Branch Lines

UBC Forestry
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Research that matters – right here, right now

- Is research a luxury or a necessity?
- Does research contribute significantly and meaningfully to the society that supports it?
- Should investing in research be a priority for government and industry in BC?

THESE QUESTIONS ARE particularly relevant during this global economic downturn that has created huge challenges for our provincial economy. In this issue of Branch Lines we present our perspectives on these questions and a selection of examples in support of our position that forest research is a wise investment for the people of BC and that the research we do in the Faculty of Forestry is of immediate benefit to the forests, the economy and the people of BC By developing new products or processes, opening new markets, recommending sustainable management practices, helping communities in transition, or confronting the myriad challenges posed by climate change, the research that we do is making a difference – right here, right now.

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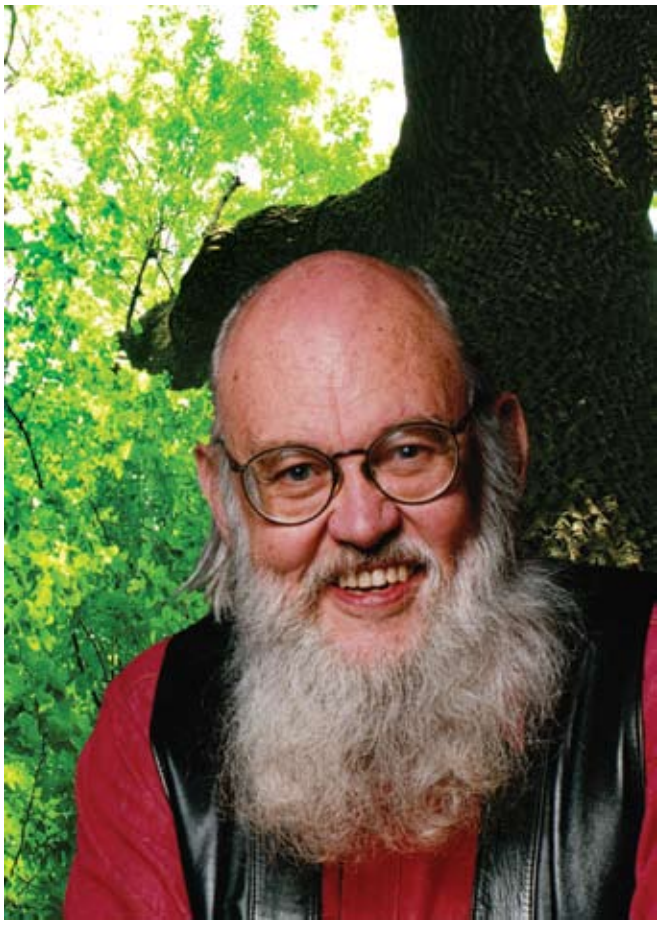
When do you know research is useful?

DR FRED BUNNELL, professor emeritus from the Faculty of Forestry, describes his major research interest as developing strategies and tactics for sustaining biological diversity within forested systems. He has long been interested in developing useful decision-support tools and more recently has focused this interest on assessing impacts of climate change and forest management on biological diversity.



You have to permit professors emeriti their strolls down memory lane – that is where much of their lives now exist. When asked to comment on the value of research to the people and province of British Columbia, comment became reflection and this stroll.

I began my research career unwittingly addicted to the cerebral organism – excited by new discoveries, finding explanatory connections, solving problems. Solving problems was especially fun and I was in the right Faculty; forestry was rampant with problems to solve. It still is. But for almost two decades it was discovery and solution that tugged at me; most of my research could be called curiosity driven and most of my funding was from NSERC. I found it as exciting to figure out how grizzly bears and black-tailed deer solved their problems as how forest practitioners could solve theirs. Parenthood changed the balance and my life became more about being a good ancestor. Curiosity-driven research that finds a solution for an organism attracts funding from pure sources, but increasingly I approached more applied sources, including the province and NSERC cooperative grants.

Gradually I became convinced the following statements are true:

- Collectively we face the two largest threats we ever have faced – climate change and loss of species.

- We must increase our reliance on renewable resources. Trees and forests are wonderful sources of renewable resources (including host to most of the world's terrestrial species) and can yield these resources with a small ecological footprint.

I've also learned that even when you design research to address a specific problem, you cannot foretell when it will become useful. You also cannot foretell where it will be useful – information moves faster than all but light and is soon transplanted.

"Useful' is difficult to define. I used a simple index: if one-third or more of the invitations to speak on the topic came from government agencies or industrial consortia

it was useful, or at least hard to ignore, but definitely more than an enchanting idea. While I may have held the grant for examples below, useful outcomes always were a product of many people.

Our work on soil respiration in the 1970s reveals how difficult it is to foretell useful. Some arctic soil organisms responded linearly to temperature increases, not in the expected non-linear way. At the time I thought this was a handy way for organisms to respond to small increases in temperature in a cold environment. We now know it has huge implications for the current question of if and when warming arctic soils will release vast amounts of methane and ratchet global warming up significantly. The relationship now is incorporated into global climate models.

In the 1990s a large NSERC grant supported the initial work refining variable-retention (VR) harvesting as a means of maintaining the conservation values of harvested forests. Only specifics stayed in British Columbia; underlying relations were moved to four continents. There is rapidly growing recognition we are losing species at a rate dangerous to us, and that VR is part of the solution.

Our more recent work on conservation priorities was supported largely by the Forest Science Program and designed to give the province a cost-effective means of allocating scarce conservation resources in a fashion more likely to ensure success. At first, the underlying concepts were not warmly received and required seven years of workshops before blooming into the Provincial Conservation Framework. NatureServe now recommends the approach to all states, provinces and territories in North America; it is being rapidly transplanted to three, possibly four, continents.

These examples were selected to help draw the following lessons. All lessons are not evident in the brief examples, but all are imbedded in them.

Recognizing useful isn't easy: Soil respiration is a simple example. We repeatedly discover that 'old' research has new meaning because we now understand the context better. The fastest our research was ever translated into legislation or policy was one year, well before it was published. More sits idle (see last point).

Passion counts: And is likely to create deeper understanding than constrained directives. We pursued our work on bears because it was fun. It became good enough to attract diverse outside funding – I never requested funds from the Nordic Council; sound research attracts even applied funding. I want to believe the work helped grizzly bear management in the province; it certainly helped Yellowstone Park and underpins the International Polar Bear Treaty.

But pedestrian isn't bad: A common criticism from less applied researchers is that applied research is pedestrian. That is partly true. Good applied research has to make connections to everyday practice and a portion of that requires straightforward approaches. I've been lucky enough to receive awards for both curiosity-driven and applied research. I am utterly convinced sound applied research is more difficult to do well, even when portions are pedestrian.

Experience counts: Selecting the best connections between research and practice is an art form. It is breadth of experience, not length, and is never just the researcher's experience that counts, but also the practitioner and policy maker. The practitioner inevitably understands parts of the system the researcher does not, and often it is only the policy maker that can reveal handles that will connect research to policy. Good applied research requires more time to reveal the connections that curiosity-driven research can ignore.

Bridges are necessary: And we have lost many. For about the first 15 years of my research career, our research projects often incorporated government personnel on the ground. Gradually, that was reduced to short visits, and finally to meetings in Victoria or regional offices. There was a concomitant trend – it took longer and longer for research to translate into policy. The forest industry still adopts and adapts useful findings quickly, but government policy increasingly lags behind understanding. I believe that the biggest current hindrance to enacting applied research is the lack of government-based resource professionals on the ground.

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Why research matters to the forest systems of BC

DR SUZANNE Simard, professor of forest ecology in the department of Forest Sciences at UBC, presents several examples of "research that matters" from her mycorrhizal ecology research group.

Research, from obsolete French, recerche, and from recercher, to search closely (for truth).

Why does research matter to the forest systems of British Columbia? There are three fundamental reasons. First, uncovering deficits in a system can only be done through research. This requires knowledge and understanding of the system followed by a measurement of the deficit. Second, fixing the deficits can be achieved by applying the results of research with fidelity in making changes to policy and practice. Ideally, this will result in more sustainable use and management of the environment. Third, further research will uncover whether the changes in policy and practice have succeeded or failed at improving environmental conditions. It is through research, or listening to what the Earth has to tell us (Thomas Berry), that society finds better versions of the truth that ultimately help us evolve toward a more sustainable future.

Let us examine the argument that research matters using an example from mycorrhizal research in our interior forests. In the dry interior Douglas-fir forests that grade gently from the lower-elevation ponderosa pine, my graduate students, colleagues Drs Dan Durall and Melanie Jones at UBCO, and I have recently discovered that almost all trees in the uneven-aged stands are linked together belowground by a mycorrhizal network. UBC graduate student Kevin Beiler has uncovered this through the use of new molecular tools that can distinguish the DNA of one fungal individual from another, or of one tree's roots from another. Moreover, he has found that the largest, oldest trees serve as hubs, much like the hub of a spoked wheel, with younger trees establishing within the mycorrhizal network of the old trees. Through careful experimentation, UBC graduate Francois Teste has determined that survival of these establishing trees is greatly enhanced when they are linked into the network of the old trees. Through the use of stable-isotope tracers, he and UBC undergraduate student Amanda Schoonmaker found that this increased survival is associated with belowground transfer of carbon, nitrogen and water. This research provides strong evidence that maintaining forest resilience depends on conserving mycorrhizal links, and that removal of hub trees could unravel the network and compromise regenerative capacity of the forests. This directly challenges historical forest practices, which have traditionally removed hub trees from dry uneven-aged forests for their economic return (which, incidentally, science has also shown are home to cavity nesting birds and mammals). A change in management practices that seeks to conserve old hub trees could make a large difference in the future stability and diversity of these forests as climate changes.

In the wetter, mixed interior Douglas-fir forests, UBC graduate student Brendan Twieg has also discovered, using molecular tools, that Douglas-fir and paper birch trees can be linked together by species-rich mycorrhizal networks. We have found that these mycorrhizal networks serve as a belowground pathway for transfer of significant amounts of carbon from the nutrient-rich deciduous trees to nearby regenerating Douglas-fir seedlings. Furthermore, we

have found that carbon transfer is enhanced when the Douglas-fir seedlings are shaded in mid-summer, providing a subsidy that may be important in Douglas-fir survival and growth, thus helping maintain a mixed forest community during early succession. This is not a one-way subsidy, however; UBC graduate student Leanne Philip discovered that Douglas-fir support their birch neighbours in the spring and fall by sending back some of this carbon when the birch is leafless. This back-and-forth flux of resources according to need may be one process that maintains forest diversity and stability. Earlier research by UBC graduate Karen Baleshta has shown that tree species mixtures are more productive and more resistant to *Armillaria* root disease than are pure Douglas-fir forests where the deciduous trees have been removed. Research at UNBC by Dr Kathy Lewis and graduate student Rhonda Delong shows that this resistance is linked to high populations of the bacterium, *Pseudomonas fluorescens*, which antagonizes the growth of *Armillaria ostoyae in vitro*. Moreover, Dr Kathy Martin and her students have shown that deciduous trees are prime habitat for cavity nesting birds and mammals, which others have shown are instrumental in dispersal of plant and fungal propagules. Ironically, free-growing policies and regulations in British Columbia still encourage forest companies to weed out deciduous trees in hopes that the forests will grow faster for increased future harvests. Small science-based changes in policy could lead to practices that better conserve the natural successional trajectory (i.e., embracing the natural regeneration of deciduous trees), protect the diversity and complexity of developing forests, and improve their resilience to biotic and abiotic stresses.

Research will be critical in helping forest ecosystems and human societies deal with climate change. Maintaining the biological webs that stabilize forests will help conserve genetic resources for future tree migrations, ensure that forest carbon stocks remain intact on the landscape, and conserve species diversity. UBC graduate student Marcus Bingham is finding that maintaining mycorrhizal webs may be more important for the regeneration and stability of the dry than wet interior Douglas-fir forests, where resources are more limited and climate change is expected to have greater impacts. Helping the landscape adapt to climate change will require more than keeping existing forests intact, however. Many scientists are concerned that species will need to migrate at a profoundly more rapid rate than they have in the past, and that humans can facilitate this migration by planting tree species adapted to warm climates in new areas. UBC graduate Brendan Twieg is starting new research to help us understand whether the presence of appropriate mycorrhizal symbionts in foreign soils promote the success of tree migrations, and if so, to help us design practices that increase our success at facilitating changes in these forests.

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Forestry research applied at Stanley Park

VANCOUVER'S famous Stanley Park lost more than 10,000 trees after a series of storms battered the West Coast with near-hurricane force winds in December of 2006. Few of us can forget the images of broken trees strewn across one our most cherished landmarks. But while many considered it a crisis, the 2006 storms that caused this damage also created an unprecedented opportunity for the Faculty of Forestry to apply lessons learned from forestry research over the past 20 years in a wide variety of disciplines.

A community need had been quickly identified, spawned by a sense of urgency from media coverage that began during the day of the storm. Funding was supplied by an incredible outpouring of public sympathy which created a $9 million restoration fund. Not in recent memory had so much community interest been focussed on a forestry-based project. A steering committee was soon formed and charged with the question –"What are we going to do?" A new role for foresters as "Protectors of the Forest" would soon be on the world stage, and the applied scientific knowledge to back up their decisions was provided by researchers from both UBC and elsewhere. Two simple objectives emerged from the process that followed: to reopen the park, and to try to minimize the chance of future damage. Both the reactive and proactive portions of the response had to be driven by scientific knowledge in order for the Park Board and the public to buy into the results. Faculty and staff expertise was actively sought by the Vancouver Board of Parks in the following areas:

- Windthrow prediction, management and prevention
- Remote sensing and geospatial data analysis

Photo: Jamie Myers

Photo: Jamie Myers

- Invasive insects and plants
- Forest pathology and entomology
- Ecosystem restoration and rehabilitation
- Wildlife habitat management
- Geoscience, hydrology and slope stability
- Fire hazard management
- Urban forestry and recreation management
- Silviculture, stand dynamics and future forest design
- Visual resource management and landscape design
- Operations, worker safety and project management
- Value-added manufacturing and marketing
- Community and First Nations forestry

The Stanley Park Restoration Plan was the blueprint for the initial reactive response. That document coined the term "Resilient Forest", and linked its importance to the long-term health of the ecosystem and social functions of a forest. UBC Forestry was deeply involved in the preparation, implementation and monitoring of the Restoration Plan, which has now been fully executed.

The long-term need led to the development of the Stanley Park Forest Management Plan – a road map for the perpetuation of the resilient forest, not only within the damaged areas, but also throughout the remainder of the park. The preparation of this plan took over a year of data gathering, formulation and review. Two UBC Forestry undergraduates and two graduate students were employed by grant funding from the Park Board in order to assist with the process. The Forest Management Plan was approved unanimously by Vancouver Board of Parks and Recreation on March 23rd, 2009 and became the first-ever management plan adopted for Stanley Park's forests. Several team members were recognized for their contributions to the effort, and the name of UBC's Faculty of Forestry occupies a permanent position on the Stanley Park Donor Wall at Prospect Point. A new relationship with the City of Vancouver also emerged as a major benefit to UBC and a permanent linkage between these two neighbours.

Paul Lawson is the manager of UBC's Malcolm Knapp Research Forest and was project manager for the restoration of Stanley Park. He can be reached at paul.lawson@ubc.ca

Photo: Jamie Myers

The applications of windthrow research

WINDTHROW IS a natural occurrence in forests of British Columbia occurring along cutblock boundaries, on road allowances and also in uncut stands. When gale-force winds occur, which is usually about every 10-20 years, thousands of hectares of forest can be blown over. Any of this timber that is not quickly salvaged is at risk for insect attacks or fire damage. Measurements of windthrow at the provincial level average 4% of the Annual Allowable Cut with a range between 2% and 12% depending on the region. This is a snapshot view and actual damage varies from one year to the next. Current windthrow models are able to identify vulnerable stands with over 80% accuracy and field and wind-tunnel studies have shown that crown loading can be reduced by up to 50% with pruning and topping treatments. Using these tools to predict and mitigate the impacts of windthrow is necessary for long-term stand yield estimation, meeting the management objectives for residual stand-structure requirements and limiting losses related to worker safety, planning disruptions, subsequent bark beetle outbreaks and timber quality.

Ken Byrne is a graduate student and member of the UBC windthrow research team led by Dr Stephen Mitchell in the department of Forest Sciences. Ken has created a new mechanistic wind damage prediction model using a model originally designed for Sitka spruce plantations in the UK, as a template. His new model, WindFIRM/ForestGALES_BC, is adapted for the stem and crown properties of Canadian tree species. This model accounts for vertical and horizontal spatial variability at the stand and landscape levels and is something foresters can use to predict wind damage.

The new model will allow forest managers to deal with risk in current and future stands. Simulation results are currently being validated using windthrow data from a BC Ministry of Forests and Range (BCMoFR) experimental installation on Vancouver Island.

This project is part of collaborations with the BCMoFR, UK Forestry Commission and UBC Earth and Ocean Sciences to improve model predictions and extend these advancements to practitioners and researchers. An international group of windthrow researchers meets each year to discuss how the models can be further developed and refined to make them more effective in their predictive abilities. The researchers also communicate their developing knowledge to others such as the recent IUFRO International Conference on Wind and Trees held at UBC.

An offshoot of this work is the development of a windthrow calculator, WindCALC, and an associated workshop for urban foresters and arborists to share

recent findings about windthrow research and our ability to predict wind damage. In the past year, more than 100 practitioners have attended courses accredited by the International Society of Arboriculture and other events related to this work including the Urban Forestry Symposium in Stanley Park, a BC Institute of Technology part-time course and customized windthrow workshops. Workshops on Vancouver Island in June attracted urban forest professionals from BC, Washington and Oregon.

The health or resilience of a forest cannot be judged by its canopy cover and Ken hopes that one of the outcomes of his research will be a better starting point to develop management strategies to reduce the risk of windthrow in BC forests.

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Research that is "win-win" for ecological and socioeconomic values

- ✓ *Protecting environmental values*
- ✓ *Maximizing stability in the timber supply*
- ✓ *Increasing market share*
- ✓ *Fostering sustainability practices to ensure that all forest resources will be there for future generations*
- ✓ *Facilitating SFM certification*
- ✓ *Improving community stability*
- ✓ *Enhancing corporate image*
- ✓ *Providing a vision of what the future forest landscape should look like so that forest managers can plan with confidence*

THESE ARE BUT a few of the many ways in which ecological and sustainability research from the Faculty of Forestry is making a difference to the people, the forests, and the economy of BC. Dr Ann Chan-McLeod, research associate in the department of Forest Sciences, offers examples of ongoing research projects: one for coastal BC and one for the Interior.

In the early 1990s the forest industry turned to researchers for help because of mounting public condemnation and environmental campaigns against timber products that were produced from traditional logging practices on coastal rainforests. A team of researchers from UBC, Simon Fraser University, University of Victoria, and other organizations joined forces to collaborate in the Forest Strategy research and monitoring program that was initiated by MacMillan Bloedel, implemented by Weyerhaeuser, and continued by Western Forest Products. The UBC team, which included Fred Bunnell, Ann Chan-McLeod, Dave Huggard, Emina Krcmar, Laurie Kremsater, Steve Mitchell, and Pierre Vernier engaged in research that would define a radically different style of forest harvesting that would effectively sustain biological diversity and conservation values while allowing the company to make a profit. This new approach, which was called variable-retention harvesting, was evaluated and refined by the researchers and the recommendations modified operational practices through an adaptive management framework. This approach raised the standards for sustainability practices, and also benefited the bottom line. The new approach received favourable attention in the marketplace, and Weyerhaeuser products gained customer preference from such clients as Home Depot. Weyerhauser was recognized and honored with the Corporate Award of the Ecological Society of America for incorporating sound ecological concepts, knowledge, and practices, for stewardship of land resources. Today, the research and monitoring in the Adaptive Management program continues to support sustainable forest management certification and build pubic support, especially with the Public Advisory Groups that are part of Canadian Standards Association certification.

Research is also making a difference to the people of the Quesnel Timber Supply Area, whose economic security, community stability and environmental values are being seriously undermined by a mountain pine beetle outbreak that has left approximately two-thirds of the forested landscape in a dead or dying state. The falldown in the annual allowable cut (AAC) is more severe in this TSA than elsewhere in the province, with projections indicating up to an 80% decline in timber supply within 10 years. The daunting task of where and when salvage logging should proceed in order to safeguard environmental values and maximize access to a stable, secure, and appropriately-priced timber supply is being addressed by researchers, who are developing a spatially explicit decision-support tool that will allow managers to evaluate and optimize management strategies and outcomes in real landscapes across spatial scales and over time. Once mitigation strategies have been identified and implemented, the AAC falldown may be reduced to as little as 26%. However, to the extent that short term measures aimed at alleviating the MPB-induced falldown will define and lock in the future forest landscape, it is critical that they be balanced against and integrated with long-term objectives such as climate change adaptation strategies. A research team, led by Ann Chan-McLeod, is developing a vision of the future forest landscape that balances current activities against future requirements for the continued and stable flow of ecosystem goods and services, and that would reduce vulnerability to climate change while meeting short- and long-term sustainability and socioeconomic objectives. To ensure relevancy to real-world needs, constraints, and objectives, we have partnered with both the Quesnel Mitigation Committee, which is composed of key representatives from the major forest industry licensees, the Ministry of Forests & Range, the Ministry of Environment, and First Nations in the Quesnel area, and the Williams Lake Timber Supply Area.

These examples demonstrate how research makes a difference to the people and the forests of BC.

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Towards more aesthetic forestry

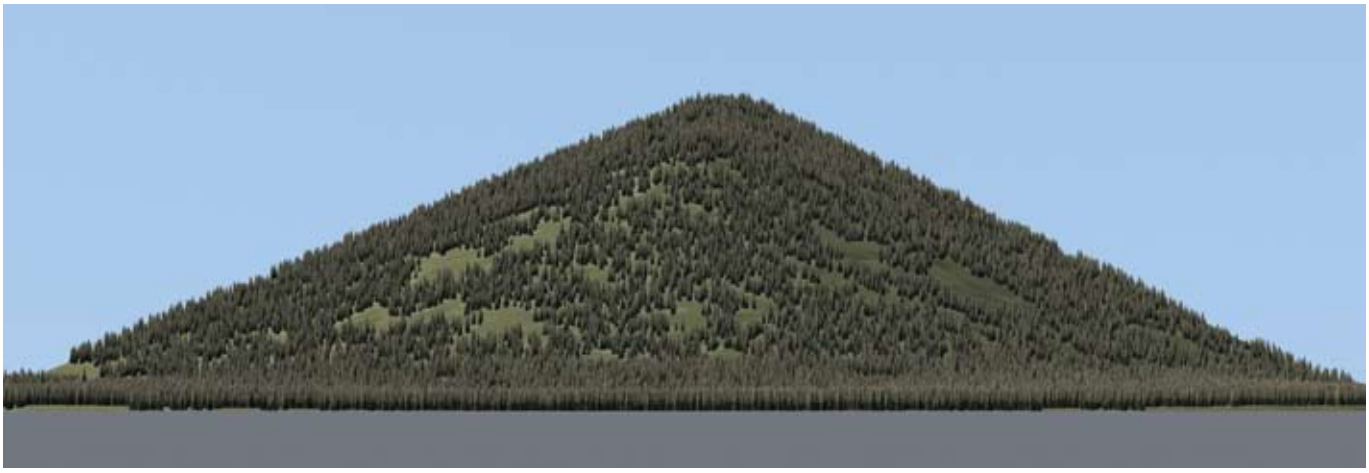
THE FACULTY of Forestry's Collaborative for Advanced Landscape Planning (CALP) has had significant impacts on how forestry is conducted in visually sensitive areas of British Columbia and around the world. This group of students, staff and faculty has made discoveries about how individuals perceive the forest landscape and explored ways to reduce the negative impacts of traditional forest management.

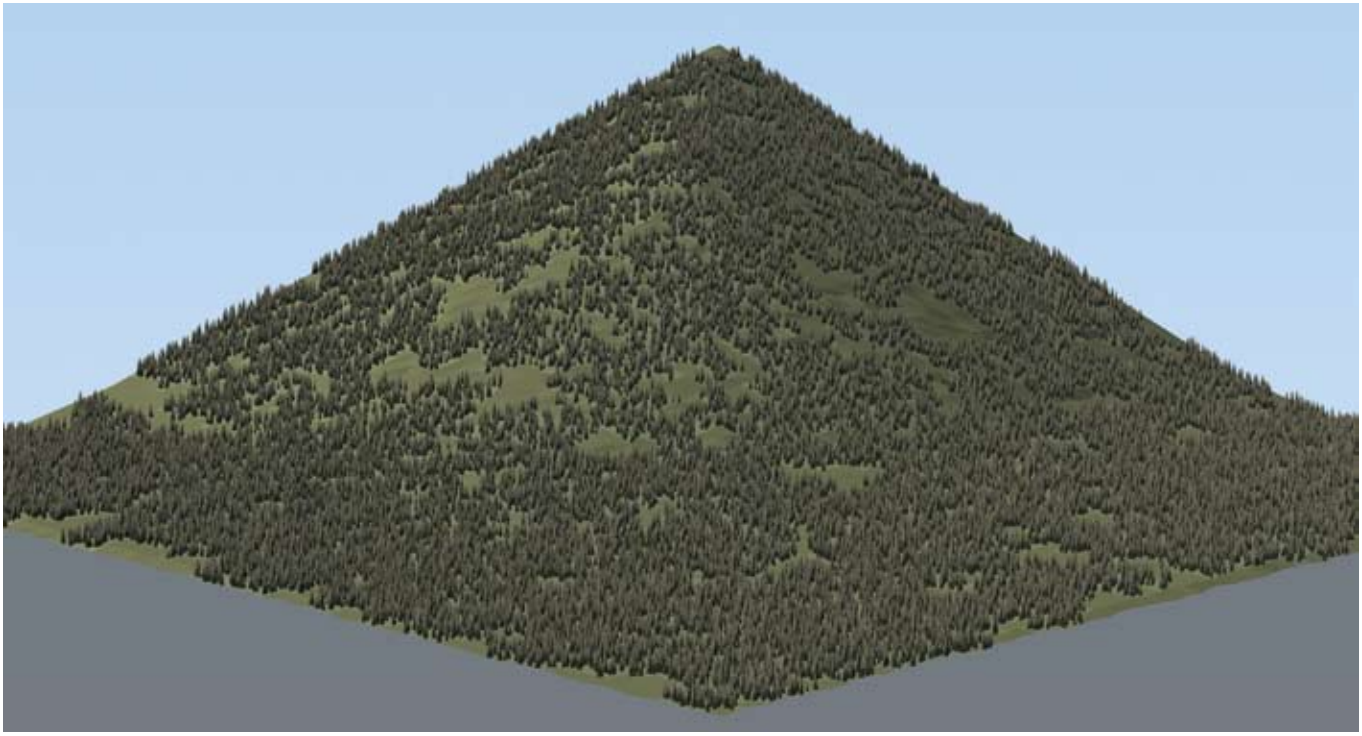
For British Columbians, our forests play a significant role in the health of our economic, recreational, environmental, cultural and spiritual livelihoods. As researchers we have been given the privilege to explore the unknown and have been charged with the responsibility to share our knowledge and discoveries. Most of us hope that our work will play a part in the decision-making processes that guide forest management. As we continue to use forests for their valuable material resources, we need to ensure that we are managing them in ways that respect our flora and fauna as well as the opinions, livelihoods and interests of a variety of people.

The aspect of forest management that interests me is visual quality – how we perceive our forests. I am specifically interested in developing tools to assist us in reducing the aesthetic impacts of harvesting while providing some balance between the ecological and economic aspects. In the past few decades a significant amount of research has been dedicated to understanding how we visually perceive the forest, and researchers have been able to hone in on key design elements that can be applied to a harvest plan in order to mitigate visual problems. As a member of the CALP team, my research is focused on adapting these design principles into a computer model that can be used to aid planners in designing a harvest plan.

In British Columbia, as in many places, there are limitations in the expertise, time, and resources available to adequately assess the visual impacts of all harvests in visually sensitive areas. Yet, assessment is a key component to ensure that companies meet the Forest Practice Branch's visual-quality guidelines.

I suspect most of us have been witness to areas where this accountability has failed. My research aims to help planners, as well as those holding them accountable, to proactively identify weak points in their design. This means translating many of the common





principles of landscape design into a model that the computer can use to estimate the aesthetic quality of a proposed plan and suggest some solutions. These tools give designers immediate feedback about how their plan may be perceived from the roadside, scenic viewpoint or other similar landmark. Through these tools, planners will be able to modify and adapt their design to minimize the visual effects.

Dr Mike Meitner and I have created a prototype which demonstrates how some aspects of visual resource management can be automated. The figures (left and above) provide graphical representation of this work. The grey space represents the earth's surface and the remaining area is the harvestable block. The trees are models of 20 m-tall pine trees. In the left-hand image, you will notice what looks like a simple face of a hill as seen from a viewpoint roughly 3 km away. In the image above you will see that same harvest plan, but from 800 m higher. At this elevation it becomes evident that the software, which was set out to meet a visual-quality objective of partial retention with an 60% harvest of the area, was successful in hiding most of the cut through a process known as screening. Granted, screening is not the answer to all visual problems, but the image demonstrates that we have the capacity to model more complex and abstract aspects of forest planning.

The next step is to develop software for business, government and academic sectors. To do this, we must look at the vast array of landscape design elements and create mathematical formulae and computer code to represent them. We will then generate 3D photo-realistic images of different landscapes and harvest plans. These images will be used in perceptual studies to help us better understand how the computer and humans both measure the aesthetic quality of a landscape. Inevitably, we hope to create a system that fits well with how individuals perceive the landscape.

The goal of the work is to provide decision makers with additional, but simple, tools that can give them a measure of the visual quality of proposed and finished harvests. Models like these can supplement the work of designers, freeing time for them to spend on the detailed elements of harvest planning. Our intention is to see the use of his model lead to improved visual stewardship of our forests.

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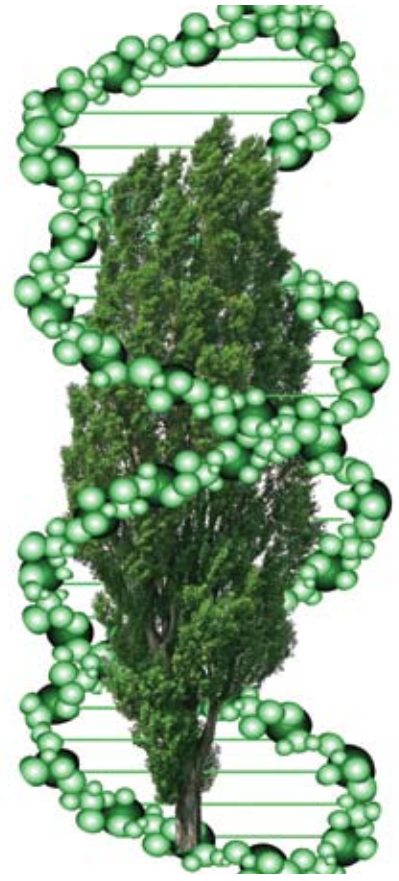
Today's forests, tomorrow's climate: Tools for management and conservation

MOST OF US realize that natural populations require genetic diversity to adapt to new environmental conditions, to allow evolution to proceed. But how do we go about conserving genetic diversity, and how can we rigorously assess whether we are meeting this goal? Dr Sally Aitken is the director of the Centre for Forest Conservation Genetics, a research group established under the mandate of the Forest Genetics Council of British Columbia and housed in the UBC Faculty of Forestry. This group addresses such questions.

As individuals, we are asking ourselves what we can do to reduce our personal contributions to global climate change through our decisions around energy use, consumerism and transportation. As professionals, foresters and other land managers we have an important responsibility to more broadly address the challenge of climate change, since how we manage our forests will affect the rates at which they sequester or emit carbon dioxide and other greenhouse gases. At the Centre for Forest Conservation Genetics (CFCG), we are developing tools to help foresters and land management agencies make decisions on how to prepare today's forests for tomorrow's climate.

One of the tools needed to make management decisions around climate change is accurate information on both current climates and predicted future climates for areas being managed. The tool ClimateBC provides such data for all of British Columbia. By entering the latitude, longitude and elevation of any location in BC, the user can easily obtain current monthly and annual average values for a large number of temperature and precipitation-related variables. The model also provides climate data for the past century, and predicted future climates from various global circulation models and carbon dioxide scenarios. Developed by Drs Tongli Wang (CFCG) and Andreas Hamann (now at the University of Alberta), with collaboration and support from Dr David Spittlehouse at the BC Ministry of Forests and Range(MoFR), this program is freely available from our website and widely used by foresters, other professionals, and the general public.

Foresters will need to know where to plant what species to increase the chance of having healthy forests in the future. Climate envelop modeling is a tool that allows researchers to take the range of climatic conditions under which species currently grow, and predict in what geographic areas those conditions will occur in the future. The results from these models are often presented as maps of future habitable areas for different species or ecosystems. In the CFCG in 2006, Andreas Hamann and Tongli Wang produced a first generation of predictions of climatic envelops for BC's major ecosystems and all of BC's tree species. These 'Flying BEC Zone' maps have been widely used for planning for future forests. We will soon be releasing a second



generation of these predictions, in collaboration with Dr Elizabeth Campbell (MoFR), that utilize a broader range of climate change model predictions as well as an improved modeling approach.

After tree species are chosen for planting, seed sources within those species need to be selected. Using seed for reforestation that originates from populations in climates warmer than the planting site is a potentially effective tool for adapting forests to climate change. Seed sources should be selected based on long-term field provenance trial results and a good scientific understanding of how populations differ for growth and health-related traits. In collaboration with Drs Greg O'Neill (MoFR), Alvin Yanchuk (MoFR) and Andreas Hamann, we have developed new analytical tools for determining the responses of individual populations to temperature and precipitation from provenance trial results. These tools can then be used to adjust seed transfer guidelines, and to plan needed seed orchard capacity for different species and seed sources for the future. Dr Pia Smets (CFCG) has also developed methods for inferring population responses to temperature and moisture in short-term growth-chamber experiments for species for which provenance trials are lacking.

We also need to understand the capacity of natural tree populations for all our native species to adapt to climate change through natural selection. To address this issue, we are utilizing state-of-the-art genomics tools that were largely developed for biomedical research. Using Sitka spruce as our fruit-fly equivalent,

Innovation in the Canadian Forest Industry FPAC photo collection (2009) photographer Martin Lipman; reproduced by permission of the Forest Products Association of Canada, 2009.

Whitebark pine seedlings at UBC

Dr Jason Holliday (now at Virginia Polytechnical Institute) has been able to identify many genes directly involved in the adaptation of populations to temperature. We have also assessed how much variation is present for these genes within populations to be able to predict how rapidly adaptation can occur.

We need to adjust conservation strategies to reflect the challenges of climate change. In British Columbia, we primarily conserve species through our protected areas network, which covers approximately 13% of the province. Large populations need to be conserved to allow for adaptation to occur. The CFCG recently published a report, with Christine Chourmouzis as lead author, documenting the current conservation status of all of BC's 50 tree species. This extensive technical report provides a thorough assessment of the extent to which our native genetic resources are currently conserved in our parks and protected areas. This document provides a baseline that can be used to strategically fill gaps in conservation and monitor populations as climate changes.

Our applied research agenda for the CFCG has been developed in close cooperation with, and overseen by, the Forest Genetics Council of BC, the BC Ministry of Forests and Range, and members of the forest industry. Our genomics research program has been funded by Genome Canada, Genome BC, and NSERC. We have collaborated closely with the stakeholders involved in the provincial forest genetics program to deliver knowledge and tools of use to them. This work would not have been possible without close collaboration with Ministry of Forests and Range scientists and their genetic materials and data. Through this cooperative structure, we hope to assist foresters and land managers with their tough decisions around managing our native forests for an uncertain future.

Further information on the work of the Centre for Forest Conservation Genetics can be found at www.genetics.forestry.ubc.ca/cfcg. Dr Sally Aitken, professor in the department of Forest Sciences can be reached at sally.aitken@ubc.ca

Forest-dependent communities in transition

FACT (Forests and Communities in Transition) is a new initiative in the UBC Faculty of Forestry established by Dr Rob Kozak in response to the increasing economic challenges facing rural British Columbia and the vulnerability of forest-dependent communities worldwide. Their goal is to conduct and catalyze research that matters to communities.

Forest-dependent communities throughout the world are increasingly vulnerable, despite the important regional socio-economic contributions that they make. In British Columbia, forest-dependent communities have reached a tipping point, largely precipitated by the global economic crisis, associated plummeting commodity prices and the outfall of the Mountain Pine Beetle infestation in the province's interior. Massive downturns in the BC forest industry and the resultant declines in employment strike at the heart of many rural communities and contribute to an increasingly uncertain future. Through FACT, we intend to address these issues by facilitating dialogue, building capacity and conducting meaningful research for and about forest-dependent communities.

We are striving to establish a global network of researchers and communities working in partnership with governments, non-government organizations, academia, industry and others to contribute to the development of more resilient and liveable forest-dependent communities. We believe that sustainable rural development and forest resource management – both internationally and in Canada – will be strengthened through thoughtful research and sharing findings and lessons.

Establishing a meaningful dialogue takes time and credibility and we recognize that it will take years to achieve our goal of being a global network. We are working towards this vision through our research collaborations, our website (www.fact.ubc.ca), participation with organizations such as the Canadian Rural Research Network and publications in scientific journals and popular media.

Collaborations between researchers and communities are becoming increasingly prevalent as funders and research organizations come to recognize the value and importance of meaningfully partnering. Research conducted in collaboration with communities has the potential to produce more relevant findings, better inform policy-making processes and produce direct community benefits. To achieve this, we need to develop capacity amongst researchers and communities to ensure that projects are conducted in an ethical, timely and rigorous manner.

Our research hinges on re-examining the types of forest products and services that are most conducive to the

Photo: Rob Kozak

Williams Lake, a forest-dependent community in BC

Photo: John Innes

Beehive burners Canfor mill at Chetwynd, BC (now closed)

long-term health and wellbeing of communities and identifying tools and approaches that will strengthen forest-dependent communities in transition. While we are committed to responding to emerging and relevant research themes, we have a number of ongoing and completed projects that focus on four areas of research: forest management and community wellbeing; community planning and engagement processes; forests and community health; and local forest-based business opportunities and capacity.

For instance, we are currently conducting a survey of elected leaders in forest-dependent communities throughout British Columbia. The objective of this study is to assess community-level perceptions of the recent economic changes, to better understand how these communities are responding and to identify potential forest-based opportunities.

Together with the City of Rossland Sustainability Commission, FACT managing director, Erin McGuigan, is helping to guide the 3600 person community in southeast British Columbia through the process of identifying indicators to monitor their progress toward sustainability. Throughout this exercise, we are examining the feasibility and challenges of applying small-scale sustainability indicators in rural communities.

On an international front, FACT recently completed a participatory sustainability planning process in Tapalpa, a small rural community in the Mexican state of Jalisco currently facing unprecedented growth. Working with Cecilia Valencia and David Flanders of the UBC Collaborative for Advanced Landscape Planning, the project addressed the need for participatory planning approaches throughout rural Mexico.

FACT researcher Dieudonne Alemagi is currently conducting research addressing the sustainability of Cameroon's forest industry, where current management practices can perpetuate poverty and violent conflicts. His research aims to analyze the impasse that is occurring between communities, logging companies and the government, and in so doing, prescribe alternative strategies for forest management that are both sustainable and equitable.

FACT researcher Wellington Spetic has recently completed a study of the forest sectors of New Zealand, Chile and Brazil, with the aim of applying lessons learned to the emerging value-added wood products sector in BC.

To learn more about FACT, visit www.fact.ubc.ca or contact Erin McGuigan (managing director of FACT and doctoral student) at erin.mcguigan@ubc.ca or Dr Rob Kozak (professor, department of Wood Science) at rob.kozak@ubc.ca

Helping make forest management sustainable

THE GRADUATE STUDENTS that make up the Sustainable Forest Management Laboratory (SFML) in the Faculty of Forestry are interested in all aspects of sustainable forest management, but particularly the application of the principles of sustainable forest management to real world situations. They have been looking at how internationally agreed criteria and indicators of sustainable forest management can be improved and what this means for forestry practices on the ground. They are working with a number of indigenous peoples looking at how they are implementing sustainable forest management. Research in the Yukon involves an examination of how the impacts of climate change are affecting forest-dependent communities and how those communities are adapting to their changing environment. This ties in with work in northeast BC, where students are looking at the cumulative impacts of development on aboriginal communities. Elsewhere in BC, projects focus on what influences the capacity of First Nations to implement sustainable forestry and at some of the barriers influencing this. Here, Dr John Innes, leader of the Sustainable Forest Management Laboratory, details some of the work that has been done by students in the group.

Over the past few years there have been more and more opportunities for researchers in BC to play a role not only in BC but around the world. This role is being increasingly acknowledged, thanks in part to efforts by the International Union of Forest Research Organizations to bring scientists and policy makers together.

As a core theme for the Laboratory, and working with the funding from the Forest Sciences Program, FOREX and other sources, we developed the Sustainable Forest Management Indicator Knowledge Base (www.sfmindicators.org). This was designed to help those developing indicators of sustainable forest management, particularly at the scale of a management unit. The greatest interest in the system has been from Australia and China: the whole site has recently been translated into Chinese by You Shijun and others, and the Chinese version will be used by the State Forestry Administration to develop regional criteria and indicator schemes that will be used to support the introduction of sustainable forest management nationally.

Working with the Forest and Range Evaluation Program of the BC Government, Alyson McHugh examined how we might better assess the impacts of salvage harvesting on stand-scale biodiversity. This work is particularly relevant given the large amount of salvage harvesting associated with the Mountain Pine Beetle infestation in the province. It is likely to be of relevance to other salvage efforts associated with other pathogen attacks, something that seems to be increasingly likely in the future. In another project based in BC, Pamela Perreault is looking at what exactly is meant when we make comments about the need for more capacity amongst Canada's First Nations. Matt Sakals is looking at a much more definable problem: the rate at which hillslope hollows, the sources of landslides and debris flows, fill up with material that could subsequently fail, creating a potentially hazardous mass movement.

In the majority of cases, such studies bring no controversy. However, a more challenging project has been the assessment of the potential effects of industrial development on the Treaty rights of First Nations in north-east BC. This has been quite a seminal project for the Lab. It has revealed all the problems (and advantages) of working in a controversial area with lots of interested parties. Erin McGuigan was able to spend several months living in some of the affected communities, learning about their concerns and priorities. This information was then used by Sonia Murray, Bogdan Strimbu and Judi Krzyzanowski in field and modelling studies to determine the likely impacts of forestry and oil and gas development.

Photo: John Innes

Wang Guangyu talking to residents of Wanzidian in Laoning Province, China, one of the study areas for our certification/sustainability project. The Forestry Department has paid for the installation of solar panels, and for a bio-gas plant (fuelled by maize husks), successfully reducing the reliance that villagers previously had on firewood from the surrounding forests.

Outside BC, but within Canada, the SFML has been involved with research for the Yukon Government. Here, a team of graduate students and postgraduate and postdoctoral assistants, including Patrick Waeber, Craig Nitschke, Shyam Paudel, Finella Pescott, Anne-Hélène Mathey, Anna Tikina, Angeline Gough and others, we have been looking at the impacts of climate change on local communities and local ecosystems, assessing the likely risks posed by the Mountain Pine Beetle, and examining the effects of past harvesting activities on caribou habitat. In addition, Ajith Chandran and Angeline Gough have been helping the Yukon Government develop a state of the forest report. Moving further afield, John Innes has been closely involved with the Sustainable Forestry Initiative certification standard moving it a bit closer to meeting some of the social and cultural requirements of sustainability, introducing language about consultation with Aboriginal peoples and consultation over activities undertaken on public land.

One issue that the Lab has been looking at is the possibility of learning from what has been happening elsewhere in the world. Reem Hajjar has been looking at the successes and failure of community-based forest management in Brazil and Mexico with a view to bringing this knowledge back to BC. If we can avoid some of the costly mistakes that have been made elsewhere, communities (and especially the First Nations' communities) are likely to benefit considerably. Joleen Timko recently completed a PhD that examined the problems facing the evaluation of the effectiveness of co-management of National Parks, comparing those in South Africa with those in BC and Alberta. Similarly, Monika Singh and Ajith Chandran are examining what can be learnt from joint management agreements between local people and the government forest service in Gujarat State in India, comparing it to the experience of the Sliammon and Tsleil-Waututh First Nations.

Undoubtedly, the greatest influence of the SFML has been in China. There, through the hard work of Wang Guangyu, Chen Juan, You Shijun and others, we have developed links with all the major Chinese forestry universities, and have also developed close links with the Chinese Academy of Forestry and the State Forestry Administration. We have developed recommendations on watershed development and the prevention of soil erosion that have been adopted, and are currently working on the implementation of the Chinese national forest certification standard, including the development of regional best management practices. With the support of the BC Innovation Council, we have been able to work with local communities in China, demonstrating the potential value of certification and undertaking analyses of the likely problems that those seeking certification will face. Some of the work we are doing on the acceptance of certified wood products in China will be of significant benefit to those seeking to export certified wood and wood products from Canada to China.

Overall, there are clearly many opportunities for Faculty of Forestry research to contribute to problems facing the BCn, Canadian and global forest sectors.

Dr John Innes, professor in the department of Forest Resources Management and Forest Renewal BC Chair in Forest Management, can be reached at john.innes@ubc.ca

Wood biomass for greenhouse heating

JO CHAU RECENTLY received a Best Thesis award for her masters thesis on the utilization of wood pellets and residues as an alternative form of energy for heating large commercial greenhouses.

The greenhouse industry is a fast growing sector of the Canadian economy. Most greenhouses in British Columbia use natural gas as their primary source of energy to provide heat for crop production and carbon dioxide for photosynthesis. However, there are concerns about greenhouse-gas emissions from the combustion of natural gas. Moreover, the fluctuation in natural gas prices, and the fact that fuel costs represent about 30% of the operating cost of a greenhouse, have forced greenhouse operators in BC to search for more economical, renewable and environmentally friendly sources of energy.

Jo Chau recently completed her graduate work in the department of Wood Science looking at the feasibility of using wood biomass (wood pellets and wood residue) as a renewable energy source to help greenhouse owners decrease their dependence on natural gas. She focused her research on the economic feasibility of using wood biomass as an energy source, air quality emissions from burning wood and the optimum mix of fuel wood.

Jo conducted a techno-economic analysis using the Net Present Value (NPV) methodology to evaluate the economic feasibility of using wood biomass for greenhouse heating. She considered variables such as: greenhouse size, boiler efficiency, fuel types, and source of carbon dioxide for crop fertilization. She also looked at four scenarios to define the feasibility of using wood biomass to generate 40% of the

total heat demand for an average sized greenhouse. Results were calculated using the engineering economics method and the Canadian capital cost-allowance guideline with the assumed boiler lifespan of 25 years. Positive NPVs were derived, which indicated that using a wood biomass boiler for providing a portion of heat demand is more economical than using a natural-gas boiler alone. The emissions from each scenario were also calculated and compared with the emission inventory from the Lower Fraser Valley region. The results showed that wood biomass combustion would contribute less than 0.1% to the background inventory when an advanced emission control system was used.

As a second study, Jo investigated the impacts of technical and market changes on the economic feasibility of using wood biomass to produce a portion of heat for an average-sized vegetable greenhouse. Although Jo found that increasing the energy contribution from a wood pellet or wood residue boiler can generate higher NPVs by reducing natural-gas usage, the savings generated from replacing natural gas with biomass are not enough to cover the installation and operation costs of wood biomass boilers.

Although wood biomass is considered to be a carbon-neutral material (the amount of carbon released during complete combustion is equal to the amount of carbon absorbed during the photosynthesis process), incomplete wood-biomass combustion could emit more particulate matter which could affect the local air quality. Thus, Metro Vancouver has proposed a new amendment to the Air Quality Management bylaw, which introduced emission limits to wood-biomass, natural-gas, and fossil-fuel boilers. Jo focused her third study on the feasibility of combusting wood-biomass in the light of constraints on feedstock availability and environmental limitations. She used linear programming to develop the optimal mix of biomass fuel for greenhouse heating applications. Her objective was to minimize the cost of wood biomass combustion, while satisfying heat demand, resource availability, and emission limits (Metro Vancouver's Air Quality Management amendment requires an advanced emission-control system be added to the boiler system). The results of Jo's study indicated that the optimum mix of fuels for an average-sized flower greenhouse could reduce total heating cost by 20% while satisfying the air-quality emission limits for wood combustion.

This research provides valuable information for BC's greenhouse industry. Investing in a wood biomass boiler can generate savings and reduce fossil-fuel usage. Installation of emission-control systems would assure the air quality for the region. Greenhouse heating is just one of the applications for wood biomass as an energy source. Other applications include household and industrial heating needs. Jo's linear programming model can also be applied or extended to evaluate other renewable energies.

Jo Chau now works for Pacific Rim Cabinets Ltd. in Delta, BC and can be reached at jochau@hotmail.com

Understanding the causes of our declining salmon populations

DR GLENN CROSSIN recently received a Best Thesis award for his doctoral dissertation on the behavioural physiology of salmon migrations and the endogenous and exogenous factors responsible for survival and mortality during this long and arduous trip.

Over the past ten years we have witnessed the collapse of many salmon stocks along the west coast of North America. Understanding the causes of these declines such that we can reverse this trend is a pressing research need which has been undertaken by Dr Scott Hinch and his colleagues in the department of Forest Sciences. For his doctoral research, Dr Glenn Crossin developed a procedure, in partnership with a postdoctoral colleague, to noninvasively biopsy migratory fish in the field, and combined this with telemetry in order to link the fate and behaviour of individual fish with their physiological state in terms of energetics, stress, and reproductive development. This procedure opened the door to research possibilities never before conceived with migratory animals (including the opportunity to integrate physiological genomics and animal behaviour across large scales).

Glenn sampled and tracked some 1000 salmon across distances up to ~ 2000 km – one of the larg-

Photo: Katy Bryan

est studies of its kind on any large migratory fish and some of the first attempts to do so within the animal kingdom.

In one study, Glenn used time-release hormone implants which he injected into salmon that were caught in the open ocean and tracked with telemetry to their natal river in order to test hypotheses about the role of maturation rate on migration timing and success.

One major finding was that anadromous fish migrations (fish which move between saltwater and freshwater, like salmon) are inherently very stressful and that natural physiological stress can reach lethal levels and result in migration mortality, perhaps as high as 20-30%. The discovery that salmon may perish 'naturally' at high levels during coastal migrations has provided new tools and results to understand an emerging crisis. Many factors have been implicated, in particular climate warming, but few can be specifically proved.

In another study, Glenn captured adult salmon after they entered the Fraser River and exposed them in a field laboratory to different thermal conditions over several weeks then released and tracked them to study the role of river temperatures on migration success.

The results showed how specific thermal levels caused migration mortality. His data were used to support testimony delivered by the research team at a judicial inquiry on missing sockeye salmon. His findings have re-adjusted the Pacific salmon fisheries management paradigm regarding the manifold influence of abiotic and biotic factors on salmon migration. His experimental data on thermal influences has led to refinements to management models used to ensure that fisheries are conducted in a risk-adverse manner.

Until this research was conducted, there was no understanding or conceptual basis for when and where wild migrating salmon begin their physiological changes in preparation for spawning. Glenn found that salmon were preparing months before in the ocean (> 800 km in advance of reaching the Fraser River) in terms of elevating their reproductive hormone levels and changing their gill structure towards a 'freshwater state'. Glenn developed the first conceptual framework to describe the physiological changes associated with homeward migrating fish.

Dr Glenn Crossin is currently an NSERC post doctoral fellow at Simon Fraser University working on Antarctic migratory bird physiology. He can be reached at crossin@interchange.ubc.ca

This is not to imply that only applied research is of value. There are many examples of curiosity-driven research having huge payback to society, although these tend to be less predictable. It is self-evident that any research that improves our understanding of any systems – be they biological, social or technological – will improve our collective ability to manage it, improve it, conserve it or work with it. I also do not imply that only research in BC is relevant; scientists in any discipline have the responsibility of being aware of all developments in their field and adapting principles and practices developed elsewhere to our situation and needs, as well as ensuring that the knowledge that we develop is shared such that it can be used globally. Nor do I imply that only research in the Faculty of Forestry is of value. One of the great strengths of forest research in BC is its collaborative nature. Every researcher in the Faculty of Forestry works with excellent colleagues in provincial or federal government, industries, universities, community groups, and environmental organizations; the pervasiveness and effectiveness of these collaborations permeate the articles in this issue.

Especially now, the direct contributions that our research makes to BC need to be identified and recognized. There is space in this issue for only a few highlights of the important and relevant research happening in the Faculty of Forestry; a short list of questions we are responding to would also include:

- How we can better manage and distribute forests to sustain the myriad organisms that rely on them?
- How we can use tree-breeding technologies and silviculture to satisfy our fiber needs while setting aside forests for conservation or recreation purposes?
- How we can sequester more carbon in forests and how can we modify forest harvesting practices in ways that sustain soil organisms and processes?
- How we can facilitate inclusion of First Nations as full partners in all aspects of forestry?

Our researchers are also active in better understanding the diverse benefits that people derive from forests and how to manage forests for their many values, developing wood-based biofuel technologies and policies, developing new wood products and markets for them, and improving the performance of timber buildings in earthquakes and in developing models through which we can synthesize current knowledge and predict outcomes of decisions, practices and policies. The UBC Research Forests, play a critical role in maintaining and facilitating the long-term field studies essential for answering complex questions.

Perhaps the question we should be asking is, "Can we afford to NOT invest in forest research in BC?"

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New masters in forest management

We are working on the development of a new course-based masters program in forest management (www.forestry.ubc.ca/msflm/).

As part of the program development and business planning we have developed a survey for potential applicants and for employers of program graduates. To help us with the design and marketing of this new program we would appreciate your input at www.surveymonkey.com/s/W6YJN6M

Electronic versus paper?

Branch Lines 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 (go to www.forestry.ubc.ca/ and click on "Publications").

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

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