle outbreak potential. Now, PhD student Antonia Musso is working out what the consequences of this discovery might be. Part of her research at the University of Alberta, in collaboration with her co-supervisor Dr Maya Evenden, focuses on the eruptive potential of mountain pine beetle in jack pine. Antonia wants to know whether this potential susceptibility in individual jack pines actually makes the trees easier to colonize and kill, which could tell us whether we can expect more or possibly worse beetle outbreaks in the boreal forest.

Back at UBC, PhD candidate Stanley Pokorny is analyzing low-density populations of mountain pine beetles in boreal jack pine forests. Low-density beetle populations live in weakened or dying trees, a short-lived resource home to numerous competitors and predators that challenge the mountain pine beetle for a place in this habitat. Stanley found there is much more available niche space in the beetle's native forests than in boreal forests, and in this measure the invaded habitat may be less suitable for mountain pine beetles. Lodgepole pine forests, the beetle's native habitat, are dense, and these forests contain many weakened trees dying from inter-tree competition. However, jack pines live in ecosystems with less nutrition, and grow in sparser stands with fewer trees, leading to fewer weak individuals for the beetles to live in during their long periods of relative inactivity. The relative lack of weakened trees leads to a great deal more competition between the mountain pine beetle, other insects, and even fungi, which all rely on those trees for survival. Based on Stan's research, Dr Burke and his Forestry Co-op student, Carmen Taylor, are currently conducting experiments on some of the mountain pine beetle's many competitors during the beetle's outbreak lulls. The experiments include infesting logs with mountain pine beetles alongside other bark beetles, as well as with antagonistic fungi, which compete with the mountain pine beetle's own symbiotic fungi for space and resources.

Through this research at UBC and U of A, much of what is being discovered is pointing towards an interesting phenomenon: while invasion of jack pine forests may give an advantage to the beetles in high populations, it appears that this invasion may be detrimental to the beetle's long-term survival in low-density populations. This is known as population state-dependence, and these UBC scientists suspect that the invasion potential of the mountain pine beetle in Alberta's boreal forests will depend on how many beetles are there. Considering that low-density beetle populations must be able to successfully establish for the beetles to become permanent in their new home, their invasion potential during low-density phases may have significant consequences for their long-term persistence in the boreal forests, and ultimately their potential to spread further east.

At the moment, we still do not know what this research means for the future of Canadian boreal forests. However, the research demonstrates the potential for climate change to complicate our understanding of the global ecosystem. The best way for scientists to mitigate the negative consequences of climate change is to make accurate predictions about how our ecosystems may react. Unfortunately, the problem facing all environmental scientists is that these drastic changes brought about by human-caused disruption, such as a host shifts by injurious species into new habitats, renders predictions based on earlier knowledge potentially much less accurate. However, through research programs like those at UBC Forestry and elsewhere, scientists are working on solutions to these pressing problems. Continued support for climate change research, from both the public and our industry partners, is critical if we want to avoid economic and ecological disasters in the future.

For further information on these research projects, contact Post-doctoral Fellow Dr Jordan Lewis Burke at jordan.lewis.burke@gmail.com , or Dr Allan Carroll (Forest Insect Disturbance Ecology Laboratory leader) at allan.carroll@ubc.ca.

Innovative tools for modelling Canada's forest sector

Canada's forest industry is undergoing an unprecedented structural transformation, as seen in widespread shutdowns in the newsprint and lumber sectors and the emergence of the bioenergy sector. Layered upon these sectoral changes are the unknown implications of biophysical threats from a changing climate. A major concern is the ability of the forestry sector to overcome threats and leverage future opportunities.

Traditionally, wood fibre from Canada's forests was harvested and processed by primary forest industries, mainly to make structural wood products such as lumber, plywood, OSB, or pulp and paper products. Residue streams generated from these harvesting and manufacturing processes, in turn, have been used as feedstock sources by the secondary industries such as fibreboard manufacturers, as well as new entrants such as wood pellet and bio-energy producers. The inter-connected nature of these sectors imposes significant challenges for assessing how future changes will affect Canada's forestry sector. Therefore, innovative tools and approaches are needed for evaluating these complexities at large (e.g. national) scales.

Integrated modelling in forestry research

Computer models that simulate complex, interacting processes have long been used to study forests and forestry systems at varying scales. Since experimentation is not feasible at large scales, these models allow researchers and decision makers to predict how certain events or policy and management options affect forests and their related systems. From a research context, large-scale simulation models often transcend the traditional boundaries of disciplines in order to reflect complex intersystem linkages that exist between ecological, environmental, economic, and social systems that affect forests. For instance, assume an economic model that is developed to explain the future of regional timber supply. Such a model would need to incorporate projections of future forest growth and yield patterns and disturbance regimes that involve methods derived from biometrics, ecology, and/or climatology disciplines.

Models that incorporate multiple systems and disciplines into a unified analysis framework are known as "integrated models". Integrated models are increasingly used by governments and international organizations to study the impact of policy options and strategies on forested systems. For instance, the European Union is informed by an integrated model called GLOBIOM developed by IIASA (www.iiasa.ac.at) regarding the impacts of bioenergy policies on global land use and land-use change.

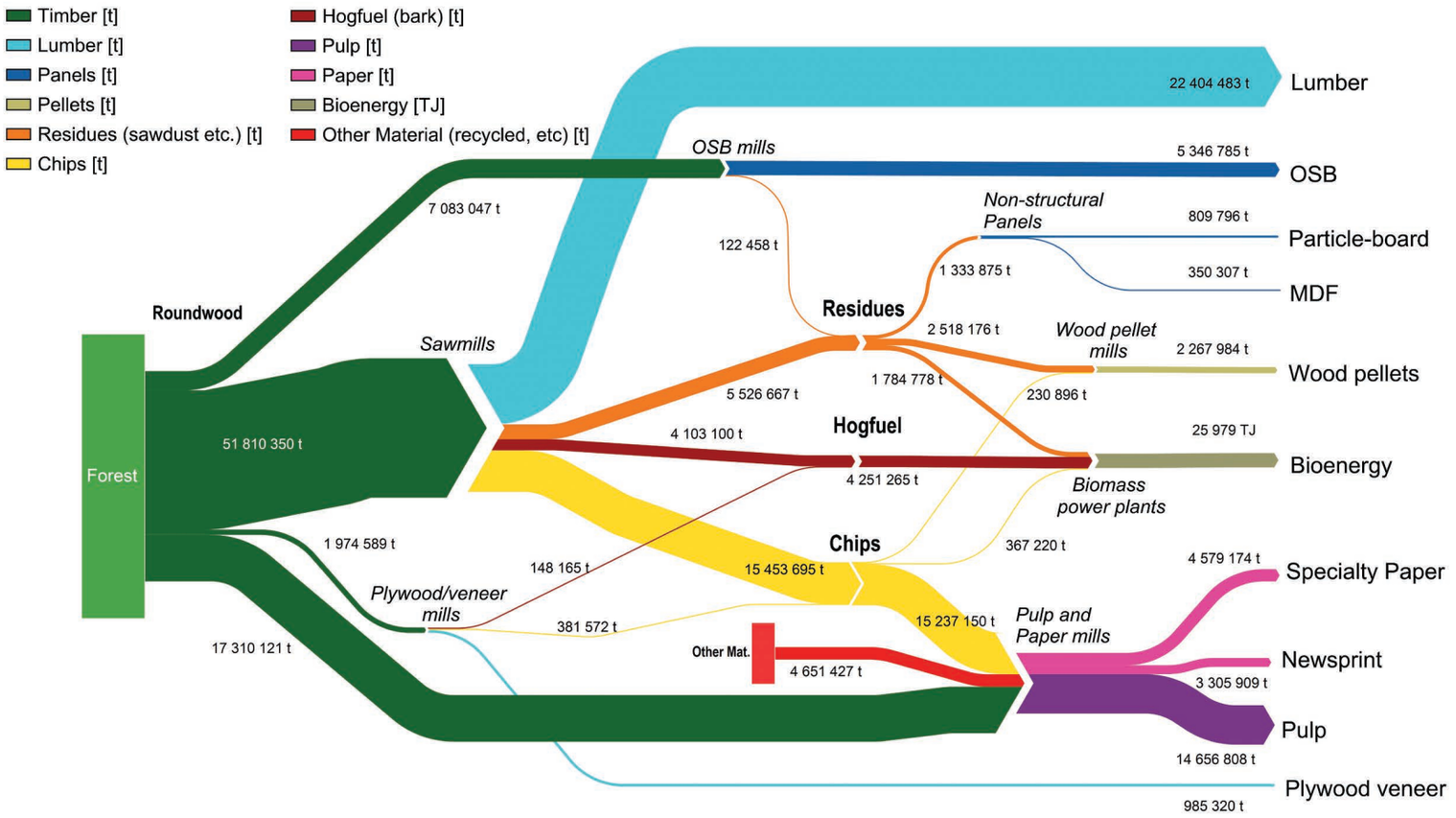
The paradigm of integrated modelling

A common approach for developing integrated models has been to expand the model structure to incorporate new systems within a single model. For instance, a model developed to simulate regional timber supply will be further developed to include model components that represent natural disturbances such as wildfires. Alternatively, integrated modelling may emphasize the re-use of models developed within individual disciplines and focus on the driving factors that link the systems these models represent. This may include integrating models at an input-output level or additionally providing feedback loops between individual models. For instance, in an integrated assessment of timber supply and fire disturbance, the forest inventory information used to estimate the fire risk could also be used to update the results of the timber supply model and vice versa. Important to this type of integration is managing the workflow of running models and updating input-outputs in different models; ie how do various models run? Synchronously or sequentially? How would outputs from one model update inputs (levers of change) of another model?

Integrating models of forests and forestry systems is particularly challenging from a computer performance point of view since such models typically use heterogeneous and large spatial datasets. Combining a series of these models and datasets proves even more challenging. In some cases, attempts at integrating or scaling up models to run at a regional or national scale results in computation times of several days or weeks! This greatly limits the number of times that these models can be run to validate and analyze scenarios in practice.

IMA: Integrated Modelling Arena

To address these issues within integrated modelling of forestry research, Dr Saeed Ghafghazi, a post-doctoral fellow in the Forest Resources Management (FRM) department working with Dr Gary Bull, has been developing a software framework called IMA. The software emphasizes a modularized development concept that enables existing or modular models to be linked in a unified analysis platform. Furthermore, IMA provides an intuitive front-end modelling environment and a 3D graphical user interface for visualization purposes. In order to resolve model integration and



computation efficiency issues at large scales, IMA uses a suite of technologies used for big-data management, distributed computing, and scientific workflow management including UC Berkley's Kepler platform, PostgreSQL, NASA's WorldWind, and components of Apache Hadoop Ecosystem. Additionally, the structure of the framework allows models to be case study independent and scalable. These features are particularly unique and useful for re-use and scaling of models in academic research, since most academic modelling efforts are bound to a specific case study which makes re-use or extension of those models very costly for future use.

With the help of a group of undergraduate students from UBC's computer science department and graduate students from Gary Bull's research lab and Queen's Institute for Energy and Environmental Policy, IMA has been developed into a stand-alone software package and applied in forest policy and economics projects.

Simulating forest fibre cascade in Canada

The Canadian Forest Service commissioned Saeed Ghafghazi and Kyle Lochhead, a PhD candidate in FRM, to develop an innovative approach to assess the impacts of economic, ecological, and climatic changes on the forest sector and, as a result, on regional forest fibre flows. This new approach involved constructing an integrated, spatially explicit simulation model that simulates the main supply chain activities of Canada's forest sector and forest fibre flows. The model was developed in the IMA software by linking 2 main modules:

- Q3 (Quantify, Query and Queue) a forest estate model, developed by Kyle Lochhead, which independently simulates harvesting and silvicultural decisions within many forest management units across Canada. This regionalized model provides outputs of available roundwood volumes and logging residue to the primary and secondary sectors from the forests.
- Fibre Cascade Model (FCM), developed by Saeed Ghafghazi, which spatially simulates forest sector supply chain activities including roundwood supply to the primary mills, residue distribution to secondary mills, and production.

The FCM model supplied Q3 with geospatial information of processing facilities locations and roundwood demand information, while Q3 provided FCM with the volumes and costs of log and logging residue supply. Using the IMA platform allowed scaling up of the model to a national scale; essentially by creating a multitude of smaller scale, regional representations of forest sector supply chains and then linking them together. Due to the innovative technologies that IMA provided for distributed computing and processing massive databases used by Q3 and FCM, thousands of management options were run based on different scenarios of future climate change impacts on forests and forest sector development. Each scenario takes less than 10 minutes to run, thereby producing an efficient means to assess the decision space. New and exciting management options have typically been attempted on a case by case basis with complications of generalizing results to other forested regions. This tool overcomes some of these challenges and is a first step towards assessing the impacts of forest management and forest sector changes at much larger scales.

For further information contact Dr Saeed Ghafghazi at saeed.ghafghazi@ubc.ca or Dr Gary Bull at gary.bull@ubc.ca.

Wildfire 2017

By Lori Daniels

Number of consecutive days of the provincial state of emergency: ***69***

Number of temperature records "shattered" this summer: ***85***

Estimated cost of fire suppression and emergency relief for evacuees: ***$700,000,000***

Total number of fires: ***1,214***

Estimated number of evacuees fleeing wildfire: ***46,500***

Total hectares burned: ***1,159,003***

Number of hours since July 7 that research forest staff and assistants fought to contain these fires: ***3,000***

Appreciation of UBC Research Forest staff, BC wildland firefighters, emergency staff and volunteers: ***priceless***

BC's extreme wildfire season of 2017 is not an isolated event. It is part of a global trend of increasing area burned and extreme fire behaviour resulting in megafires with tremendous social, ecological and economic costs – as witnessed in recent years in western Canada, the USA, Argentina, Chile, New Zealand, Australia, Indonesia, India, Portugal, Greece, Spain, Italy, France… Over the past decade, record-breaking heat waves in spring and early summer meant fire seasons started earlier with longer, more pronounced, summer droughts – BC's new normal due to climate change. Rather than a once in a lifetime event, 2017 is the pinnacle of several "exceptional" fire years, with tremendous costs to citizens, communities, the province, and forest management companies. Evidently, forests and communities in BC are not resilient to wildfire and adaptation is urgently needed.

Understanding wildfire is a necessary first step to ensure adaptation is effective. Wildfire is an essential ecosystem function and evolutionary force to which many trees, plants and fauna are adapted. In British Columbia, historical fire regimes varied among forest types. At one end of the spectrum, high-severity crown fires burned at intervals of one to several hundred years in subalpine, sub-boreal and boreal forests (eg SBPS, SBS, BWBS, ESSF BEC zones). Given the cool and mesic climate, these closed-canopy forests have abundant fuels that become susceptible to fire during drought. Over time and space, these fires diversify forest composition, structure and fuels, affecting fire behaviour and forming natural firebreaks – perpetuating landscape diversity and variable fire effects. At the opposite end of the spectrum, low and mixed-severity fires historically dominated the warm, dry valley-bottom and montane forests in the southern interior (eg PP, IDF zones and dry subzones in the MS, ICH and ESSF zones). Lower severity surface fires burned at intervals of <10 to 60 years, scarring trees and creating openings for new tree cohorts. Surface fires maintained grasslands and open woodlands and reduced surface fuels and understory tree density in montane mixed-conifer forests. Within individual fires and over time, higher-severity fire contributed to stand- and landscape-level forest complexity and diversity.

Societal perception of wildfire as a destructive force has justified a command-and-control management approach. Tasked with protecting lives and livelihoods dependent on forests, the BC Wildfire Service developed world-class expertise, successfully detecting and suppressing 92% of wildfires while less than 4 ha and within 24 hours of ignition. Success over several decades yielded unforeseen consequences. Easy-to-control surface fires were virtually eliminated from dry forests. As a result, trees encroached into grasslands, surface

fuels accumulated, and forests became denser. Understory trees form ladder fuels that conduct surface fire to tree crowns, increasing potential fire severity. In absence of fire, sub-boreal and subalpine forests simultaneously matured into uniform fuels across landscapes that enable fire spread and intensify fire behaviour. These forests were also prime habitat for mountain pine beetle, which increased the ratio of dead-to-live trees or led to abundant surface fuels after salvage logging. The negative impacts of fire suppression on forest diversity and health, hazardous fuels, and vulnerability to high-severity fire is called the "fire suppression paradox". It is an important factor explaining this year's extreme wildfires: abundant, uniform fuels combined with hot, dry, windy weather drove fast-moving wildfires with volatile behaviour that proved difficult to contain and suppress.

Transformative changes to management are essential to achieve forest and community resilience to contemporary and future wildfires. In 2012, BC's mandate for wildfire management expanded to encourage sustainable, healthy and resilient ecosystems as well as protecting life and values at risk. Innovation such as "fighting fire with fire" may seem counter intuitive over the short term but long-term solutions must include fire on the landscape. Managed wildfires – a variant of fire suppression known as 'modified response' – is one strategy allowing wildfires to burn if they pose low risk to life and property. These wildfires are key to restoring ecosystem function in naturally flammable landscapes and are an effective mechanism to reduce and diversify fuels, create natural firebreaks, and lower risk of subsequent uncontrollable wildfires. Closer to communities and critical infrastructure, wildfires continue to be suppressed. In the wildland-urban interface, the chance of successfully stopping wildfire is enhanced when hazardous surface and ladder fuels have been reduced and the canopy opened by thinning forests and prescribing fire. The resulting forest structure in "shaded fuel breaks" is less likely to conduct crown fire and create defensible space to aid firefighters in case of a wildfire. Note, reducing fuel hazards is analogous to insurance – it provides a safeguard in the event of an emergency (wildfire) but does not guarantee emergencies (wildfires) will not happen. Therefore, all communities in BC surrounded by forests would benefit from proactive fuels management, regardless of forest type and degree of disruption to historical fire regimes. Despite documented benefits, only 10% of the 685,000 ha of interface forests with very high fuel loads and vulnerable to crown fires were treated from 2004-2015. As discussed below, inadequate funding and numerous policy conflicts are among the barriers that perpetuate hazardous interface fuels, leaving communities across BC vulnerable to wildfire.

Funding for wildfire management that prioritizes suppression over mitigation is costly and not working. From 2004-2015, BC allocated only $163 million to proactive interface and landscape fuel treatments but spent $1.82 billion on emergency wildfire suppression. The 2017 wildfires exceeded suppression capabilities, burned over a million hectares, forced evacuation of >46,500 people, and cost ~ $700M (to date) for suppression and emergency support for evacuees, alone. Indirect, long-term costs of human health impacts, lost cultural values, ecosystem services such as water and timber supply, livestock, biodiversity, environmental and habitat degradation will greatly exceed direct costs. Our society cannot afford the high cost of extreme wildfires that affect communities. A meaningful financial commitment – at least equivalent to the ongoing costs of emergency fire suppression – is overdue to address the ongoing consequences of wildfires in the interior of BC. Before dismissing this cost as prohibitive, consider that the provincial government prioritized $17 billion from 2000-2015 for seismic upgrades to mitigate potential consequences of a high-magnitude earthquake –100 times the funds allocated for wildfire mitigation over the same period.

Fuels mitigation and wildfire preparedness are a shared responsibility; however, conflicting forest management objectives and policies have hindered fuel treatments and increased costs. Conflicts arise when fuel hazards are on crown lands adjacent to communities and in forests on the harvestable land base. Municipalities have been made responsible for interface fuels treatments but do not have legal jurisdiction to treat forests on crown land. On the harvestable land base, trees cut to reduce fuel hazard are subject to stumpage fees (eg, added costs) and forests must be restocked by planting trees (eg replacement of ladder fuels). Designed to ensure sustainable forest management, application of these policies in the interface are perversely counter-productive. Hazardous fuels in tenured forests adjacent to communities pose a unique problem: it is not cost-effective for licensees to prioritize harvesting the low-quality wood, which perpetuates hazards. Innovations such as using the biomass generated by fuels treatments for bioenergy is often deemed not economically viable due to transportation costs or fees to access biomass imposed by licensees. Without incentives to overcome these costs and become carbon-neutral, biomass is typically piled and burned on site, directly contributing to atmospheric CO_2. Liability, smoke constraints, attrition of expertise, and lack of formal training opportunities within the provincial government have diminished the use of prescribed broadcast burns to reduce logging slash, reduce and maintain other fuel hazards, and restore ecosystem function in dry climatic zones. These example conflicts and others are resolvable, but require leadership and compromise to prioritize long-term community safety over short-term economics.

For many communities in British Columbia, it is not if but when wildfire will pose a threat. Hazardous fuels, the legacies of past (and current) management paradigms, exacerbated by climate change make our forests and communities highly vulnerable to wildfire. Transformative change to fire and forest management requires leadership to overcome these barriers and enable solutions. Forest professionals, experts on managing forests to achieve specific objectives, are poised to make important contributions to safeguard BC communities from wildfire and increase forest resilience. Now is the time to rise to the challenge.

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Community-based conservation in Kenya

First and only community-owned rhino sanctuary in East Africa.

Kenya is all too commonly characterized by simplistic portrayals of rural communities plagued by poverty, or as a wild landscape for iconic wildlife, such as elephants and rhinoceroses. These dominant narratives, perpetuated outside of Kenya, mask the socio-economic and cultural diversity of Kenyan society. They maintain a simplistic and romanticized image of Kenya as a developing country whose wildlife is its only virtuous asset.

Since the early 1990s, a new approach to wildlife conservation in Kenya has changed the governance and control of wildlife and in doing so has directly challenged these all too common narratives. After a century-long history of state control over wildlife, most of which was entrenched in policy inherited from the British colonial government, new forms of community-owned and managed land-use practices are emerging.

Historically, centralized control over wildlife has resulted in local communities bearing the disproportional costs of living with wildlife while having little access to the benefits. Conservancies are community-based approaches to protecting wildlife that enable the rights and benefits of conservation to be captured by indigenous landowners. In Kenya, 68% of wildlife resides outside of national parks and reserves. Therefore, not only do conservancies hold promise for addressing past inequalities and poverty alleviation, they also hold enormous potential for biodiversity conservation.

Currently there are 177 conservancies in Kenya covering 50,000 square kilometers of land. The land, resources and wildlife held within community-owned landscapes only exist today because of the local cultures, institutions and knowledge systems that have regulated communal land use for generations. Recognizing the contribution made by communities to conservation – as conservancies endeavour to accomplish – is a significant step forward for community rights in Kenya and the preservation of Kenya's wildlife heritage.

While these new approaches to conservation offer a promising alternative to state-controlled national parks and reserves, they too have their own challenges. Conservancies are often complex social landscapes where equity in participation and knowledge are complicated by power dynamics between stakeholders. There is a multifaceted network of institutions and participants in Kenyan conservation, all with varying objectives and ideologies contributing to the governance of community-based conservation. First, there is an increasingly heterogeneous community made up of individual interests and motivations, particularly concerning wildlife. Secondly, there are often the interests of national and international conservation NGOs,

donors, researchers, aid and development programs and eco-tourism enterprises all contending to assist, influence and fund community conservation efforts. These are intertwined within the framework of national, county and local levels of government and parastatals such as the Kenyan Wildlife Service and the Kenyan Forestry Service nationally mandated to own wildlife and forests. Add to this stakeholder group other non-conservation orientated business interests and the complex network of stakeholders and their diverse interests in community conservation begins to become apparent.

The practical implications of this complex landscape present challenges for community objectives to maintain a central focus in decision making. However, when successful, conservancies may also create opportunities to create win-wins for development and conservation. The conservancy approach to governance is designed to foster partnerships between stakeholders and communities so they may work together towards securing land for conservation and ensuring benefits reach the community. However, successful partnerships require certain conditions to exist, the most important of which is how included communities are in the decision-making processes.

Kasmira Cockerill is a Masters student with over 6 years of experience in community-based conservation in Kenya. Kasmira is working with Dr Shannon Hagerman in UBC Forestry's Department of Forest Resources Management to explore the roles of various stakeholders in the governance of community-based conservation. Her research seeks to understand how knowledge is utilized in decision making and how participation of various actors is related to the current achievements and barriers to success within this governance approach. Specifically, Kasmira investigates aspects of knowledge ownership and the politics of representation to understand how networks of stakeholders produce governance outcomes. The goal of this project is to understand how governance structures may be improved to produce more equitable and ecologically effective outcomes.

This project builds on Kasmira's past relationships in the area and adopts participatory research methods to encourage participant's knowledge and experiences throughout the research. Kasmira is working in close partnership with Sera Community Conservancy located in the semi-arid rangelands of Northern Kenya. Sera Community Conservancy is part of the Northern Rangelands Trust (NRT), a collection of over 33 community conservancies in the north of Kenya with the agenda of transforming lives, securing peace and conserving natural resources. Sera Conservancy is an unique place to explore issues of governance and the negotiated priorities between participants in community conservation as it supports the first ever community owned Rhino Sanctuary in East Africa.

In looking at Sera Conservancy, Kasmira is exploring the role and influence of partner organizations such as NRT within the conservancy structure as a bridging organization. Bridging organizations are institutions that seek to address the institutional complexity by bringing stakeholders together to consider multiple forms of knowledge, mitigate conflict, strengthen synergies and govern relationships. Bridging organizations can also serve to reinforce the use of certain forms of knowledge (eg western compared with local knowledge) and may perpetuate existing power dynamics. Kasmira's research will explore the ways in which NRT as a bridging organization influences community-based conservation governance within Northern Kenya.

The available land for the protection of wildlife in northern Kenya is found in landscapes which include people and their livelihoods. The future of successful conservation in Kenya will rely on negotiating multiple and contested objectives through new modes of governance such as community conservancies. These negotiations will inevitably include tough decisions and trade-offs between conservation and development objectives across multiple scales. With rural communities becoming further empowered to control their land and resources through conservancy governance strategies, the future of conservation is rightfully in their hands.

For further information contact Kasmira Cockerill at kasmira.cockerill@alumni.ubc.ca or Dr Shannon Hagerman at shannon.hagerman@ubc.ca.

Monitoring barren-ground caribou

Barren-ground caribou are a circumpolar ungulate that migrate from the Boreal forest in winter months to the Arctic Ocean for calving in summer months. These animals are highly migratory and utilize several habitats throughout the year. They are grouped into herds by calving ground use, and these herds can number in the hundreds of thousands. Traditional knowledge and scientific assessments agree that these herds tend to undergo large natural fluctuations in size, in some cases by an order of magnitude. However, recently there has been a consistent decline across multiple herds and at a rate which is unprecedented since monitoring began in the 1970s. This has led researchers and managers to suggest that current declines may not be part of a natural cycle but may be due to factors from which they may not rebound if left unchecked. In support of this notion, COSEWIC recently upgraded barren-ground caribou to "Threatened" status.

Three factors complicate monitoring barren-ground caribou herds: the herds use huge tracks of land throughout the year, their ranges are extremely remote, and the observed declines occur over decades. Greg Rickbeil's recently completed doctoral research was focussed on developing novel methods for monitoring caribou herd - habitat interactions across space and time using remotely sensed and spatial data sets. His research project was a joint partnership between Dr Jan Adamczewski (Government of the Northwest Territories) and Dr Nicholas Coops (UBC Department of Forest Resources Management). Herd movements have been tracked for many years; first in the 1990s using ARGOS satellites, and then using GPS satellites in the 2000s and beyond. These data sets allowed Greg to observe which habitats are used by which individual animals and when. Additionally, telemetry data (space and time animal location data) can provide insights into animal behavior. When animals are focused on foraging they tend to move slowly and in random patterns and their turning angles increase. When animals are focused on migration, they tend to move in fast straight lines. Greg examined these telemetry tracks to better understand what we might expect an animal to have been doing at that location in space and time. This is hugely beneficial in understanding how movement changes throughout the year and how these movements relate to environmental cues.

The project capitalised on animal movement and remote sensing data which have spatial and temporal accuracy – something that was not possible even in the 1990s. Adopting these new technologies across wildlife disciplines will better enable researchers to ask novel wildlife science questions, assess population trends, and monitor habitat conditions across wildlife ranges.

Greg set out to identify which key environmental conditions affect barren-ground caribou's habitat use. His goals were to: a) identify how a certain environmental condition might

interact with barren-ground caribou, b) map it across caribou range spatially and through time, and c) assess how it has changed through time. Greg used satellite data to provide 3 key pieces of habitat information: vegetation productivity, lichen mat condition, and fire disturbances. Caribou are highly selective foragers, so monitoring vegetation productivity may offer some insight into caribou foraging, but it can also offer other pieces of information. Shrub species are expanding their range in the Arctic at the expense of tundra, and many of these shrub species are not palatable for caribou and actually impede movement. Conversely, some vegetation species are important forage species, such as tussock cottongrass. Therefore, assessing changes in vegetation productivity was critical to better understanding changes in caribou populations more generally. Land-growing lichen is also important forage throughout the year, therefore assessing changing lichen mat conditions for caribou was also related to the movement data. Lastly, fires not only remove land-growing lichen from the landscape but also dramatically alter forest structure for decades post fire, so considering both lichen removal and forest structural changes with respect to fire was critical.

Greg's published research showed that vegetation productivity affected barren-ground caribou movement. In tundra ecosystems, vegetation productivity resulted in slower caribou movement rates, suggesting more foraging was taking place in these locations. In shrub environments, however, increasing productivity had the opposite effect, resulting in caribou moving through an area more rapidly. Unfortunately, this increase is being driven by shrub expansion more than by increased tundra vegetation productivity, meaning that high quality caribou habitat is likely being lost due to the greening of the Arctic.

Improved lichen mat condition (ie locations which had increases in estimated lichen mat volume) resulted in slower movement rates - indicating that caribou forage more intensively in areas where there is more lichen coverage. More importantly, Greg's work demonstrated that lichen mat conditions are declining across barren-ground caribou range, likely due to shrub expansion. So cumulatively, shrubs are expanding likely at the cost of lichen mats, reducing foraging opportunities.

Lastly, fires were found to almost completely remove foraging type behavior even 26 years post fire, which was the maximum length of the fire data set. This result was expected as fire consumes most land-growing lichen, which can then take up to 100 years to recover. Despite this, caribou movement changed significantly as time since fire increased, suggesting that as habitats recovered post fire something was forcing caribou to move in different ways. Movement rates were lowest around 10 years post fire, then increased afterwards. This increase in movement may be a result of changing forest structure where standing dead trees finally fall, forcing caribou to use particular paths rather than moving across the burn.

Greg's work highlights the need for range-wide management of environmental conditions, especially fires given the severe effects these have on caribou foraging opportunities. As the temporal length of environmental data sets increases, researchers should be even better able to understand how caribou habitat is changing and what this might mean for this iconic and important global species. Expanding our ability to access and utilize novel technologies for conducting wildlife science will continue to be critical in keeping pace with the increasing challenges facing our wild species.

For further information contact Dr Greg Rickbeil at grickbeil@gmail.com or Dr Nicholas Coops at nicholas.coops@ubc.ca.

research lab profiles

Centre for Forest Conservation Genetics

Trees are remarkable organisms. They can live for centuries, and a single species can dominate forests across a wide range of environments. Some trees are among the largest organisms alive. Trees produce the raw material for our forest industry, and are the architects of forest habitats for many species. But how can trees grow over such a wide range of environments and climates? Do our native tree species have sufficient genetic diversity to adapt to climate change? Will our parks and protected areas adequately conserve their genetic diversity for the future? What trees should we be planting to increase forest adaptation, health, productivity and resilience to climate change?

Members of the Centre for Forest Conservation Genetics (CFCG) in the Department of Forest and Conservation Sciences strive to answer these questions by better understanding the basic biology and evolutionary history of conifers, and by applying that knowledge to questions of forest management and conservation. We study genetic diversity and adaptation in tree populations, evaluate the ways in which climates are changing and how that affects forest health, and translate that knowledge for people who are managing and conserving forests.

Healthy trees for new climates

When replanting harvested areas, foresters typically use local tree seed, as the parent trees have adapted genetically over long periods of time to the local climate conditions. However, with a rapidly changing climate, tree populations are becoming mismatched with their local climates, resulting in a widespread genetic maladaptation to climates and associated pests and pathogens.

The **CoAdapTree Project** is led by Sally Aitken, Sam Yeaman (U Calgary) and Richard Hamelin (UBC and Laval) and funded by Genome Canada, Genome BC, the BC Ministry of Forests Lands, Natural Resource Operations & Rural Development, other co-funding agencies, and forest industry partners. CoAdapTree's goal is to develop strategies and recommendations in support of growing forests that are better adapted to future conditions. We are studying climate adaptation in Douglas-fir, western larch and jack pine by sequencing DNA in trees from many locations and identifying genes that reflect variation in the geographic and climatic variables of their natural source location. Rafael Candido Ribeiro is testing Douglas-fir seedlings for traits and genes related to temperature and drought tolerance. Pia Smets, Dragana Vidakovic, and Christine Chourmouzis provide project management and technical assistance. Our collaborators are also investigating genetic resistance to Dothistroma blight in lodgepole pine and to Swiss needle cast in Douglas-fir. The results will help tree breeders and foresters select and plant trees that will be healthy in new climates in western Canada.

Evolutionary processes in conifers

We are studying evolutionary dynamics in BC conifers to understand how tree populations adapt to or migrate in the face of climate change. Joane Elleouet is using tree ring analysis and genetic data of Sitka spruce to understand the genetic and demographic processes involved in range expan-

sion. Susannah Tysor is building models based on the timing of reproduction and wind to evaluate whether pollen movement will facilitate adaptation. Jon Degner is studying hybridized populations of white and Engelmann spruce to understand how past hybridization facilitates adaptation to current and future climates. Vincent Hanlon is estimating somatic mutation rates by comparing DNA sequences between the bottom and top of very tall Sitka spruce from the Carmanah Valley.

Biogeoclimatic Ecosystem Classification (BEC) and new climates

Research is needed to adapt the BEC to a changing climate. Building on Tongli Wang's software ClimateBC, Colin Mahony is using new climate data to project the effects of climate change in BC's forests. Colin has also developed methodology to project where novel climates are likely to emerge, important because we don't know how species and ecosystems will respond.

Conservation genetics of BC's native trees

The CFCG maintains a catalogue of the genetic conservation status of all of BC's native species in BC parks and in the seedbank of the BC Tree Seed Centre. The goal is to develop strategies for conservation of genetic resources, and to inform recovery plans for endangered species like whitebark pine. Work includes maintaining provenance trials of whitebark pine and Garry oak, chairing the provincial Genetic Conservation Technical Advisory Committee of the Forest Genetics Council (Pia Smets), and developing new methods for assessing levels of protection from ecological and forest cover data (Tongli Wang). We also host the BC Big Tree Registry.

Sally Aitken (PhD, Professor and Associate Dean – Research and Innovation), leads the CFCG. She has studied the adaptation of trees to climate from a time when anthropogenic climate change was a potential but not yet realized threat to our forests until now, when its effects are obvious and profound. @SallyNAitken

Tongli Wang (PhD, Assistant Professor) is the Associate Director of the CFCG. He is well known for developing ClimateBC and Climate NorthAmerica software, and for "flying BEC zone" projections of shifts in the geographic distributions of climates associated with BC's major ecosystems. He also leads the development of new analytical methods to extract knowledge of climate adaptation from provincial field-based provenance trials.

Pia Smets (PhD, Research Associate), is Project Manager for the CoAdapTree Project, and leads plant growth experiments. She collaborates on CFCG genetic conservation projects and manages controlled climate chambers for the department.

Christine Chourmouzis (MSc, horticulture technician) leads plant production and field sampling for CoAdapTree. She also does fieldwork for a variety of projects, including Garry Oak and whitebark pine experiments, and maintains websites for the CFCG, CoAdapTree, and the BC Big Tree Registry.

Dragana Vidakovic (PhD, research technician), manages the CoAdaptTree wet lab. She is responsible for extracting and preparing DNA and RNA samples for high throughput sequencing and genotyping, and oversees the collection of leaf, DNA and RNA samples.

Colin Mahony (PhD candidate) is building on his experience as a Registered Professional Forester to study the emergence of unfamiliar 21st century climates at local, provincial, and continental scales, with a particular focus on the Biogeoclimatic Ecosystem Classification. @mahony_c

Joane Elleouet (PhD candidate) studies the range expansion of tree species through patterns of genomic variation.

Susannah Tysor (PhD candidate) is using reproductive phenology and wind models to learn how lodgepole pine pollen moves and to explore what patterns of pollen-mediated gene flow mean for adaptation to climate change. @scisus

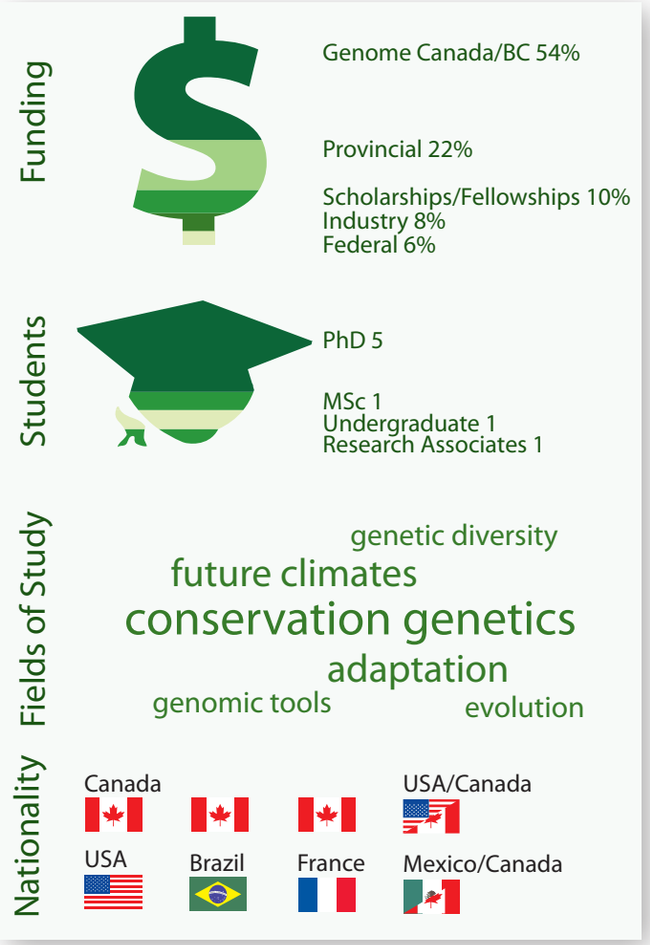
Jon Degner (PhD student, co-supervised with Loren Rieseberg) uses genomic tools to study how 3 of BC's spruce species naturally interbreed, how that interbreeding helps them adapt to the environment, and how these processes inform our understanding of speciation. @jc_degner

Rafael Candido-Ribeiro (PhD student) uses landscape genomics to identify genes involved in Douglas-fir climate adaptation. This project seeks to further understand the patterns of adaptation of Douglas-fir across its broad geographic range and in selectively bred populations.

Vincent Hanlon (MSc student) studies genetic differences within individual trees, ie somatic mutations, to better understand the rate and pattern of evolution in Sitka spruce.

Erik Alonso (summer student) helps with sowing, counting, thinning, and watering seedlings in the greenhouse, and is getting valuable field experience.

You can find us at http://cfcg.forestry.ubc.ca/, http://coadaptree.forestry.ubc.ca/, and http://blogs.ubc.ca/aitkenlab/. Sally Aitken can be reached at sally.aitken@ubc.ca



Is Mexico City moving towards sustainability?

By Nuria Monica Navarro Perez de Leon

The enormous metropolis of Mexico City is home to almost 9 million people. Such a dense population not only has high resource demands but also has an important number of negative outcomes such as congestion, garbage generation, water over-exploitation, air pollution and vehicular traffic. These heavy demands and associated outcomes have left Mexico City in a worrying environmental state. Despite the obvious problems that the city faces every year, decision makers are still increasing the amount of concrete and asphalt, both horizontally and vertically, while paying minimal attention to the associated rapid decrease in natural vegetation and the disappearance of public green spaces and trees.

Despite governmental discourses claiming that Mexico City is moving towards a more sustainable future, is becoming a greener city and is taking actions to combat climate change, policies and debates are not supported by actions. How can the city combat climate change when every year road construction is expanding across the city landscape and the increasing use of private vehicles makes transportation in the city a living nightmare? How can the city become greener if, for the past 15 years, road construction has caused the removal of 56 thousand trees, with no compensation or replanting happening? How can a city become sustainable if, in a radius of 5 km, one can encounter 20 shopping malls that consume massive amounts of energy and water while depriving resources to local dwellings? The truth is that any actions taken without consideration of the importance of natural vegetation and social engagement cannot move Mexico City towards a more sustainable and greener future. It is in this context that I recognized my personal passion for urban forestry as an approach to developing greener, more sustainable cities. By studying urban forestry, I realized, I could find ways of helping my home city. As a result, I chose to temporarily leave my home city and enrolled in an MSc program at UBC's Faculty of Forestry under the supervision of Dr Cecil Konijnendijk, an internationally well-known urban forest researcher.

I selected the district of Coyoacan for my research project - one of the oldest and greenest districts in Mexico City. Here I observed that the management of green areas is very rudimentary, consisting of grass cutting, plant watering, and removal of obstructing branches. With such minimal vegetation management it is no surprise to find trees, particularly street trees, in very poor states of health due to pests, diseases, decay and neglect.

I wanted to find out how much these street trees, even in their current situation, might be contributing in terms of ecosystem services. As urban forestry provides benefits to local communities, I was interested to know people's opinions towards the street trees and their knowledge of the benefits that these trees can provide. I spent the summer of 2016 measuring trees and doing passer-by surveys. I submitted my data to i-Tree Eco6, a software suite provided by the USDA Forest Service to analyze and quantify the tree benefits.

My results indicated that even in their poor condition, the street trees in Coyoacan are providing substantial benefits. However, the fragmentation of the urban forest around the local neighborhoods means that benefits are unevenly distributed among the local people. One possible reason for this may be the street layout (rectangular or curvilinear) of the neighborhoods which impacts the number of trees that can be planted. For example, some curvilinear neighborhoods have no sidewalks or enough space to plant trees.

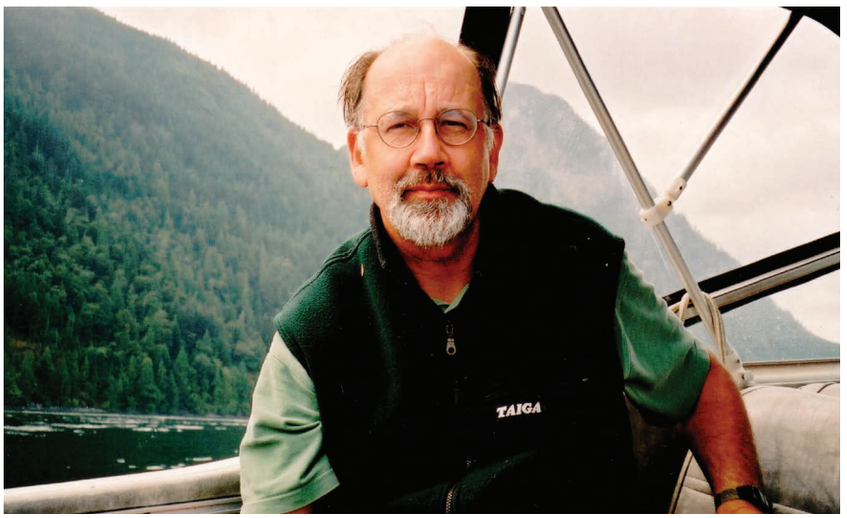
My survey results suggest that increasing tree cover in the city is one of the top 3 actions that should be implemented with public resources. People liked trees and appreciated them for their different benefits. Almost 70% of survey respondents wanted trees planted near their houses.

I hope to continue my research in urban forestry and help my home country move towards recognizing urban trees as valuable assets to society. Ultimately, I would like to be able to encourage better social engagement in the caring of Mexico City's urban forests such that their street trees are healthy and productive for the long term.

For further information contact Nuria Monica Navarro Perez de Leon, MSc student in the Department of Forest Resources Management, at nuriamnavarropl@gmail.com or Dr Cecil Konijnendijk at cecil.konijnendijk@ubc.ca.

development & alumninews

Memorial scholarship honours influential professor of wood science



On April 5 2016 Dr David Barrett, UBC alumnus and Professor Emeritus in the Faculty of Forestry, passed away after a valiant fight against cancer. In his memory, family members, friends and colleagues have established a scholarship for graduate students with an interest in wood science.

"In creating the scholarship, we wanted to honour Dave's enormous contributions to wood science and the forest industry," says Barry Ford, Marketing Director for Offshore Markets at Coast Forest Products Association, and a longtime friend. "We want to help students of a similar mind pursue their interests."

Dave Barrett was a leader in wood mechanics and timber engineering. He graduated from UBC in 1965, and received a PhD in Wood Science at the University of California Berkeley. He joined UBC in 1984, became head of the Wood Science department in 1993, and played a major role in establishing the Centre for Advanced Wood Processing in 1996.

"When Dave joined UBC there really wasn't the sophisticated wood science program there is today," says Greg Wirtz, Dave's stepson. "The body of research he undertook drew students to UBC from around the world."

Frank Lam is the Senior Chair and Professor of Wood Building Design and Construction in the Faculty of Forestry, and he worked closely with Dave over many years. "Dave made significant contributions in the field of wood science and timber engineering," he says. "He helped shape the renewal of UBC's Wood Science education. His research in the area of ingrade testing, stress volume effects and load duration effects had national and international impacts."

Barry Ford cites Dave's work on Canada Tsuga as an example of how he helped facilitate international trade. In the period after the massive earthquake in Kobe, Japan in 1995, Japanese building standards were raised and Canadian forest companies had to meet them.

"Dave helped the Japanese Ministry of Construction develop new test methods, and helped Canadian forest companies meet the new standards," Barry says. "He was very adept at understanding the timber industry, and he was able to match wood science and research to the needs of the marketplace."

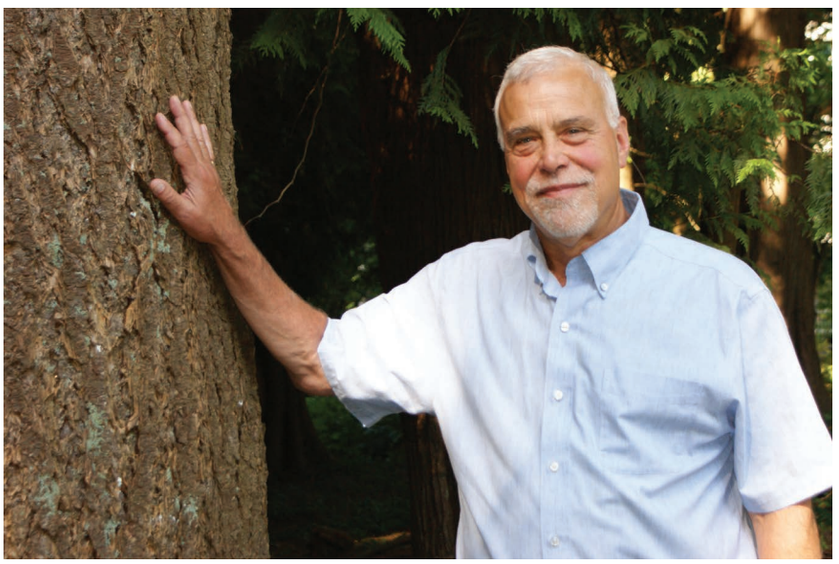
Greg Wirtz agrees. "Dave was an academic, but a practical one. He worked closely with a lot of local and regional forest product companies to develop standards for our lumber that are compatible with international requirements," he says.

The **Dr J David Barrett Memorial Scholarship in Wood Science** is available to outstanding graduate students with preference for those with a demonstrated interest in timber engineering and/or wood science. The inaugural award went to PKM Moniruzzaman, a PhD candidate whose research focuses on the stability of cross-laminated timber wall systems. PK received an MSc in Civil Engineering from UBC Okanagan and a BSc in Civil Engineering at the Bangladesh University of Engineering and Technology. PK has received 3 previous student awards from UBC.

Greg, Barry and Frank welcome interested alumni and friends to contribute to this scholarship fund in tribute to Dave's influential legacy in wood science and his deep love of forests and the outdoors. Contributions can be made at https://memorial.support.ubc.ca/david-barrett/

Your gift to the Faculty of Forestry can have an enduring impact on the lives of students, decades into the future. To find out more about establishing a student award, please contact Emma Tully at 604.822.8716 or emma.tully@ubc.ca.

Faculty member establishes award for students entering forestry



For many Branchlines readers, Dr Peter Marshall needs no introduction. As a professor since 1983, and Associate Dean Undergraduate Studies of the Faculty of Forestry from 1998 to 2016, literally thousands of students have met him in his office, a classroom, or a forest.

Dr Marshall received his Bachelors and Masters degrees from University of Toronto, and his PhD from UBC. He is a former President of the Association of BC Forest Professionals and the Canadian Institute of Forestry. His career accomplishments have been recognized twice by the Canadian Institute of Forestry: he received the Canadian Forestry Achievement Award in 2005 and the Presidential Award in 2014.

Peter's deep empathy with the undergraduate experience has led him to establish an Entrance Award for outstanding under-represented students. "In my role as Associate Dean I saw how often students held down jobs outside of school so that they would have enough money to study… and they still did well. That says a lot for their abilities, and I want to do my part to ease some of their difficulties," he says.

The Peter Marshall Centennial Scholar Entrance Award in Forestry is offered to students entering Forestry at UBC who are under-represented in the general Faculty population. This includes Aboriginal students, students from rural communities, immigrant and refugee students, first generation learners, students aging out of care, and students with lower socio-economic status.

"We want to get to a place where the population as a whole is represented in the student body," Peter says. "I wanted to encourage students who aren't bursary recipients; who are doing well academically but still struggle financially. I also wanted this award to recognize achievements outside of school. I believe that sports, the arts, or community volunteering can really help a student think more broadly and understand different perspectives."

The urge to give back to students stems from Peter's own experience at University of Toronto. "I received some awards as an undergraduate, and they were incredibly valuable in practical terms, and also a tangible recognition of things I had worked hard to achieve," he says.

The first recipient of Peter's award is Marley Lightfoot, who transferred to UBC from University of the Fraser Valley in Fall 2016. Marley is in the Urban Forestry program, and hopes eventually to be involved in city planning and urban design.

"Once I found out about the Urban Forestry program, I knew it was the one for me. Every course in the program encompasses what I love, and what I've always wanted to learn about," she says. "Because of this scholarship, my student loans will not be as extensive, and I am trying my very best to minimize the amount of money that I will owe after graduation."

Peter feels that students like Marley reflect the current and future face of forestry. "Today's students have wider interests, and they are more international and diverse than even 10 years ago," he says. "They look beyond the province to see that forestry is very much a national and international profession. What we do has some impact globally and is also affected by what goes on globally. Our students are more aware of this now than ever before."

The Faculty of Forestry is grateful to Peter Marshall and all other donors who help enrich students' lives through scholarships and bursaries. To find out more about establishing a student award, please contact Emma Tully at 604.822.8716 or emma.tully@ubc.ca.

A Forester in tourism

Dave Butler, BSF'81, RPF, RPBio

How did a forester end up in tourism, you ask?

After growing up in the open ponderosa pine forests of the Okanagan, I wanted to be a wildlife biologist. But I had no idea how best to do that. During first year Science at UBC, I discovered UBC's forestry program and instantly realized that it was an intriguing route that combined a long list of passions for me, while at the same time learning the language of forest management.

I took as many resource management and wildlife courses as I could during the next 4 years at UBC, along the way acting as a dendrology teaching assistant for Dr John Worrall (always fun!). In the summers, I worked as a park naturalist and then as a habitat technician. In my final year, I wrote my graduating thesis under the guidance of Dr Fred Bunnell, who had always been – and continues to be – an inspiration. In my spare time, I worked as an auxiliary RCMP constable at the UBC detachment. To say that I saw the darker sides of the University Endowment Lands would be an understatement. But my partner and I did win best costumes at a fraternity Hallowe'en party one year …

I left UBC after graduation in 1981, armed with a freshly-printed forestry degree, and drove east to Banff National Park. The next day, I started as a park warden. That experience included mountain rescues and poaching investigations, horseback boundary patrols, and tranquilizing misbehaving grizzly bears (yes, I often wondered if firing a dart into a jean-clad human butt made more sense…). In Banff, I also met Hans Gmoser, the father of heli-skiing and the founder of Canadian Mountain Holidays (CMH). That meeting changed my life.

After Banff, I worked in a range of provincial ministries doing resource tenure management, and obtained my professional forester and professional biologist designations. But I always remembered meeting Hans Gmoser. He was wise, sincere, kind and genuine, and he'd found a globally-unique way to share the mountains of BC with visitors. And he and his colleagues were committed to acting as stewards of very special places.

Since 1997, I've been privileged to be the Director of Sustainability at the company founded by Hans Gmoser: CMH. There's no doubt that the critical thinking I learned at UBC has been instrumental in my success, although in hindsight, I wish I'd taken courses in human psychology (resource management is largely about working with people … and people are curious beings to figure out …).

My role at CMH focuses on government and community relations (both indigenous and non-indigenous),

environmental management, and land and resource tenures. I manage the company's development programs (glading, spacing and brushing ski terrain) and I'm proud of the innovative and collaborative work we're doing with forest licensees such as Canfor, Revelstoke Community Forest Corp and Downie Timber. I'm also heavily involved in management of species such as mountain caribou, mountain goats and wolverines.

Since my time at UBC, I've become a passionate advocate for tourism in British Columbia. It's now one of our largest natural resource sectors, and yet, it's poorly understood. One of tourism's challenges is that it's not a commodity. It's not measured in cubic meters, tonnes, animal-unit-months, or gigajoules. Instead, I see tourism providing transformative experiences to visitors from around the world every day, experiences measured in smiles and changed lives, repeat visits, fresh ways of looking at our province, and $ billions to the economy. For those of us who travel, we innately know that tourism – like no other sector -- connects people to each other, to landscapes and ecosystems, and to cultures.

Because I won't be at CMH forever, I've begun a gradual transition to the next stage of my career: author. My first novel, Full Curl, will be published by Dundurn Press on September 30th of this year. It's a mystery/thriller, the first of at least 3 in a series. Through fiction, I've discovered a new path for exploring the economic, social and environmental issues faced by western communities. It's a path that takes me back to my time in UBC Forestry.

Do Rainbows Come in Green? Urban Forests and Multicultural Citizenship

A public event hosted at the Faculty of Forestry will celebrate the diversity of our relationships with trees and forests in cities. Organised in collaboration with the Peter Wall Institute for Advanced Studies and the Canadian Urban Forest Network (Pacific Region), the event's activities will demonstrate the importance of trees in our lives, and the many forms that relations between trees and people can take.

A photo exhibition in the atrium of the Forest Sciences Centre will present work from professional and amateur photographers, under the theme 'people and their trees'. The exhibition will be opened with a performance by Polymer Dance (www.polymer-dance.com), a Vancouver-based contemporary dance improvisation ensemble. This is followed by a panel debate on the topic of urban forests and multicultural citizenship, with involvement of leading international scholars such as Pierrette Hondagneu-Sotelo, sociologist and author of books such as 'Paradise Transplanted: Migration and the Making of California Gardens'. Panel members Arjen Buijs (Wageningen University, Netherlands) and Alan Simson (Leeds Beckett University, UK) have studied the impact of multiculturalism on the use, design and management of urban nature. Local and Canadian perspectives will also be addressed. The panel, which will be interspersed with brief, personal 'tree stories', will be moderated by Cecil Konijnendijk, professor of urban forestry at UBC.

This free event will run from 5–7pm on October 23rd. Light refreshments will be available. For online registration, please visit www.greenrainbows.pwias.ubc.ca.

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