

branchlines

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Forestry
University of British Columbia

dean's message



This issue of *Branchlines* features some of the work of the many graduate students in the Faculty of Forestry. This is a critical group of people in the Faculty – not only are they receiving training in research techniques, but they are also making substantial contributions in their own right to the body of knowledge. Many of us are dependent on graduate students to undertake the research that we are involved with, and it is important that they have the opportunity to describe their work, not only to their peers but to the broader community. At any given time, UBC Forestry graduate students can be found all over the world; they are important ambassadors for us and demonstrate just how diverse and international in scope the research is that is undertaken in UBC Forestry.

The type of work undertaken by a graduate student varies depending on whether it is for a MSc (or related degree) or for a PhD. The former tend to be more focused, looking at a specific problem, and are generally completed in 2 to 3 years. The research for a PhD takes longer, usually from 3 to 5 years. An example of a typical MSc project is provided on page 6. In this work, Cosmin Man developed a specific tool that enables links to be made between 2 important forest models. This will help us to work out how much carbon a forest is sequestering.

Another example is provided by the work of Chelsea Nilausen, who is looking at the social acceptability of a particular technique used in tree breeding. The social acceptability of the techniques used in genomics is becoming increasingly important as the general public has developed considerable hostility to some of the approaches.

An example of the more detailed research associated with a PhD is provided on pages 8 and 9, where David Levy-Booth describes how he is unraveling some of the complexities associated with the establishment and growth of trees on wet, low-fertility sites. In particular, he is looking at how nitrogen fertilization may help, always cognizant of the possible issues surrounding greenhouse gas emissions (nitrous oxide is an important greenhouse gas). Another example is the work of Trisha Atwood, which has revealed the importance of predators in the carbon dioxide dynamics of aquatic communities. This ground-breaking work has been published in the prestigious journal *Nature Geoscience*.

In some cases, teams of MSc and PhD students work together or in tandem to unravel the complexities of particular issues. Such an approach has been adopted by the Centre for Alpine Studies, which has been looking at the ecology of mountain birds. This work has revealed some important information, such as the longer life expectancy of birds breeding at high altitudes. This of course raises many other questions, providing fertile ground for further research in the future.

Finally, we feature some of the important work that our donors and alumni are doing. I would particularly like to thank Peter Bentley for his tremendous contribution towards the cost of a new dining hall at the Loon Lake Camp in the Malcolm Knapp Research Forest. We are working hard to find the remaining funds necessary to complete this development, which will mark the final chapter in the re-development of the Camp.

John L Innes
Professor and Dean

Resources
for the **future**

The conference will bring together world leaders in the forest resources field, and provide them with a venue to share their expertise and identify potential solutions.

The anticipated audience includes policy makers, researchers, industry leaders and NGOs – all stakeholders in the future of the world's forests.

Globalization
How will globalization impact forests?

Plantations
What are the consequences of increasing reliance on plantations?

Bio-products and advanced building systems
What are the implications of new and emerging products on forests and forest research?

Forest ecosystem services
How will forest ecosystem services develop and affect human communities and landscapes?

IUFRO Task Force Conference
Vancouver, August 27 – 29, 2013
<http://iufro2013.forestry.ubc.ca>

The IUFRO Resources for the Future Task Force, led by Dean John Innes, was established in 2011 to bring understanding to the effects of globalization on the world's forests. To help accomplish this, the Task Force is holding a conference at the For-

est Sciences Centre, UBC, August 27-29 2013. The conference will focus on 4 key themes that have been identified as being critical to the future of forest resources globally:

- globalization and its impact on trade in forest products;

- plantations as a source of future fibre;
- emerging bio-products and advanced building systems using wood; and
- forest ecosystem services and how these can be financed.

The conference will feature more than 20 speakers from around the world, including Andy White (Rights and Resources Initiative, Washington DC), Luis Neves Silva (WWF New Generation Plantations, Portugal), Rob de Fégeley (Institute of Foresters of Australia), Dr Miles Drake (Senior Vice-President R&D, Weyerhaeuser), and Dr Sven Wunder (CIFOR, Brazil). We also plan to have an award-winning architect keynote speaker to talk about the future of wood in commercial building.

The audience will be drawn from across the globe, with professionals from industry, NGOs, government, Indigenous groups and academia. There will be break-out sessions to encourage discussion between the speakers and participants. This will be an important opportunity to learn about the future use of the world's forests and the goods and service that they provide – especially how the forests of British Columbia will fit into the global picture.

We encourage people to register before it is sold out. Space is limited to 250 people. To register, please visit: <http://iufro2013.forestry.ubc.ca>

For more information please contact Dr William Nikolakis at william.nikolakis@ubc.ca or 604.822.6509.



New book – Alan Lindsay Orr-Ewing: The Father of Forest Genetics in British Columbia

“Alan had some special gifts, there is no question, but those gifts were backed up with perseverance, willingness to seek out and listen to others (humility), high standards and, on the personal level, courtesy, graciousness, and humour.”

These words by Dr Frank Sorensen describe Dr Alan Orr-Ewing in “Alan Lindsay Orr-Ewing: The Father of Forest Genetics in British Columbia”, a book written by UBC Alumni Gerry Burch, RPF (Ret) and Dr Michael Meagher, RPF (Ret). Through stories told by his family and colleagues in government, academia and industry, this book reflects on Dr Orr-Ewing’s life and research and

shows the great impact of one man’s dedication, especially in the field of forest genetics. He is regarded as the man most responsible for conceiving and developing the tree-improvement program in British Columbia. Dr Orr-Ewing was both the first to receive a Doctorate from UBC’s Faculty of Forestry and the first recipient of the Distinguished Forester Award from the Association of British Columbia Professional Foresters in 1970.

Copies of the book can be ordered through the Forest History Association of British Columbia’s website at www.fhbc.org.

New report on REDD+ stakeholder engagement

The Forest Investment Program at the World Bank has recently released a learning product on stakeholder engagement in REDD+. It is based on a review of the consultative processes among government agencies, major REDD+ initiatives, indigenous peoples and local communities, as well as the private sector. The review was conducted by Dr Hosny El-Lakany (Adjunct Professor, Department of Forest Resources Management at UBC).

The review concludes that co-ordinated stakeholder collaboration is needed to avoid overlaps and gaps and further emphasizes the importance of strong national

leadership; improved dissemination of information; capacity building for stakeholders; simple governance mechanisms for the consultative process; and information and knowledge sharing of traditional knowledge, innovations and practices. The report calls for improved modalities for collaboration with the private sector and notes that consultative processes must be adapted to the specific circumstance of the target countries.

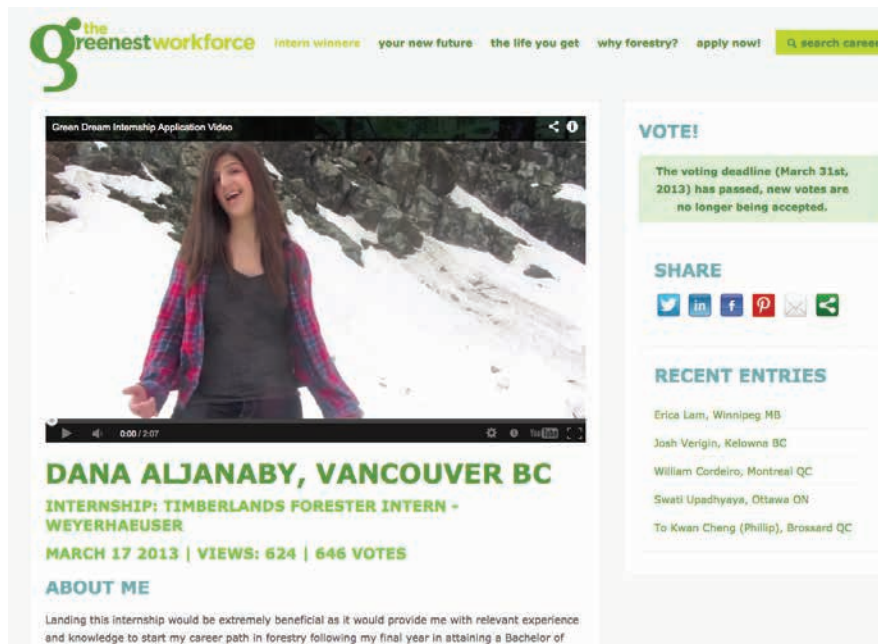
The full report is available from the Climate Investment Fund, World Bank (www.climateinvestmentfunds.org/cif/).

Commonwealth Young Foresters Award winners coming to BC

The Commonwealth Forestry Association’s Young Forester Award is designed to support the professional development of foresters below 35 years of age through the provision of a short-term work placement in a country other than their own. This year’s Award winners are Shimona Quazi from Bangladesh and Tolulope Daramola from Nigeria who will each undertake a 3-month work placement at

UBC’s Alex Fraser and Malcolm Knapp Research Forests in British Columbia, later this year. The Award winners are supported by grants from the CFA and will carry out a wide range of activities while on their placements. They will post a daily diary on the CFA website at the time at www.cfa-international.org.

Winning the Green Dream through social media



The screenshot shows the 'the greenest workforce' website. At the top, there are navigation links: 'intern winners', 'your new future', 'the life you get', 'why forestry?', 'apply now!', and a search bar. The main content area features a video player for 'Green Dream Internship Application Video' showing Dana Aljanaby. Below the video, her name and details are listed: 'DANA ALJANABY, VANCOUVER BC', 'INTERNSHIP: TIMBERLANDS FORESTER INTERN - WEYERHAEUSER', and 'MARCH 17 2013 | VIEWS: 624 | 646 VOTES'. To the right of the video, there is a 'VOTE!' section with a deadline notice: 'The voting deadline (March 31st, 2013) has passed, new votes are no longer being accepted.' Below that is a 'SHARE' section with social media icons for Twitter, LinkedIn, Facebook, Pinterest, Email, and Print. A 'RECENT ENTRIES' section lists other winners: Erica Lam (Winnipeg MB), Josh Verigin (Kelowna BC), William Cordeiro (Montreal QC), Swati Upadhyaya (Ottawa ON), and To Kwan Cheng (Phillip, Brockard QC). An 'ABOUT ME' section begins with the text: 'Landing this internship would be extremely beneficial as it would provide me with relevant experience and knowledge to start my career path in forestry following my final year in attaining a Bachelor of

By Dana Aljanaby

I chose a forestry path because I always saw myself doing something environmental, and working to manage our forests sustainably is a gratifying career, to say the least. After hearing about UBC's phenomenal forestry program first hand, I knew it was what I wanted to do.

When a guest lecturer in one of my courses brought up a nationwide contest that would give 8 students the chance to land a summer internship working in the forestry industry, I couldn't ignore the opportunity. The contest was put on by the Greenest Workforce, a website that was recently launched by the Forest Products Association of Canada, in hopes of intriguing more young people to consider working in the forestry field. So, the first chance I got, and with the help of a fellow forester, I filmed my application video in the hope of winning a 4 month internship with Weyerhaeuser in Grande Prairie, Alberta. However, the application video was only the first step! I needed my video to get enough votes to place me in the top 5, which wasn't too hard with the immense support from

my family and friends. Being in the top 5 landed me an interview with Weyerhaeuser, and a couple of days later, I got the awaited phone call saying I had got my Green Dream internship! I was beyond excited to spend my summer somewhere new and gain forestry experience working for such a well-known company, applying what I have learned in school to the real world. Along with the paid internship, I also received an iPad mini to blog about my experiences throughout the summer for the Greenest Workforce website. With only 2 weeks before I had to relocate, I happily packed up my car and 14 hours later, I was

in Grande Prairie.

Now, 3 weeks into the job, I am all settled in and love how my summer has turned out so far. The first week of work was mostly orientation, training, and first aid. The weeks thereafter, I have been working with the Timberlands operations crew, laying out block boundaries, roads, creeks and crossings best suitable for harvesting and log hauling. I'm the only female working with a group of males, most of whom have about 30 years working in the industry, but they are extremely friendly and passionate about their work, and it's been a pleasure working with them so far.

So far, my short time with Weyerhaeuser has been a great experience. They are a great company to work for, with extensive safety values, highly competitive wages, and enthusiastic, passionate employees. I love being able to work outdoors and stay active, and I can't wait for the rest of the summer to play out. I am extremely grateful to have been given such an amazing opportunity, and to gain experience in forestry that will jumpstart my career following graduation next year!

Dana has just completed the 3rd year of her BSF program in the Faculty of Forestry. To view her winning application video visit <http://thegreenest-workforce.ca/index.php/en/win>.



Forest planning and carbon budget models

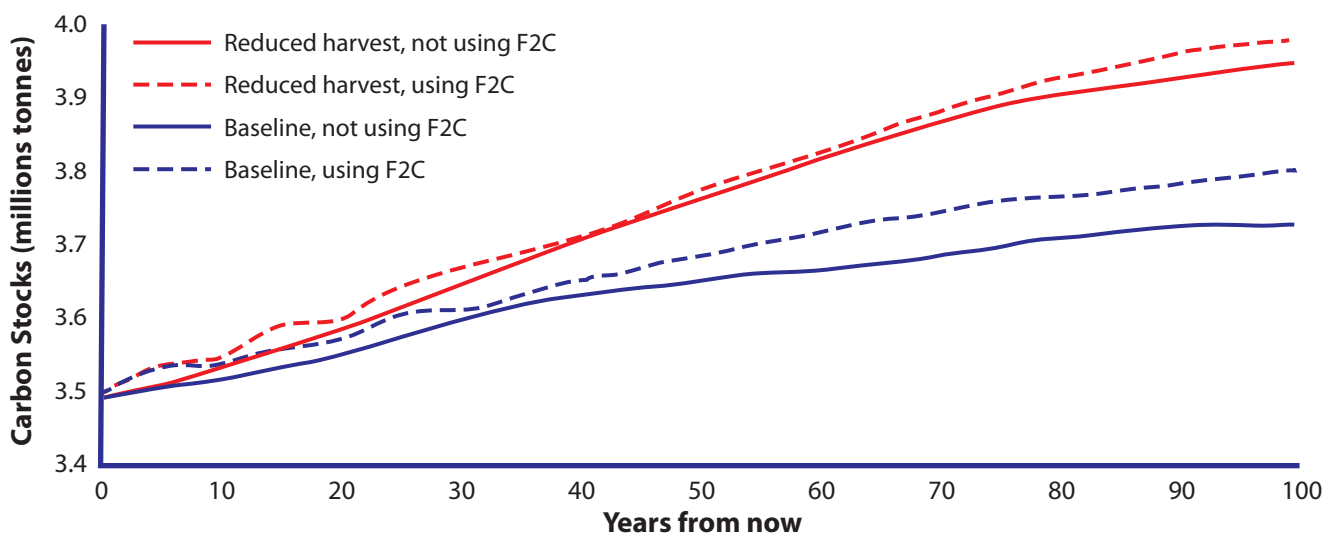
For the past 4 years, the University of British Columbia has been mandated under the Greenhouse Gas Reduction Targets Act to be carbon neutral. While meeting the international targets established by the Kyoto Protocol for its core academic buildings and adopting an aggressive climate action plan to reduce emissions entirely by 2050, UBC still has to buy carbon credits from the Pacific Carbon Trust until emissions are reduced entirely. Forest-based carbon projects are recognized by the BC government as potential generators of high quality carbon offsets. This means that our Alex Fraser and Malcolm Knapp Research Forests have the potential to participate in UBC's Climate Action Plan through appropriate forest management strategies that will facilitate the capture and storage of additional carbon. Two models have been used to analyze this potential. FPS-ATLAS, a spatially explicit forest planning model has been used to estimate forest age and volume over time, and CBM-CFS3, a spatially referenced stand and landscape level model, has been used to simulate carbon dynamics in a forest ecosystem. One challenge in using these separate models is that many scenarios need to be run and this requires an efficient means for the transfer of FPS-ATLAS results to CBM-CFS3. Cosmin Man, as part of his doctoral studies in forest planning (with Dr Kevin Lyons), has developed a tool that consists of a series of tables and queries that are linked to a macro that facilitates one-click generation of CBM-CFS3 friendly import tables. The utility tool has been named F2C which stands for FPS to CBM. The latest version (F2C v2.0) was released in August 2012.

The F2C tool has a fully-customizable design to provide flexibility for the user. Developed as an MS Access 2000 file compatible with the CBM-CFS3 requirements, it consists of 11 tables containing stand types, transition rules, growth and yield curves, and harvesting schedule information. These tables are linked by 18 queries to generate the 7 tables needed to create a project under the CBM-CFS3 interface. The F2C utility tool has undergone extensive

testing since its first release. One of these tests was a comparison of the carbon stocks estimates, with and without using the F2C tool, for a very complex forest estate. For this test, the inventory of UBC's Alex Fraser Research Forest was adapted to incorporate a combination of even aged and uneven aged silviculture systems addressing a complex suite of visual quality, wildlife habitat, research, timber, and carbon objectives. The 9,812 ha forest was organized into 8,670 spatially explicit polygons grouped into 213 stand types that characterize the central interior forest region. Two scenarios were considered; (1) the baseline, and (2) a 50% harvest reduction below the baseline level. The comparison of the carbon stocks estimates with and without the F2C tool shows differences up to 74,000 tonnes for the total ecosystem carbon stocks (see graph) which can lead to significant differences in the annual carbon credits flow. These differences are caused mainly by the mismatch between the timing of the disturbance schedule and the shape of the carbon curves used by FPS-ATLAS. F2C facilitates the transfer of the disturbance schedule into CBM-CFS3 and eliminates the timing errors. Therefore, using the F2C tool provides more accurate estimates of the ecosystem's carbon stocks which allow more accurate estimates of the carbon credits flow.

Cosmin is currently using the F2C tool to analyze the potential of both of UBC's research forests to offset UBC's emissions. The research forests are actively managed for a complex suite of objectives, and Cosmin is analyzing the potential of a range of scenarios to produce carbon credits while conducting a sensitivity analysis for a range of financial and forest management variables. Also, the F2C tool is being used by undergraduate students in a sustainable forest management course and by graduate students enrolled in the Master of Sustainable Forest Management at UBC.

For further information, or for a set of YouTube videos describing the use of F2C, contact Cosmin Man at cosmin.man@alumni.ubc.ca.



Improving our forests one gene at a time

The iconic forests of British Columbia are world-renowned for their lush green landscapes, rich diversity, and home to one of the few remaining temperate rainforests on the planet. The forests are deeply rooted in the lives of British Columbians, founding many rural towns, driving a \$4 billion pulp and paper industry, and thriving as the world's greatest supplier of softwood lumber.

However, the forests of BC are not immune to disease, pests or natural disasters. Indeed all of these factors exist naturally and have occurred periodically for millions of years. The trouble is that with an ever-changing climate and environment these conditions are being seen more and more frequently. Moreover, as the world continues to become increasingly dependent on the natural and renewable resources provided by our trees, we need to reflect on our current forest management regimes and evaluate which approaches can be improved.

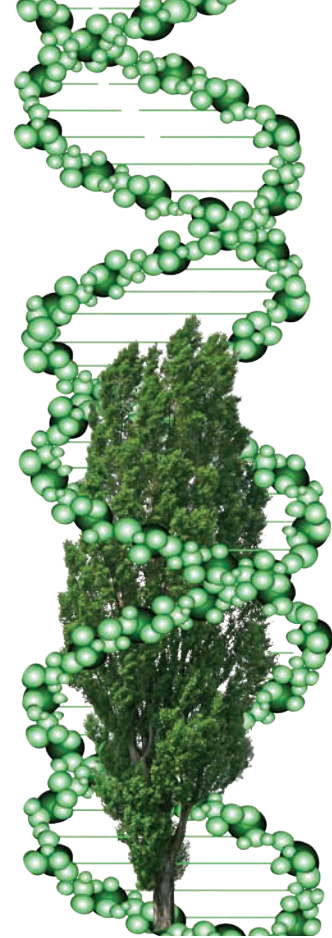
Although the field of biotechnology has been around for thousands of years, there has been considerable development in this area over the past century. Biotechnology is defined as the use of biological systems, organisms or processes as a means for improving technologies or creating products. Modern biotechnology has transformed our world and improved the lives of humans in countless ways, including medical therapies, vaccinations, medication, fermentation, growth and yield in agriculture, biofuels and household products. Over the past 20 years or so, there has been significant interest in an innovative type of biotechnology called marker-assisted selection (MAS) and, more recently, its potential use in forest management.

MAS is an information tool that allows desired traits to be flagged on the genome. Often referred to as 'Smart Breeding,' MAS identifies whether specific traits are present in the DNA. This is an innovative approach to conventional tree breeding which traditionally selects for phenotypic characteristic, such as growth rates and leaf colour. The ability to identify genotypic characteristics, such as disease and drought resistance, without using the manipulative approaches taken in genetic engineering, has allowed MAS to present as an interesting alternative in tree breeding.

The greatest advantage of using MAS is that this approach will save time. Normally breeders need to wait decades before being able to determine if a wanted trait has been expressed. MAS could foster a new era in forest management by allowing for early detection of genotypes, and the potential for assuring a seedling has multiple desired genes, while maintaining natural offspring inheritance.

The mountain pine beetle has been devastating the forests of British Columbia for the past 15 years. It can be argued that it would be best to restock the impacted regions with seedlings that are stronger, healthier, and more sustainable; all characteristics that could be identified with the assistance of MAS.

Chelsea Nilausen is an MSc student working with Dr Gary Bull (Department of Forest Resources Management, UBC) on a partnered project with the Université Laval, Québec. Chelsea's work falls under the larger GE3LS (genomics and its ethical, economic, environmental, legal and social aspects) project, funded by Genome Canada. She will be focusing on the potential

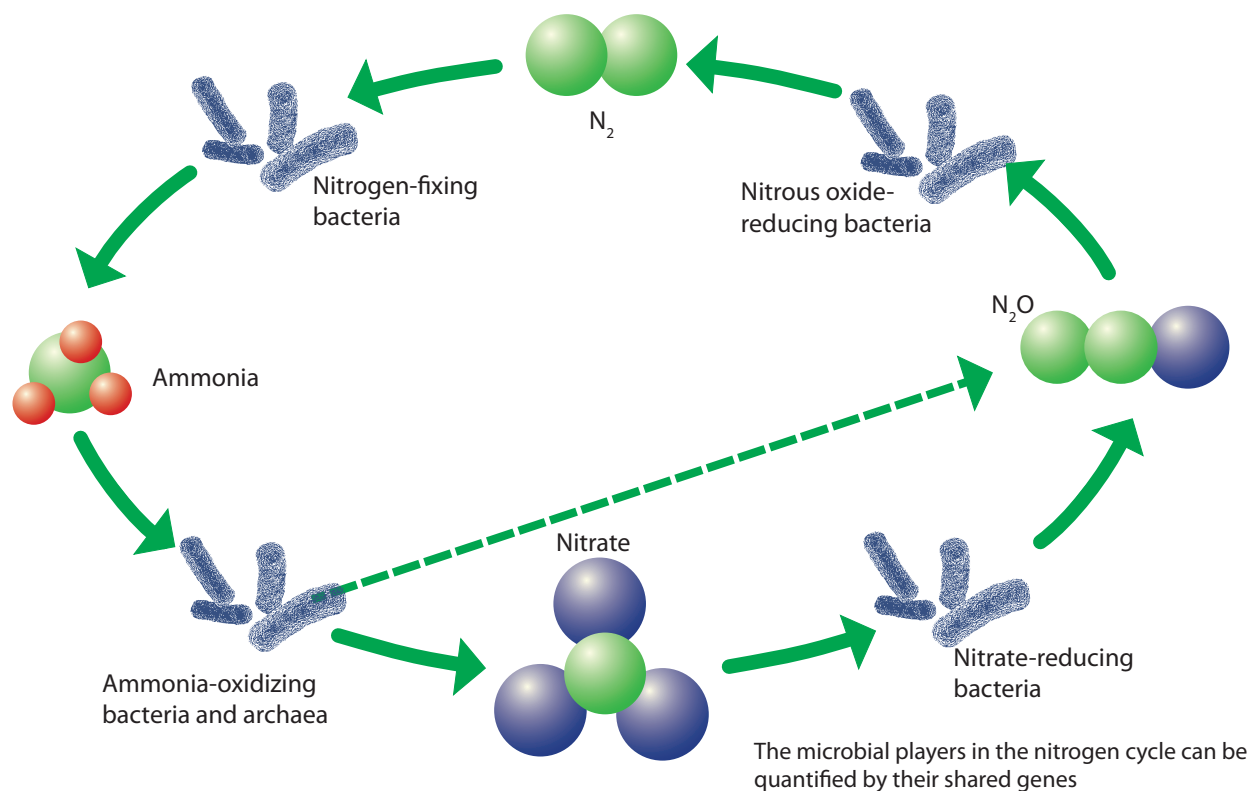


use of MAS in British Columbia and plans to survey stakeholders with a vested interest in silviculture. Chelsea will determine the perception of innovative biotechnological tools, such as MAS, and whether or not that perception is contingent on the context of implementation.

Chelsea will use both qualitative and quantitative research methods to achieve her objectives. She will investigate the perceived costs, benefits and hurdles of using MAS by interviewing stakeholder groups, such as forest industry silviculturists, municipal and provincial government representatives, environmental groups and First Nations. As part of her survey, she will be informing participants about the advancements, successes and potential benefits of using this tool. In her final analysis, Chelsea hopes that her study will reflect opinions most relevant to forest management, and will reveal the future of marker-assisted selection as a new era for forestry in British Columbia.

Chelsea Nilausen will be conducting interviews with her stakeholder groups this summer. For further information about this research project, contact Chelsea at chelseanilausen@gmail.com.

Microbial ecology in regenerating forests



Climate change and the timber supply

Over 18-million hectares of lodgepole pines have died in the heart of British Columbia, the result of a massive beetle infestation that was likely spurred on by global climate change. This large-scale disturbance unleashed a host of challenges for communities and forest managers, with repercussions including gaps in the mid-term timber supply and intensified focus on the role that Canada's forests play in a changing climate. A key challenge for the Province of BC is to develop strategies for regenerating forests while minimizing environmental impacts including climate change.

To ensure timely closure of the timber supply gap, the BC government has proposed widespread tree planting in areas hard hit by the mountain pine beetle, and application of nitrogen fertilizer to regenerating forests. In 2011, over 10,000 hectares of trees were planted and 24,000 hectares were fertilized in accordance with this plan. Fertilization can assist in the regeneration of sites that have economically viable trees, but have poor productivity due to nitrogen limitations and high soil moisture. Lowering the water table, by digging drainage ditches or creating soil mounds in which to plant, can improve regeneration in these areas. Expanding silvicultural operations would benefit the economy of the province.

In addition to the economic incentives to manage wet and waterlogged forest stands, the environmental

impacts must be considered. For example, fertilization has been shown to suppress soil microbiological activity. Although reduced microbial activity may at first appear to be deleterious, it can also increase soil carbon sequestration by reducing the rate at which organic material decomposes. Another concern is that the nitrogen in the fertilizer can be converted into the potent greenhouse gas nitrous oxide (N_2O), which has a global warming potential 300 times that of CO_2 . All of these potential effects of fertilization depend on how the soil microbial community reacts to it, though evidence of microbial responses is often conflicting.

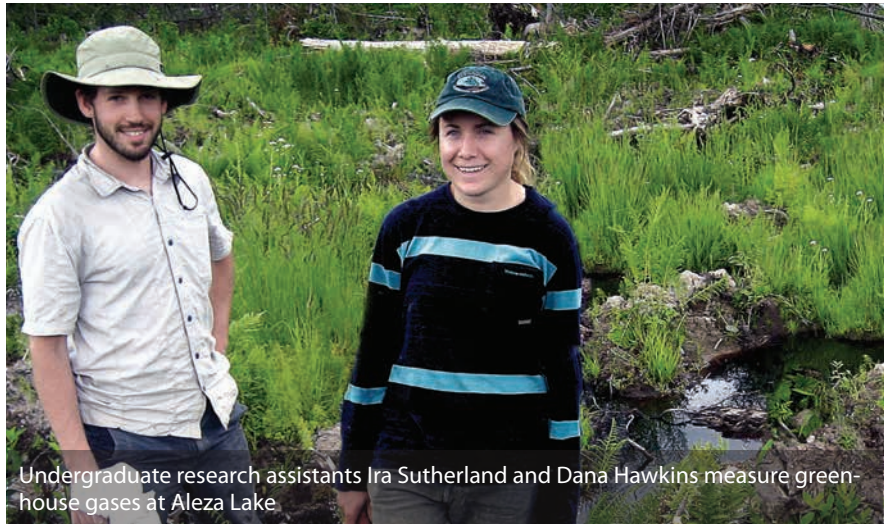
These complex, intertwined issues are being addressed in new research by PhD candidate David Levy-Booth and supervisor Dr Sue Grayston in the Faculty of Forestry. The project, entitled *Microbial groups involved in greenhouse gas fluxes following fertilization and mounding of low-productivity forest soils*, focuses on mitigating greenhouse-gas emissions from regenerating stands on waterlogged sites that are being managed through mounding, drainage and fertilization. In order to address these issues, fundamental research is required to understand how forest ecosystems work, particularly the vast, unseen and diverse communities of soil microorganisms that drive ecosystem functioning.

Breaking open the black box

On television programs, such as HBO's *The Wire*, police detectives painstakingly elucidate criminal

associations by linking together grainy surveillance photos pinned to a cork board. In soil microbial ecology the goal is also to determine relationships: between soil physico-chemical factors, microorganisms and ecosystem services. The tools are different, but microbial ecologists are also detectives attempting to crack open the so-called 'black box' of soil communities. Until the turn of the millennium, many ecologists considered the characteristics of the microbial community in soil to be a 'black box' – either too complex to meaningfully study, or inconsequential to ecosystem functioning due to functional redundancy. However, since the widespread adoption of molecular tools, researchers have been piecing together the complex relationships between genes, organisms and ecosystems that drive the functioning of our forests.

By 2013 researchers in the Faculty of Forestry's Belowground Ecology Group had collected enough soil and gas samples to begin to figure out how the microbial community would respond to the use of fertilization and site drainage. We have found that fertilization increased N_2O emissions at least two-fold. Drainage ditches and depressions created by mounding were hot spots for N_2O emissions. These areas also created an anaerobic environment that suppressed the bacteria in the soil, leading to a reduction of CO_2 emissions. We have also linked



Undergraduate research assistants Ira Sutherland and Dana Hawkins measure greenhouse gases at Aleza Lake

these greenhouse gas emissions to specific groups of microorganisms in the soil.

Modeling microbes - single genes or communities?

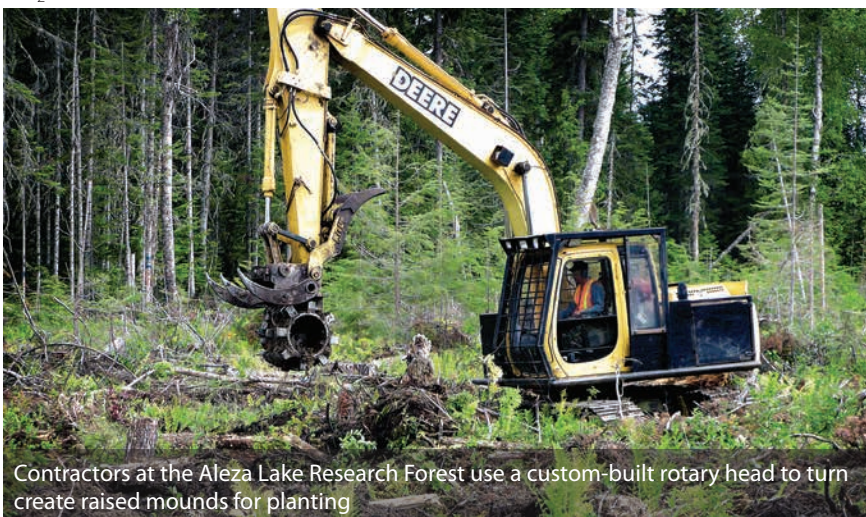
Links between soil microbial communities and greenhouse-gas emissions can be used to develop frameworks for understanding ecosystem function. For example, CO_2 emissions were linked to the abundance of a bacterial marker gene called 16S, a component of the ribosome that can be used to study taxonomic diversity. But N_2O emissions did not correlate directly with any of the genes quantified in the study. This could have been a roadblock to being able to improve the ability of researchers to predict N_2O fluxes. But knowledge of the genetic pathways in the nitrogen cycle helped create a model that would link the relationships between the quantified genes to ecological function instead of only using a single marker.

N_2O production can be performed by several different microbial groups including those that oxidize ammonia, and those that respire using nitrates when oxygen is limited. Nitrous oxide itself can also be used for respiration, converting it to inert nitrogen gas. We found that the best metric to predict N_2O emissions was to calculate the difference between the genes that add N_2O to the atmosphere and those that remove it. We were able to develop a structural model that exposed how each gene in the nitrogen cycling pathway influenced each other and the N_2O flux.

The case isn't closed

It is unclear what the long-term effects of fertilization and site drainage will be. In the short term, the release of N_2O after fertilization will add to the greenhouse effect. But as the study continues, we will be looking for signs that emissions slow. Additionally, the soil is expected to sequester more carbon as organic material is incorporated, balancing the effect of the N_2O released into the atmosphere. The vast underground network of microorganisms still contain many secrets, but like good detectives, the microbial ecologists in the Belowground Ecology Group are patiently mapping out the major players in the game and their relationships to each other.

David Levy-Booth is a PhD candidate in the Department of Forest & Conservation Sciences. He can be reached at dlevybooth@gmail.com.



Contractors at the Aleza Lake Research Forest use a custom-built rotary head to turn create raised mounds for planting

High mountain lifestyles: The secrets of alpine birds



Male horned lark erects his 'feather' horns to defend his alpine territory

Photo: Meagan Grabowski (BSc, UBC)

In mountain habitats, temperatures approach freezing almost nightly and it can snow or hail on any summer day. In such conditions, humans need a winter-rated sleeping bag for a comfortable rest, but small 20 to 40 g songbirds are able to survive and maintain their eggs at almost 40°C (the body temperature of birds) sitting on their ground nests above the permafrost for about 19 hours/day. At low elevation, birds start breeding in March and produce 3 to 4 broods of young annually. However, the same species in alpine habitats, faced with the constraints of cold temperatures and prolonged snow pack, may not start nesting until June and thus only have time to produce 1 brood per year. Little is known about how songbirds achieve their high elevation lifestyles, yet over 90 bird species in the Pacific Northwest, and many mammals, amphibians and reptiles, live and breed successfully in the often inhospitable mountain habitats.

Professor Kathy Martin (Department of Forest and Conservation Sciences) and her students conduct research aimed at understanding avian alpine ecology and conser-

vation. She began this research by asking whether mountain birds were inferior individuals unable to compete for a more benign territory at lower elevation, or whether these birds live life differently in mountains to compensate for the rigorous conditions. Her research on common songbirds such as Horned Larks, Dark-eyed Juncos and Savannah Sparrows in western Canada has revealed some secrets to alpine living. Alpine summer is very short; birds in the alpine have 55% less time to breed compared to the same species at lower elevations. High elevation songbirds are larger and heavier and have up to 20% higher annual survival than their low elevation counterparts. Kathy Martin has found that most birds living in alpine habitats are not inferior individuals; rather mountain birds adopt a slower lifestyle where they produce fewer offspring each year compared to birds at low elevations, but live longer and thus have more years to breed and replace themselves. Some songbirds thrive in the alpine. Alaine Camfield (PhD, UBC Forestry) and Michaela Martin (BSc, UBC Forestry) found that Hudson Bay Mountain in Smithers sup-

ports stable populations of Horned Larks and Savannah Sparrows while at low elevations in North America, populations are declining due to habitat loss and degradation.

Behavioural adaptations of birds enable them to live successfully in the alpine. Incubating Horned Larks adjust their time on the nest to keep their eggs warm with a pattern of sitting on their eggs for about 25 minutes and then taking a 10 minute recess off the nest to feed during the daytime hours. Over night when temperatures are usually close to freezing, they spend 90-95% of their time incubating. Beth MacDonald (MSc, UBC Forestry) found that during particularly cold or stormy conditions, larks may leave the nest for periods of 1 hour or longer (up to 6 hours). These long breaks from incubation probably are important to maintain the parents' body condition during difficult times, but may come with a survival cost to their offspring; as 10% fewer eggs hatched during a year when colder daytime temperatures resulted in the parents taking more long recesses. We need a better understanding of the thermal tolerance of developing embryos

to appreciate the consequences for songbirds when conditions worsen in the alpine due to climate change. However, it is clear that avian embryos are more cold tolerant than previously thought.

It is not only cold but dangerous to nest on the ground. Predators such as foxes, coyotes, weasels, and ravens readily prey on eggs and young anytime during incubation or the nestling period, so alpine birds must try to evade detection for several weeks. However, if predators detect them, birds must act quickly to squeeze in a replacement nest in the compressed breeding season in order to produce any offspring in a breeding season. To reduce the possibility of predators getting too successful at finding their nests, songbirds diversify their nesting ecology to co-exist. Despite the structurally simple alpine habitats, Sparrows, Larks and Pipits choose nest sites with varying amounts and types of ground cover. They also initiate breeding at different times, with the larks starting nearly 2 weeks earlier than the other two species. Horned Larks are amazingly hardy songbirds; they can start building nests when 95% of the ground is still snow-covered. This early start sometimes means they have to incubate through 1 or more snowstorms, but an early start may enable them to produce 2 broods



Hungry horned lark nestlings have brightly coloured mouths to beg their parents for food

Photo: Kathy Martin

in one summer.

You might wonder why birds choose to live in such rigorous conditions when they appear to have options at lower elevations. We do not know the full answer, but alpine habitats supply plenty of food for breeding, enough to compensate for the low temperatures. In coastal mountains, mosquitoes and other hardy insects provide an abundant feast for songbirds. Nest predation rates, although variable, are generally lower in the mountains.

Many secrets about how birds adopt their slow lifestyle to adjust to life at high elevation have yet to be revealed. For most species breeding across elevations, we do not know whether the alpine supports stable populations. Do birds breeding in the mountains differ genetically from their low elevation counterparts, or simply

switch to a slow lifestyle if they find themselves at high elevation? We know some birds can adjust their physiology or biochemistry to avoid severe stress responses to low oxygen levels or to extreme weather events that result in certain failure for birds breeding at low elevation. Jennifer Greenwood (current PhD student) is investigating physiological coping mechanisms such as oxidative stress for mountain songbirds breeding near Revelstoke, BC.

Kathy Martin's research has application to the conservation and management of birds. Some alpine populations may differ genetically, and thus may represent new subspecies or new species. Mountains may represent critical refuge habitats for some open country species, such as Horned Larks, that are showing rapid population declines at low elevations across North America. Since alpine habitats are experiencing globally significant warming, it is critical to determine the vulnerability of alpine birds to climate change. With a slow life style, birds breeding in mountains may be reasonably well buffered against extreme weather events that cause breeding failure every few years, but the impacts could be catastrophic if climate change reduces their survival.

Kathy Martin can be reached at kathy.martin@ubc.ca or kathy.martin@ec.gc.ca. Information on alpine birds is available at the Centre for Alpine Studies website: <http://alpine.forestry.ubc.ca/>.



Alana Clason (BSc, UBC) working as a field assistant and coping with clouds of hungry mosquitoes on Hudson Bay Mountain, Smithers, British Columbia

Photo: Matthew J Tomlinson (MSc, UBC Forestry)

Effects of predators on freshwater CO₂ emissions



Lake in Yukon

The Earth is currently experiencing its sixth mass species extinction, and like those before it, predators are amongst the most vulnerable of species to be lost due to small populations, low reproductive rates, and large home ranges. Climate change, overharvesting, and land-use change have resulted in the loss and global homogenization of predators from nearly every ecosystem. Predators play a vital, and potentially irreplaceable, role in how ecosystem communities are structured and the functions and services those ecosystems provide. The removal or introduction of a non-native predator can create an ecological phenomenon called a “trophic cascade”. Strong trophic cascades can have striking influences on the abundance of plants at the base of the food web. As plants are a major sink for the greenhouse gas CO₂, the indirect effect of predators on plant abundance has wide ranging consequences for greenhouse gas-induced climate change. However, we know very little about the potential effects that predator loss or the introduction of non-native predators will have on the CO₂-storage capabilities of ecosystems.

Freshwater ecosystems represent a large, natural source of CO₂ gas to the atmosphere, emitting a similar amount of CO₂ gas (1.65 Pg C yr⁻¹) as emissions from

land-use change. Within freshwater ecosystems, a bulk of the carbon is stored in algae or dead leaf matter that has fallen into the water from the surrounding forest. When aquatic animals or microbes consume this plant matter, they release large amounts of CO₂ gas into the water; when concentrations of CO₂ in the water become too great the ecosystem releases CO₂ into the atmosphere. Ecological theory predicts that freshwater predators may be able to control the amount of CO₂ that is created within freshwater ecosystems by either directly or indirectly influencing the population sizes of the organisms that consume algae or leaf litter.

The ability to predict future atmospheric CO₂ concentrations is limited by large knowledge gaps in our understanding of local carbon cycling within many ecosystems, and the biological and physiochemical processes that control them. Thus, an understanding of the influence predators play in CO₂ dynamics of freshwater ecosystems and the effects their extinction will have on CO₂ cycling is important for making future predictions about atmospheric CO₂ concentrations and global climate change. Doctoral candidate Trisha Atwood and Professor John Richardson from the Department of Forest and Conservation Sciences, in collaboration with

researchers from UBC's Biodiversity Research Centre and the University of California have just completed a series of studies on the effects of predators on the exchange of CO₂ between freshwater ecosystems and the atmosphere. The studies experimentally tested the effects of predators on CO₂ dynamics of freshwater ecosystems to better understand the consequences that losing these animals may have on greenhouse gas dynamics and global climate change.

In March of 2013 Trisha and colleagues published the first of their results in the journal *Nature Geoscience*. They investigated the effect predator loss would have on community structure and CO₂ dynamics of 3 distinct freshwater ecosystems (ponds, bromeliads, and streams). The team manipulated the presence or absence of predacious fish, damselfly larva or stonefly larva predators, and then monitored CO₂ fluxes along with prey and primary producer biomass within the 3 ecosystem types. Ecosystems where predators were present had substantially lower carbon dioxide emissions compared to ecosystems where predators were absent. These results showed a surprising consistency in the effect of predators among all 3 ecosystem types, despite differences in predator type, hydrology, climatic region, ecological zone and level of in situ

primary production. This study demonstrated the general ability of predators to markedly influence carbon dioxide dynamics of freshwater systems.

Following the results of the *Nature Geoscience* study, Trisha and her colleagues tested the role of additional processes on the effects of predators on CO₂ cycling of freshwater ecosystem. In the first of these studies, they found that stream ecosystems were unable to compensate for the role that a lost top predator played in community structure and CO₂ cycling, but the ecosystem was able to compensate for the loss of a dominant grazer or detritivore species. Results from this study suggest that some predator species play a unique and irreplaceable role in the way their ecosystems function and that the loss of these species can have permanent implications on the CO₂ cycling of those ecosystems. In a second study, the team demonstrated the important influence interactions amongst predators (eg, competition and facilitation) have on the overall effect of predators on CO₂ dynamics. Results from this experiment showed that competition among predator species for prey and space can decrease the overall effect of predators on CO₂ dynamics of freshwater ecosystems. This study not only showed the importance of including more complex commu-



Predatory damselfly larvae live in bromeliads

nity compositions in experiments on the effects of predators on CO₂ dynamics, but also suggests that changes to the composition of natural communities through species invasions are likely to change the magnitude of predator effects on CO₂ dynamics. Finally, in their third experiment the team demonstrated the effects that a warming climate and eutrophication will have on the magnitude of effects of predators on community structure and CO₂ dynamics of freshwater ecosystems. The results of this study show that a 3° C increase in water temperature reduced the effects of predators on their prey leading to greater CO₂ emissions from freshwater ecosystems. Conversely, results showed that eutrophication enhanced predator effects on CO₂ dynamics, leading to decreased CO₂ emissions.

Global climate change is a complicated process, and scientists are just starting to put the puzzle together on how our actions are influencing it. Our role in the global decline of predators, and their impact on carbon dioxide dynamics is just one piece of that puzzle. These studies provide the first experimental evidence that alterations to predator abundance, in conjunction with global warming and eutrophication, has the potential to irreversibly alter the role freshwater ecosystems play in future regional and global carbon cycles.

For further information contact Trisha Atwood at tatwood16@gmail.com.



Inside the water filled wells of bromeliads lives an abundant aquatic community

development & alumni news

Serving up learning at Loon Lake: Peter Bentley makes largest-ever gift to Forestry

Imagine you're a kid who has cancer. One of the great joys of your summer is attending Camp Goodtimes at Loon Lake. You get to explore the forest, swim in the lake, and hang out with other kids who are going through the same things you are. You've got bunk beds, scary campfire stories; the whole thing.

Except for a place to eat. There are 130 kids and counsellors in your group, and the dining hall only fits 90. At every meal you have about a 1-in-3 chance of eating outside, rain or shine.

Or imagine you're a Forestry student, staying at Loon Lake for your field school. You are working hard in the forest every day, and mealtime is refueling time. But a burst water line in the dining hall means that dinner tonight consists of anything that doesn't need to be washed or cooked.

The dining hall at the Loon Lake Research and Education Centre has seen better days. Built in 1974, it was originally intended to serve only field school students. Today, between 70,000 and 80,000 meals are served each year to young campers, community group members and corporate teams. This isn't a place you can just close for renovations.

Thanks to a \$1 million gift from Peter Bentley, the Loon Lake Dining Hall will be replaced by 2015.

Now retired from a successful career at the helm of Canfor Corporation, Peter Bentley is a longtime friend of UBC. He was active in the World of Opportunity campaign in the early 1990s, and has served on the Faculty of Forestry's advisory council and the Sauder School of Business' advisory board. In 2003 Peter provided support for UBC

Robson Square, helping ensure that UBC had a presence in the heart of downtown Vancouver.

"I was so impressed with the facilities at Loon Lake; it reminded me of my young days out in the woods," Peter says. "But when we went to lunch in the dining hall I saw a few holes." He adds, with his customary understatement, "I wanted to do something for UBC and I thought this would be useful."

Peter's gift to the Faculty is the largest philanthropic investment from an individual it has ever received. In recognition of this, the new dining hall will be named the Bentley Family Hall.

"I'm glad to be in a position to help," he says. "I'm an alumnus and so is my wife, and 3 of my 5 children are alumni too. UBC is a great university!"

Replacing the dining hall is a



multi-step process. First, the old Staff House will be demolished to make room for the new hall. Then the dining hall will be built, and once it's up and running the old hall will be thoroughly renovated and turned into accommodation to replace the Staff House.

"We're cutting Douglas-fir timbers for the new dining hall right now," says Paul Lawson, Manager of the Malcolm Knapp Research Forest. "We have built a new drying shed and the timbers should be ready in a year. Then in the summer of 2014 we will start building the new hall as a dovetail notched timber frame. It should be ready to use in 2015."

The dining hall project is the final stage of Loon Lake's redevelopment, which began just under a decade ago. Forestry alumni have been loyal in their support of Loon Lake through the annual alumni appeal, enabling many improvements to the facilities and equipment.

The Faculty of Forestry is deeply grateful to Peter Bentley and the Bentley family for their foresight and generosity. However despite



Peter Bentley's generous gift, funds are still needed to ensure this multi-step project is completed. The entire cost of the project is \$3 million, and we have raised \$2 million to date.

The new dining hall will enable Loon Lake to thrive for the benefit

of future generations of students, researchers, children, educators and community organizations.

To learn more about how you can get involved in this project, please contact Emma Tully, phone 604.822.8716 or email emma.tully@ubc.ca.



HALCO supports operations research in the Faculty



HALCO Software Systems Ltd, founded in 1988, celebrates its Silver Jubilee this year! To recognize this milestone, and in honour of their founder, Howard Arthur Leach, HALCO recently established a \$5,000 annual scholarship in the Faculty of Forestry. The **Howard A Leach Scholarship in Operations Research** will be awarded to undergraduate students in the Wood Products Processing program, who have a demonstrated interest in the field of Operations Research.

Mr Howard A Leach graduated from the University of Cambridge, England with first class honors in Mechanical Sciences in 1953 and Chemical Engineering in 1955. He began to develop his computer programming and optimization skills working for IBM and other companies in England. Mr Leach has always been interested in linear program modeling and began applying his programming skills to the North American forest industry in 1968. In 1970, he developed the SAWSIM® program – a very flexible computer program that can accurately model the processing of logs in any sawmill. (SAWSIM® is widely recognized as the industry standard sawmill simulation program the world over, and has been continuously updated ever since to reflect

changes in technology and operating practices in the industry). Howard continued to follow his passion by founding his own company H A Leach and Company Ltd. in 1970, which later became HALCO Software Systems Ltd. in 1988.

In celebration of the company's 25 years in business and Howard's 80th birthday, HALCO Software Systems Ltd established an award to support students who would carry forward Howard's legacy – students who are capable and interested in applying operations research in the forestry / solid wood sector. Covering the full costs of tuition, the Howard A Leach Scholarship in Operations Research is one of the most prestigious and highly coveted scholarships available to an undergraduate student in the Faculty of Forestry.

Brad Turner, Principal and Senior Consultant at HALCO says "While our primary motivation for setting up the Howard A Leach Scholarship in Operations Research was to recognize the contribution made by Howard Leach to the forest industry, we are also motivated by the increasing need for operations research and optimization skills in the industry. The wood products business is becoming more complex all the time, with new products, processing technologies, and market structures. Going forward, for both individual companies and the industry as a whole to remain competitive, there will be an increasing need for people with both a solid understanding of the wood products industry, and operations research and optimization skills".

The Faculty of Forestry is extremely grateful to HALCO for supporting student learning as a way to honour their founder; celebrate 25 years in operation; and encourage the forest leaders of tomorrow.

Support like this is vital to the success of the Faculty and ensures that students are able to fully focus on their studies by easing the financial burdens of higher education.

If you are interested in learning more about how to support a student, please contact Deepti Mathew Iype, deepti.mathewiype@ubc.ca or phone 604.822.0898 for more information.

...we are also motivated (to establish this scholarship) by the increasing need for operations research and optimization skills in the industry... "

Alumni in action

One of the common questions raised by alumni is “What happened to my classmates after graduation”? Our students wonder “What can I do with my degree?” To answer both of these questions, this column features stories from our alumni, highlighting the various career paths our graduates have followed.

Rob Friberg, a UBC Forestry alumni from the class of 1990, knew that he wanted to make an impact supporting sustainable forestry from a young age. Looking at what he has accomplished so far, he is most proud of the forest plans and projects he has been a part of, from here in British Columbia, to Chile and the Congo.

His story began on rural Vancouver Island where he grew up on the family’s woodlot, enjoying outdoor activities and spending his weekends skidding Douglas-fir logs and running them through a portable saw mill with his dad. His childhood experiences, along with the realization of the importance of BC’s forest resources and wanting to influence their sustainable management, led Rob to pursue a degree in Forest Resource Management at UBC’s Faculty of Forestry.

Rob’s fondest memories of the Faculty are of 2 of his professors – Dr Hamish Kimmins and Dr John Worrall. Dr Kimmins’ ecology class and Dr Worrall’s field excursions were memorable because the professors made a point of being interested in their students and connecting with them. Dr Worrall’s field excursions also gave students the chance to connect in a forest environment.

After graduation, Rob’s next step was to explore some of the world’s forests, so after an 8-month position with Weyerhaeuser he traveled to Kenya and Uganda visiting agro-forestry and forest ecosystem restoration projects with a fellow UBC student. From there he traveled to Sweden, Denmark and England to gain a wider perspective by observing the different international forest practices. Many of the people he visited while traveling were made through his time at UBC, either fellow students that had been employed abroad or exchange students. Rob believes that “it is important for students to take advantage of the opportunity UBC provides to build networks with fellow students. That way there will be friendly faces to meet them along life’s journeys”.

After returning to Canada and working for Weyerhaeuser in Okanagan Falls for 15 years, Rob found travel calling him again. He made one of his most difficult career decisions – leaving a secure job with people he liked working with, to do something that seemed much less secure and familiar. That decision was to volunteer with CUSO International in Chile, who were partnered with the Chilean Ministry of Forests and International Model Forest Network, the latter is based in Ottawa.



His role was to support community based sustainable forestry initiatives.

This experience led Rob to start consulting and in 2009, after 2.5 years in Chile he founded a consulting firm, New Forests Outlook Ltd, with the Canadian International Development Agency as his very first client. Since 2009 he has worked on a wide variety of contracts for different organizations including Natural Resources Canada, and through CIDA supported the model forest strategic planning process in Cuba. Currently, he is working on sustainable forest management and conservation projects funded through the forest carbon markets with 2 focus areas: BC coastal communities and the Democratic Republic of Congo. Rob’s role has been to support project design, quantification of carbon sequestered through forest conservation measures, and ensure projects result in positive benefits for climate mitigation, for local communities and for biodiversity.

Rob is very happy with the career forestry has given him. When asked if he has ever thought of what other jobs he could have chosen, he believes he’s “hit it pretty well with forestry”! The only other careers he could see himself doing would have been a forest ecologist or a part time bush pilot, the latter mostly for the excitement and the chance to explore many remote BC locations. In terms of where he sees himself heading, he believes in the importance of “effective evaluation of the social and environmental impacts of policies and programs, and their continual improvement through adaptive management. I’d like to be making an impact in this area,

Continued on back page.

Birders' legacy supports forest conservation research

Richard Schuster came to Vancouver in 2009 with a Master's degree in zoology from his native Austria, following his heart and looking for interesting work. Richard soon found a position as research assistant to Dr Peter Arcese, FRBC Chair of Conservation Biology, who valued Richard's computer science and field skills. Dr Arcese put him to work on Mardart Island, in the Southern Gulf Islands of BC, where Werner and Hildegard Hesse were first exposed to field research in the 1950s. The Hesse's annual contributions in support of Peter's research funded Richard's start in BC, and in 2010, helped launch his PhD after he won a Hesse graduate fellowship, made possible by the Hesse's generous gift to UBC aimed at establishing a perennial fund in favour of graduate and undergraduate research on the conservation of wild birds.

Richard now focuses his work on conservation in the Coastal Douglas-fir (CDF) zone, an area encompassing southeastern Vancouver Island, the Gulf Islands and mainland fringe on the Georgia Strait, and recognized as the most imperiled ecosystems in western



“I think that my research is advancing the work that they cared so strongly about and the passion they had for birds.”

BC. As one of the most desirable places to live in all of Canada, half of the CDF has been converted to human use since 1850, and less

than 3% of its original “old growth” forest remains. As a consequence of habitat conversion, the CDF now supports 117 species at risk and 29 red-listed plant communities.

Restoring CDF habitats to the point that it will continue to support its iconic native species, Arbutus and Oak woodlands, and old growth communities amid a growing human population is highly complex work. At present, Richard is providing state-of-the-art mapping for bird species to predict where investments in conservation and restoration are most likely to

support threatened species and communities in the future.

This fall, Richard will work with world leaders in conservation planning to develop novel solutions to conservation area design in the CDF in 3 ways. First, using 6 years of survey data on birds and specialized planning software, he will use predictive maps of focal bird communities to prioritize habitats for conservation.

“Many bird species rely on mature or old forests in the CDF, including the brown-creeper, Townsend’s warbler and Pacific

wren," he says. "The data that I and others have collected since 2005 are the basis of my research and allow me to create maps that show us where these species prosper."

Second, he is exploring covenant and land purchase agreements as methods of restoring old-growth CDF ecosystems. "I am examining recidivism rates in land-use covenants, to see if outright purchase or covenants represent a more effective long-term conservation strategy" he says.

Third, Richard is examining the role of carbon markets to offset the cost of land conservation by investigating how alternative carbon markets and restoration scenarios can be used to maximize biodiversity conservation.

Richard's research will advance the conservation and restoration of critical wildlife habitat in the CDF by providing planning tools for decision-makers that explicitly compare the costs and benefits of alternative actions using the most up to date and extensive data sets available for the region. By doing so, Richard is also producing a model approach likely to be emulated worldwide.

Richard has received a Hesse Fellowship in 3 consecutive years. "It's the largest part of my research funding, and I'm very grateful for the support," Richard says. "A

lot of funding sources are out of reach for me because Masters students in Europe rarely publish their research and so often have less of a track record on their arrival."

Werner and Hildegard Hesse began their decades-long relationship with UBC in the 1950s, as students in night-school courses on birding. They developed a deep love of birding and ornithological research that included their participation as bird counters in the Canadian Arctic, the compilation of the BC Christmas Bird Count for over 20 years and many forays to Mandarte Island as volunteers. The Hesses both passed away in 2008, but their estate gift has bolstered bird research in the faculties of Forestry and Science, and leaves a lasting legacy to generations of students dedicated to improving prospects for the persistence of native species in BC.

"I am very grateful to be benefitting from the Hesse legacy," Richard says. "I think that my research is advancing the work that they cared so strongly about and the passion they had for birds."

A gift to UBC Forestry in your will can have an enduring impact on teaching, learning and research for decades to come. Please contact Emma Tully, emma.tully@ubc.ca or phone 604.822.8716 for more information.

Even the sun came out to the Alumni and Friends BBQ & Tour

On Thursday, April 25th, over 100 Forestry alumni, friends, faculty, students and staff met at the Malcolm Knapp Research Forest for the annual Alumni and Friends BBQ & Tour at Loon Lake. This year we were happy to see the sun join us for the entire day. We started off with a tour of the research forest with 2 stops: the thinning project to hear from Professor Bruce Larson and the students; and then from PhD candidate Jason Leach on rain-on-snow events and hydrologic impacts on streams and watersheds. Afterwards, we gathered at Koerner Lodge for a reception hosted by Dean John Innes. The group experienced a beautiful traditional greeting by Willie Pierre from the Katzie First Nation, and Dean Innes shared highlights from the Faculty and updates on the fundraising efforts to build the much-needed new dining hall at Loon Lake.

After a feast of steak and prawns, the day was finished off with birthday cake to celebrate Emeritus Professor Gordon Weetman's 80th birthday.

To see a few photos from the event, visit the alumni forestry website at www.getinvolved.forestry.ubc.ca/events/.

Make sure to put next year's date in your calendar – Sunday, April 27th, 2014. Yes, we're having it on the weekend next year, so we hope more of you will be able to join us and bring your families.



George Weyerhaeuser Jr 1954 – 2013

It is with great sadness that we report the death of George Weyerhaeuser Jr. George served as an inaugural member of the Faculty of Forestry's Forestry Advisory Council, and was chair of the Council for the past 18 years. He was appointed to the Council in 1995 while living in Vancouver and serving

as the chief executive officer of Weyerhaeuser Canada. After returning to the US, George continued to support the Faculty and led the Council tirelessly following his retirement from Weyerhaeuser in 2008. We have a lot to thank George for and he will be greatly missed by the forestry community as a whole.

Upcoming events – save the dates

We have some exciting alumni events coming up around BC and we hope you are able to join us. Make sure you mark these dates in your calendar:

- Okanagan Days – July 9th -11th, 2013 – www.alumni.ubc.ca
- Class of 1983 Reunion – Saturday, August 17th, 2013
- Alex Fraser Research Forest Alumni and Friends BBQ and Tour – Tuesday, August 27th, 2013

Alumni in Action – continued from page 17

innovative policy and program planning to ensure sustainable forests and forest communities here and internationally.”

Looking back at his alma mater, he believes that being a UBC alumnus is an important connection to his educational roots and a window for networking with forestry colleagues and expertise at UBC. For current students and new gradu-

- Forestry Alumni and Friends Event in Nelson, BC – Friday, August 30th, 2013

For more information, keep an eye on the monthly Alumni E-Newsletter or contact Janna Kellett by email at janna.kellett@ubc.ca or by phone at 604.827.3082.

ates, he has the following advice:

“Be clear on your personal career purpose. Someone said it well at a recent CIF meeting in Vancouver – try to avoid doing something just because someone else is doing it. Think of the end goal and what you'd like to be doing 30 to 40 years from now”.

Electronic versus paper?

BranchLines is currently mailed to over 4,000 forestry alumni, interested groups and individuals. We also post an electronic version of each issue on our Faculty website www.forestry.ubc.ca/branchlines/.

If you would prefer to stop receiving paper copies we can notify you by email when electronic versions are available online. To change your subscription from paper to electronic notification please send your request to jamie.myers@ubc.ca.

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