branch lines

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Making smarter conservation decisions for migratory species

GLOBAL ANNUAL INVESTMENT for migratory animal conservation exceeds several billion dollars. Canada's forests provide seasonal habitat for many migratory animals, including some of our most threatened species (e.g., Acadian Flycatcher, Kirtlands Warbler, Wood Bison, Woodland Caribou). Designing effective recovery plans for these species presents enormous challenges. Migratory birds for example, are influenced by multiple events across land and sea – regions that are often separated by thousands of kilometres and span international borders. To date, conservation strategies for migratory species have failed to take into account how migratory animals are spatially connected between different periods of the year (i.e. migratory connectivity) bringing into question the utility and efficiency of current conservation efforts, from both a conservation and economic point of view.

In an effort to find better solutions to the problem of where to conserve habitat for migratory species, our research has focussed on integrating decision theoretic models with information on migratory connectivity derived from stable isotopes. Decision theory and optimization have been used in forestry for decades in virtually every aspect of the supply chain from determining when and where to cut timber to when and where to sell timber.

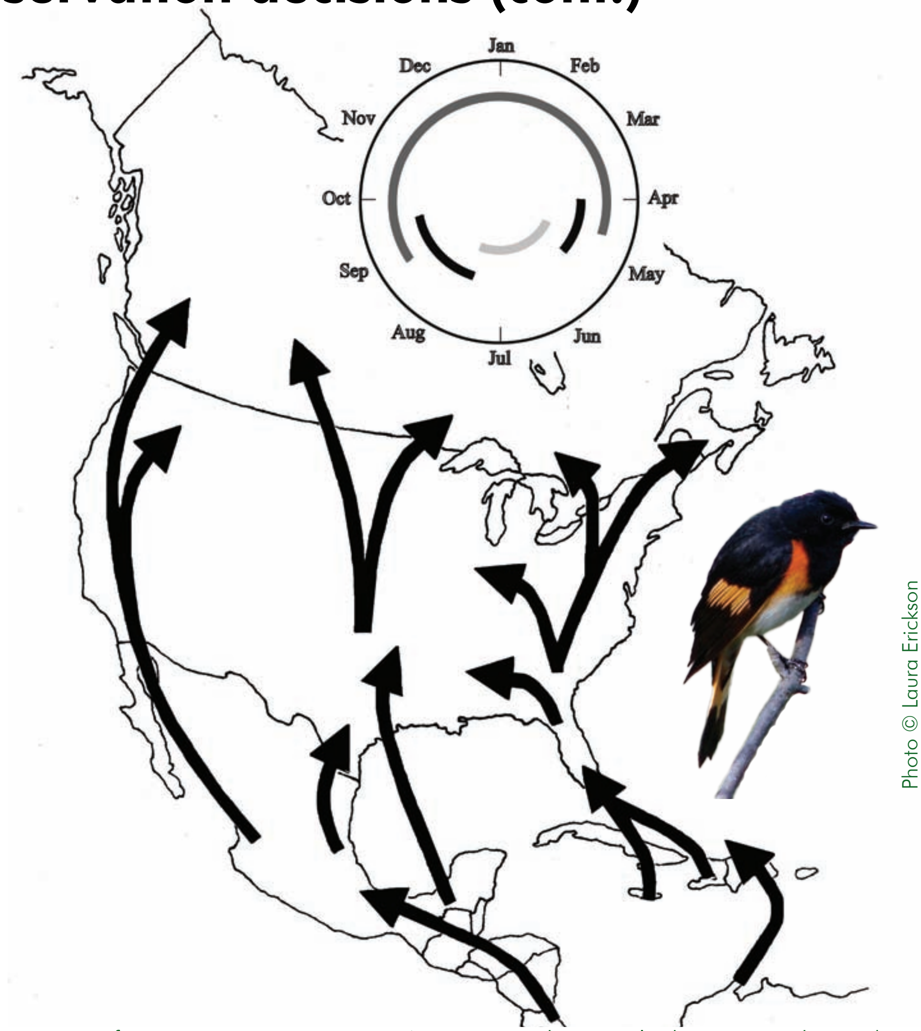

Photo Matthew Reudink

American redstart – Neo-tropical migrant.

Making smarter conservation decisions (cont.)

We are now using this framework to determine when and where to conserve migratory species.

Using the American redstart *Setophaga ruticilla* (front page), a Neotropical-Nearctic migratory bird whose winter habitat is under threat as an example, we can illustrate the importance of considering information on migratory connectivity by examining two very different conservation strategies. Our first conservation strategy used the acquisition of winter habitat based on land cost, relative bird density, and the rate of habitat loss to maximize the abundance of birds on the wintering grounds. Whereas, our second strategy maximized bird abundance across the entire range of the species by adding the constraint of maintaining a minimum percentage of birds within each breeding region in North America using information on migratory connectivity as estimated from stable-hydrogen isotopes in feathers. Redstarts conduct a complete molt once a year on the breeding grounds. Because feathers are metabolically inert after growth, stable isotope signatures acquired from the diet are fixed in feathers once they are completely grown. In North America, δD values vary with latitude and, therefore, reflect the location at which birds grew their feathers. Using this technique, distinct patterns of regional connectivity between the breeding and wintering grounds for species were determined (figure opposite).



Patterns of migratory connectivity in American redstarts. Black arrows indicate the migration pathway connecting winter and summer populations of American redstarts. Outer semi-circle of calendar represents non-breeding period, middle semi-circle migration period and inner semi-circle breeding period. Using stable isotopes collected from feathers deposited on the breeding grounds we determined the winter location from which these birds originated.

Our results suggested that failure to take into account migratory connectivity in our conservation strategy may doom some regional populations to extinction. If our conservation goal is to maintain the historical range of a species, then the loss of entire sub-populations is catastrophic. By including information on how species move across the landscape throughout the year, the cost of different management actions (e.g., protecting or restoring land), the level of threat occurring in different parts of the species range and the relative abundance of species across their range, in our optimization problem, we can make more intelligent and cost–effective conservation decisions. Our framework can be used to identify efficient conservation strategies for migratory taxa worldwide, including insects, birds, mammals, and marine organisms.

For further information contact Tara Martin, Centre for Applied Conservation Research, at 604-827-5843 or tara.martin@ubc.ca or download our recent paper. Martin, T. G., Chadès, I., Arcese, P., Possingham, H. P., Marra, P. & Norris, D. R. (2007) Optimal conservation of migratory species PLoS ONE, 2, e751.doi:710.1371/journal.pone.0000751.

Honeycomb panels – *how do they stack up?*

THE PARTICLEBOARD INDUSTRY in Canada is facing a competitive squeeze on a number of different fronts, which raises questions about its capacity to compete with the adoption of alternative light-weight composite panel materials in ready-to-assemble (RTA) home and commercial furniture and cabinetry. There is a persistent conflict between the need for reduction in density of particleboard and MDF panels for transport and handling, which in turn poses problems for the fastener holding capacity in the core of boards. A further problem in the market place for particleboard is reduced production capacity in Canada caused by recent mill closures, and shortages of suitable woody waste raw materials that are lost to bio-energy generation. This has inflated particleboard prices in the North American market place by 25 to 30%, making it even less competitive with imports from overseas and substitutes such as hollow core panels and MDF.

UBC's Department of Wood Science has a new project involved with the study of hollow core panels as a replacement for solid core particleboard and MDF in RTA furniture in Canada. Light-weight honeycomb technology has been around for decades in the shipping and aerospace industry, and is increasing in popularity in the modular furniture industry which is seeing a trend towards a more simple thick and blocky appearance. The manufacture and use of kraft paper honeycomb panels for furniture and cabinetry is much further advanced in Europe where, for example, Egger Eurolight is a fully developed furniture sandwich panel made from laminated thin particleboard and kraft paper honeycomb.

The use of honeycomb sandwich panels for furniture is belatedly starting to grow in North America, with two large furniture companies in Quebec installing honeycomb sandwich panel manufacturing lines for furniture applications using German-based technology. A few small custom-builders of modular furniture, for example Bensen Furniture in Vancouver, make table and shelving units from honeycomb panels that they fabricate themselves onsite. The ability of such enterprises to meet larger orders for their pack down modular furniture products is hampered by a current lack of domestic suppliers of prefabricated honeycomb sandwich panels for purchase as stock panels, much like a furniture manufacturer would pre-purchase particleboard or MDF stock panels. Much kraft paper honeycomb is manufactured in North America (mainly US), but is mostly formatted for packaging, pallets, dunnage, separators, and door cores. Further hampering the adoption of honeycomb sandwich panels by the RTA furniture industry in Canada is the almost complete lack of readily available comparative information on the performance of different kinds of honeycomb panels with conventionally used solid panels.

There is significant scope for the development of hollow core composite panels for modular furniture components that serve the same function as solid slabs of particleboard or MDF but with greatly reduced raw material (wood and resin) usage. Our project will put commercial and laboratory made honeycomb panels of various types though their paces and generate performance models and comparative properties data designed to facilitate the further adoption of honeycomb sandwich panels by the RTA furniture industry in Canada.

For further information contact Kate Semple (ksemple@forestry.ubc.ca) or Greg Smith (greg.smith@ubc.ca) in the Department of Wood Science.

Honeycomb sandwich panels can be found in many imported thick furniture items. Left: a local custom-built veneered tabletop, and right: a mass-produced plastic coated tabletop.

Mapping in Haida Gwaii / Queen Charlotte Islands

REMOTELY SENSED IMAGERY is a commonly utilized tool for natural resource management, especially for managing broad landscapes. New sensors collect data at the resolution of metres and sub-metres (such as the QuickBird satellite), requiring new techniques for the analysis and extraction of information. UBC's Gergel Landscape Ecology Lab and Haida Mapping co-hosted a four day workshop on spatial analysis and accuracy assessment of high resolution imagery from July 9 – 12th, 2007 in the Queen Charlotte Islands. This workshop was made possible by funding through FSP and NSERC and included managers and researchers representing the Ministry of Environment, Ministry of Forests and Range, Parks Canada, and Haida Heritage. The workshop was held at the recently opened Qay'llnagaay Haida Heritage Center (below).

The tools and topics covered were aimed at improving data extraction for projects currently in progress on the island, improving future projects between UBC and island collaborators, and to spark debate about how mapping can aid ecosystem management. Each day introduced new concepts and tools which were demonstrated using recent imagery from coastal BC watersheds. The topics covered included a comparison of high vs. low spatial resolution data, comparison of traditional pixel-based versus newly-developing object-based classification methods, an introduction to LiDAR (Light Detection & Ranging), as well as accuracy assessment. Each day-long session was taught by a different instructor, with graduate students from the lab of Sarah Gergel, including Shanley Thompson, Jessica Morgan and Trevor Lantz, as well as LiDAR specialist Chris Bater from the lab of Nicholas Coops.

A highlight of the workshop was a poster session held on Tuesday evening at the Haida Heritage Center. Posters from Haida Mapping, Parks Canada, Ministry of Environment, Ministry of Forests and Range, Gowgaia Institute and UBC were presented, each displaying mapping projects of relevance to the islands in an event open to the public.

As more remote sensing datasets - including aerial photographs - become widely available for Haida Gwaii, additional landscape-level questions can be asked, but they will require creative and novel techniques for data extraction and analysis. Future collaborative workshops on the island are underway to address the use of historic aerial photos for mapping ecosystem baseline conditions as well as to develop formal linkages between mapping, monitoring and active adaptive management on the islands.

For further information contact Sarah Gergel, Co-director of the Centre for Applied Conservation Research, at 604-827-5163 or sarah.gergel@ubc.ca.

Breeding without breeding

An opportunity or a pipe dream?

DOMESTICATION OF wild species is most commonly accomplished through deliberate selection and breeding. Although breeding is both an art and a science, modern breeding programs, with their systematic approach and sophisticated mathematical nature, have left very little of the "art" component. Forest tree domestication has been practiced for many millennia and one of the best examples is the European selection and propagation of stone pine (*Pinus cembra*). This tree has been selected for frequent and abundant seed-cone crops and high yields of pine-nut seeds. The selected trees exhibit large crowns to accommodate the hefty seed-cone crops (see photo opposite). This phenotypic selection approach, while effective, requires many generations and a very long time to reach the desired "type." Attempts to accelerate the rate of progress in breeding have resulted in the development of modern methods that encompass three major stages; namely, selection, breeding and testing (Figure 1). This scheme is the hallmark of forest tree breeding programs all over the world, including B.C. Desired phenotypes are selected, based on their appearance, grafted and planted in arboreta. Selected trees are bred using pre-determined mating designs for progeny production needed for testing and selection for the second round of breeding.

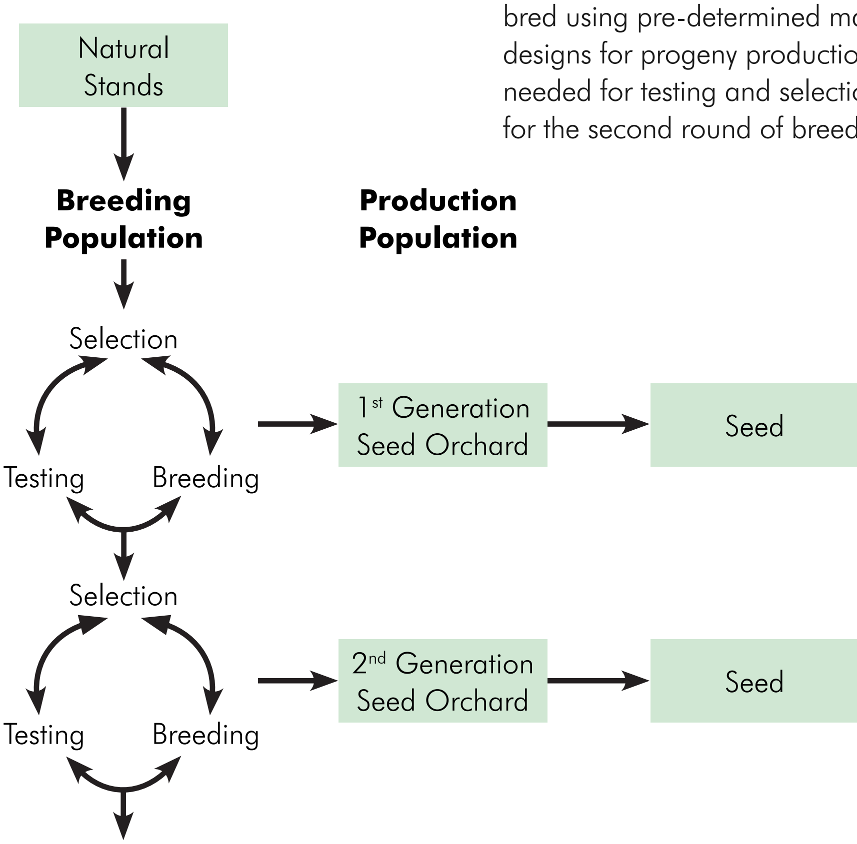


Figure 1. The progression of a breeding program: from selecting trees in natural populations, through successive breeding cycles, and creating production populations (seed orchards).

Testing is often done over large geographic areas and relatively long periods of time to ensure the selection of the appropriate progeny or parents. An important by-product of every breeding cycle is the selection of the best individuals of the breeding population. These individuals are then planted in seed orchards for the production of genetically improved seed needed for seedling production for forestation programs (Figure 1).

While this process is effective and has delivered high genetic gains, it is unreasonably time consuming, needs organizational commitment for continuation, and requires flexibility for changing selection goals. Completing the breeding component (i.e., crosses among the selected parents) can be a very elaborate and time consuming process due to reproductive phonology or output differences among parents, and in most cases is not error free. If this part of the process is eliminated, breeding efficiency will increase. With the concurrent use of DNA fingerprinting and pedigree reconstruction, natural crosses among selected trees within breeding arboreta could be unraveled and parents could be identified. This way mating designs could be created without making one single cross (i.e., nature makes the crosses and we reconstruct them). This short-cut approach has been demonstrated using a sample of seed from a Douglas-fir seed orchard and a mating design was successfully constructed (Figure 2).

Breeding without breeding (cont.)

Pinus cembra.

If the parents of progeny can be identified using this approach, then can we increase the breeding efficiency by skipping the testing phase? Testing is usually done by planting replicated sets of progeny from crosses in randomized arrangements within and over multiple sites. If progeny of the selected parents produced from natural pollination are planted as reforestation blocks (and tracked by seed donor), then selection of superior individuals among the progeny of this seed parent is possible and the pollen donor of the selected individuals can be determined. This process will provide an opportunity to select among progeny of multiple crosses following true field performance (i.e., no controlled crosses and no groomed testing trials). This situation is currently being evaluated using a retrospective study of more than 7,500 trees produced from 60 parents and planted over 3 test sites. Preliminary analyses indicate that 90% of the captured genetic gain using conventional breeding methods can be obtained without breeding and testing, hence "Breeding Without Breeding (BWB)". Our results suggest that the combined use of DNA fingerprinting, pedigree reconstruction, and advanced quantitative genetic analyses may be able to provide a means to capture a high percentage of genetic gain with minimal effort and at substantially reduced costs.

The utility of BWB using reforestation blocks planted with bulked orchard seedlots (i.e., unstructured planting material) is under investigation. The potential time and cost savings of BWB may be extremely relevant in developing countries or with minor tree species that do not warrant the establishment of full blown breeding programs.

For further information contact Yousry El-Kassaby, Department of Forest Sciences, at 604-822-1821 or y.el-kassaby@ubc.ca. This work is supported by an NSERC Discovery Grant.

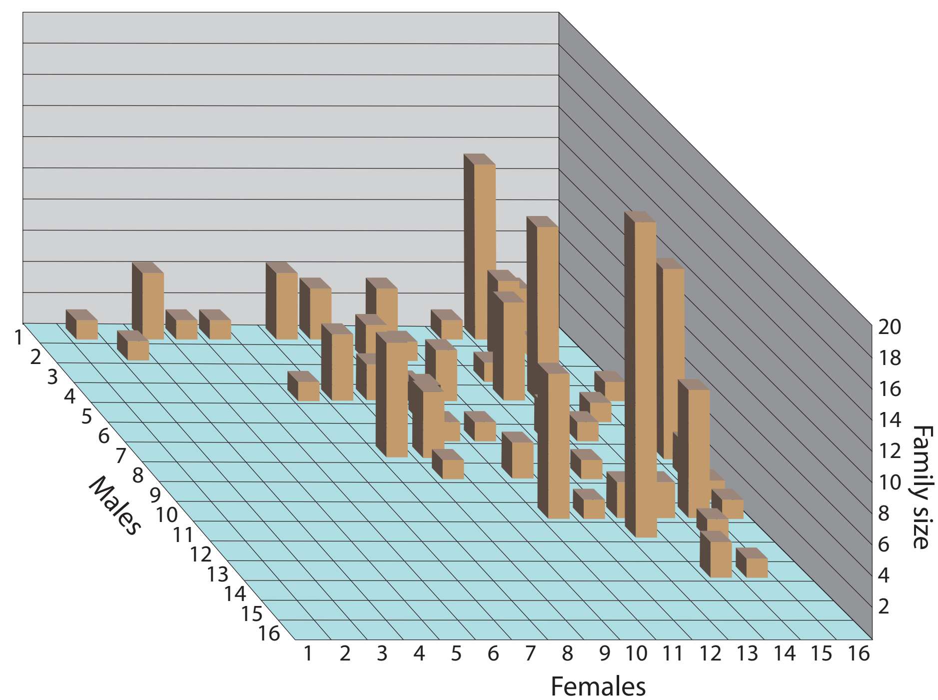
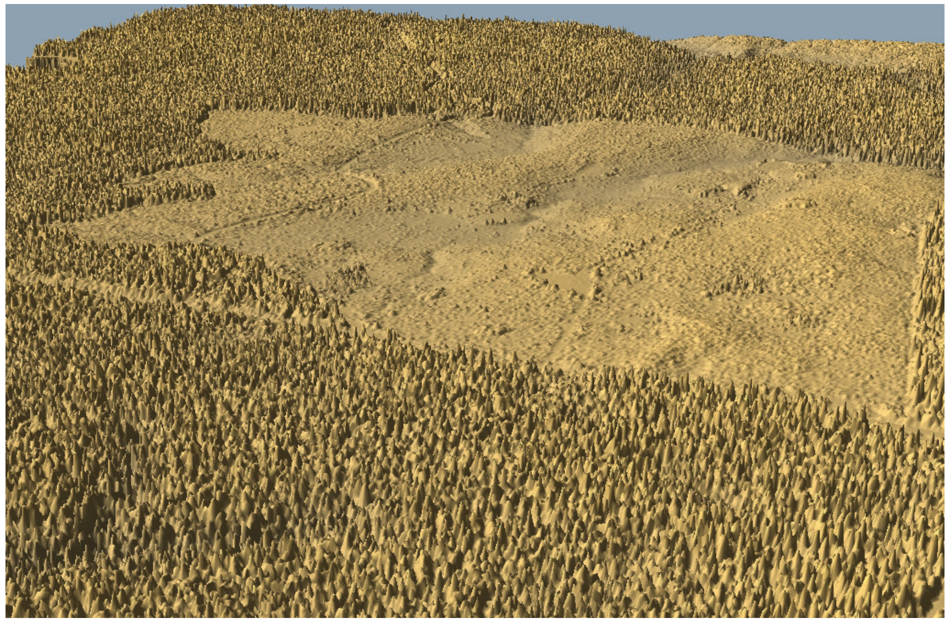


Figure 2. Formation of a mating design known as incomplete partial diallel using DNA fingerprinting and pedigree reconstruction.

Kissing the sky

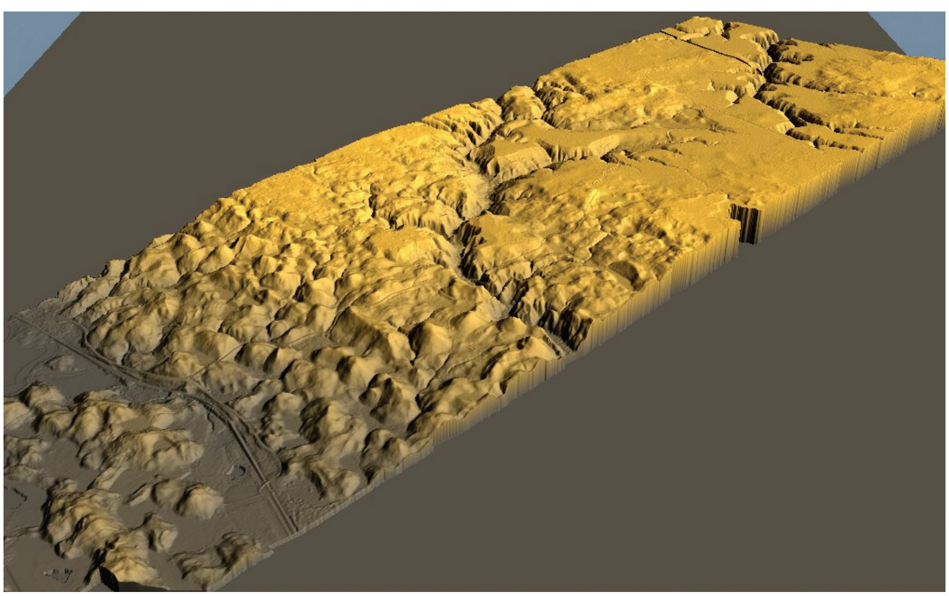
Evaluating new remote sensing technologies at Aleza Lake Research Forest

THE ALEZA LAKE RESEARCH Forest Society, the University of Northern British Columbia, the BC Ministry of Forests and Range, and the University of British Columbia have recently teamed up to evaluate and compare the use of two relatively new remote sensing technologies to assess high priority forest values in managed and unmanaged spruce/subalpine fir forest types in the SBS wk1 (wet-cool) ecozone east of Prince George. While conventional airphotos and optical satellite imagery demonstrate limitations (e.g., time consuming analysis and low resolution), LiDAR (Light Detection And Ranging) and large scale digital aerial photography both have the potential to assess forest condition efficiently, providing detailed information to describe topography and forest structure.



A forest canopy model image generated from LiDAR data with a vertical exaggeration of 3x. Note the 17 year old cutblock in the centre where retention patches are easily identified.

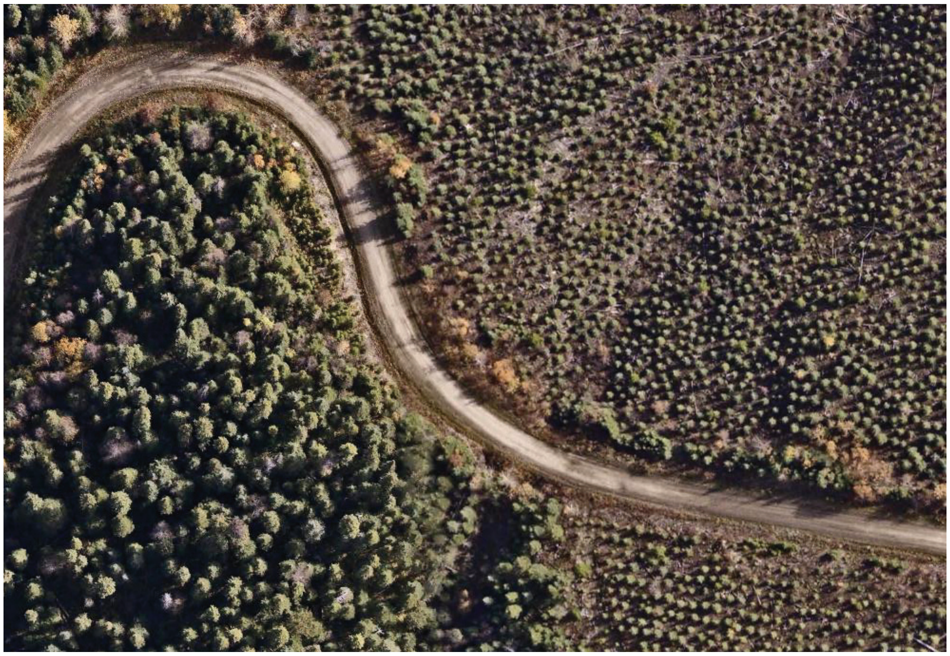
The data for this study uses recently acquired LiDAR (Aug., 2006) and large scale digital photography (Oct., 2006) for a 1,250 hectare section of the Aleza Lake Research Forest (ALRF). The area was specifically located for its: 1) topographic and vegetative diversity; 2) overlap with recently measured sample plots; 3) diversity of management regimes including unharvested forest, partial cuts, and clearcuts; and 4) overlap with areas targeted for harvest in the next 5 years. Our focus is to evaluate the use of these two systems in the context of measuring three forest values: understory conifer vegetation, timber volume, and carbon stocks.



A LiDAR-generated digital elevation model image with a vertical exaggeration of 5x. This data also produced 1m contour topographic maps of the Aleza study area.

Although LiDAR has been around for about 40 years, its application as a forest management tool is only now fully realized. Mounted in an airplane, the LiDAR system emits intense pulses of light (lasers) toward the ground. Each signal is reflected from either ground or forest canopy surfaces to the plane and the time between emission and reception is recorded. Each time measurement is converted to the laser's travel distance, and each tract of land surveyed produces a

Kissing the sky (cont.)



High resolution digital aerial photography from the Research Forest showing a 16 year old spruce plantation (same one as shown in the LiDAR canopy model) next to an age class 8 unmanaged forest.

set of distances which can be used to determine the ground elevation and density and height of forest canopy layers. This technology generates high resolution data where tens of thousands of pulses are transmitted each second and returned at a sampling distance of less than 1 m.

Large scale digital photography allows capture of tree and forest attributes under a broader range of illumination conditions than conventional inventory photography. Imagery processing is eliminated since film is not used, and therefore product turnaround time is reduced. Softcopy photogrammetry with stereo viewing at a computer monitor using 3D glasses allows the interpreter to selectively view canopy structure to optimize inventory typing process, while strategically capturing the digital elevation model points.

Commonly used forest inventory tools (e.g., maps, conventional airphotos, regionally calculated yield tables) can present unique challenges with respect to planning harvest units and estimating their timber volumes in complex forest types. ALRF stands are strongly affected by subtle changes in topography, comprised of patchy, multi-aged forest types, and are composed of natural stands at the end of their optimal rotation age. These characteristics limit the ability to determine stand productivity and ultimately timber yield within potential harvest areas using current tools and methods. This study will determine if LiDAR and/or digital photography can overcome these limitations by using canopy densities and heights to improve harvest planning and by identifying areas with low productivity, canopy gaps, and understory regeneration.

Previous work on carbon stocks at ALRF measured all above- and below ground carbon in 147 stratified random plots (2003-2005). This work attempted to model forest management effects on carbon stocks to identify the best management options to optimize carbon sequestration. Using Landsat Thematic Mapper imagery with this data, researchers generated a series of spatially explicit carbon stock maps covering an 18 year forest management period. However, this data was too coarse and therefore inadequate for predicting carbon stocks in complex late seral stands. Using a portion of these carbon sample plots, the present study will determine if LiDAR can better quantify *in situ* forest carbon.

Should this analysis reveal a strong relationship between the remote sensing data and ground measurements, there is potential to interpolate the data to surrounding forest stands and to implement these systems as viable and inexpensive tools to conduct carbon budget, timber volume, and potentially other forest assessments across broad landscapes and over time.

For further information contact Melanie Karjala, Project Coordinator, Aleza Lake Research Forest, at 250-960-6338 or karjal0@unbc.ca.

Funding for this project is provided by the BC Forest Science Program. LiDAR algorithms were provided by Bluewater Business Solutions, Prince George.

Hot in my backyard

Using visualizations to bring the science of climate change into our everyday lives

UBC'S LOCAL CLIMATE Change Visioning Project is working to bridge the significant gap between global climate science and local policy by generating realistic imagery that lays out four local climate futures for local communities. The project aims to downscale global climate models and scenarios to a scale that matters to decision-makers and people – their neighbourhoods and backyards. The project is using GIS and simulation techniques to paint pictures of four alternative climate worlds with its first partner community, Delta. These worlds extend out to 2100 and are based on alternative decisions being made on adaptive or mitigative responses early in the century. They include:

1. **A Do Nothing** world where no effective action on climate change is taken,
2. **An Adapt to Risk** world where proactive measures are taken to reduce community vulnerability but no actions are taken to reduce greenhouse gases,
3. **An Efficient Development** world where sustainable development principles slowly curb (but do not reduce) greenhouse gas emissions,
4. **A Deep Sustainability** world where major emission reductions are made early in the century.

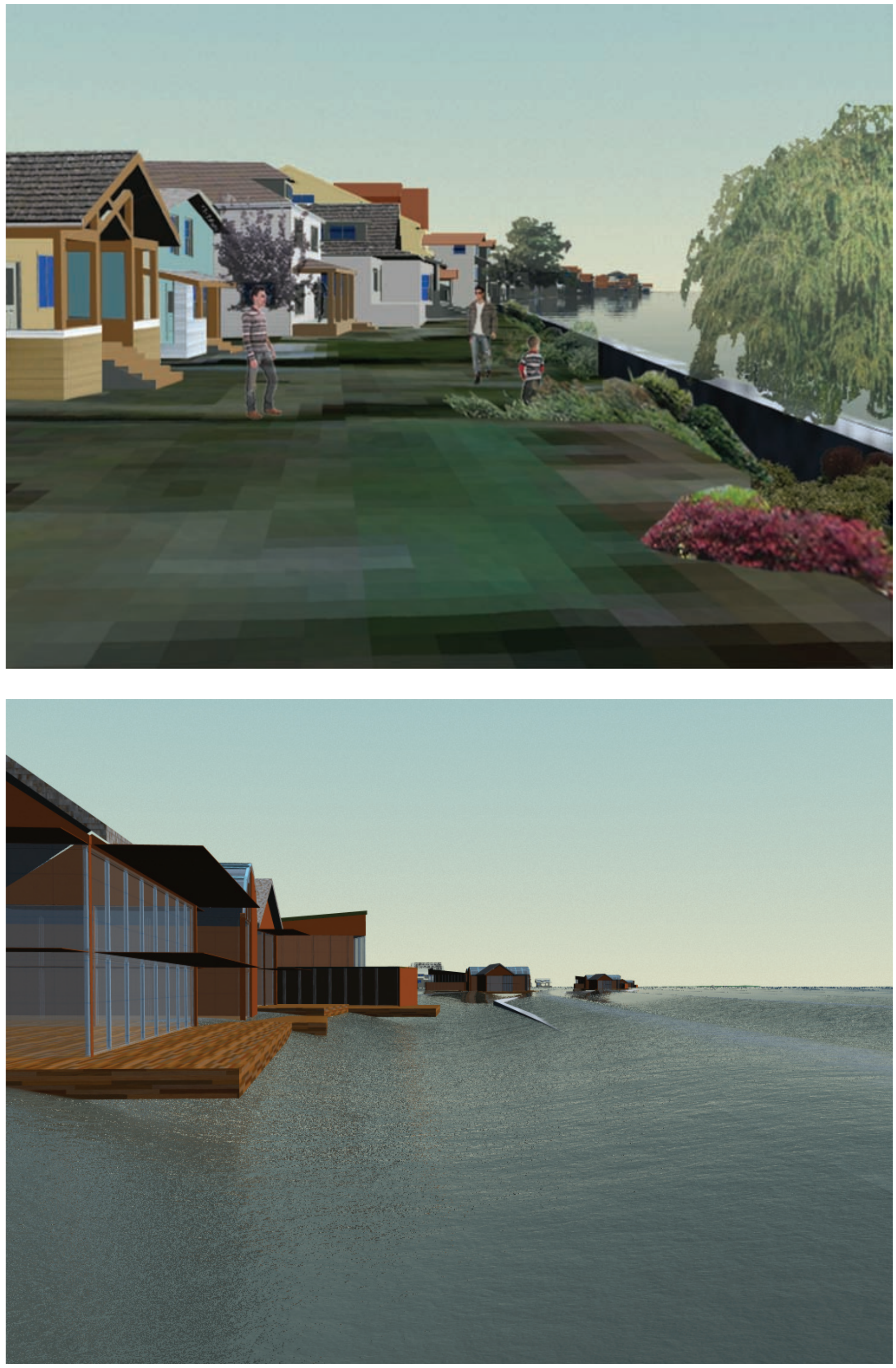


Figure 1: Visualization of existing coastal community (top), and the same scene with low-carbon, flood-adapted homes in 2100 during a high tide storm surge event (bottom).

The Local Climate Change Visioning Project uses visual imagery mixed with best available science to: build capacity for action in communities, generate an initial portfolio of potential response options available to a community, and motivate community efforts in generating and meeting their emission reduction targets (Figure 1).

Hot in my backyard (cont.)

This study provides compelling imagery to municipalities and their residents that communicates what in their urban and rural environments must change in order to meet the greenhouse gas (GHG) emissions reduction targets compatible with stabilizing atmospheric carbon dioxide concentrations in World 4. (Figure 2).

Figure 3: Photo of low tide condition in 2007 (top), and the same scene with possible high tide storm event visualized with sea-level rise (bottom).

Figure 2: Photo of a typical sub-urban scene in Burnaby (left), and a visualization of how this same area would look by 2020 if it were to adhere to GHG emissions target reductions for climate change stabilization (right).

Figure 4: Aerial visualization of 2007 mean tide (left), and projected sea level for 2100 high tide storm event corresponding to an IPCC regionally downscaled global climate model scenario, showing flooding at top of picture (right).

This 2-year project uses imagery to link local climate scenario data with the Intergovernmental Panel on Climate Change (IPCC) carbon emissions scenarios. Few studies exist that measure just how effective visualizations are at translating scientific data or influencing our awareness and behaviour (Figure 3).

The defensibility of the image library produced in this study has been tested in a series of perception-testing workshops, giving researches insight as to the utility of these tools for influencing attitudes and stimulating policy response (Figure 4).

Our preliminary results suggest that the visualizing of different futures at the local scale increased awareness about the interconnected and local aspects of climate change impacts. Awareness was also increased about the response options available to decision-makers and community members – leaving people with a degree of optimism about things that can be done. The local nature of the imagery also increased the emotional response to the climate problem as people were able to view familiar places in four alternative futures.

For further information contact David Flanders (flanders@interchange.ubc.ca) or Stephen Sheppard (stephen.sheppard@ubc.ca) at UBC's Collaborative for Advanced Landscape Planning. www.calp.forestry.ubc.ca

Biodegradeable roads

IN REGIONS WHERE the mountain pine beetle is active, inexpensive gravel is usually unavailable for surfacing temporary in-block roads. Temporary in-block roads constructed of the local soil, which can have a high silt and clay content, perform very poorly when hauling occurs during periods with rain and the ground is not frozen. Warmer winters, reduced transpiration of soil water, and the need to harvest mountain pine beetle-killed timber have resulted in the need to extend the operating season into periods when the ground is wet but not frozen. This project will assess whether mulching windrows of waste wood from right-of-way logging can produce an all-w eather road surface for in-block roads. Using mulched wood for the road surface will reduce the environmental impact because; it does not produce fine sediments, the permeability of mulched wood is much higher than for most gravels and sand, and it poses less of a barrier for reforestation.

Many regions in British Columbia do not have local sources of rock suitable for surfacing all-weather roads. In these regions surfacing material has to be hauled long distances, and the cost of hauling this material often limits the construction of any temporary all-weather roads. However, by using waste wood that is mulched on site, we can significantly reduce the cost of constructing all-weather temporary roads. Such temporary roads can increase the efficiency of logging operations in two ways. Firstly, using all-weather roads will increase the length of the operating season, and this will reduce scheduling conflicts and the need to stockpile large amounts of timber. Secondly, using in-block roads that have a reduced environmental impact will allow trucks to venture further into the cutblocks, which will reduce the skidding distance.

Photo Ken Day

Figure 1: Windrow of waste wood from right-of-way logging

Photos Darcy W. Moshenko

Figure 2: Gyro Trac GT-25 mulching windrow of waste material

This project is being conducted at the Alex Fraser Research Forest at Williams Lake. To date, three spurs have been laid out. Each spur was divided into three 50 m sections with the following treatments; waste wood from a 40 m right-of-way, waste wood from a 20 m right-of-way, and no waste wood. The waste wood from the right-of-way was windrowed along the centerline

Biodegradeable roads (cont.)

Photo Darcy W. Moshenko

Figure 3: Mulched waste wood.

using a John Deere 1270 Feller Processor (Figure 1). A Gyro Tech GT-25 mulcher was used to mulch the windrow of waste material (Figure 2). The depth and mass of mulch produced by the mulcher was sampled for each treatment, to characterize the resulting road surface. The mulched waste material appears to be well graded and if it stands up to the trafficking tests should produce a useable road surface (Figure 3).

One of the objectives of this study was to determine if sufficient mulched material could be produced from waste wood generated during right-of-way logging. Our study used right-of-way widths of 20 and 40 m as we needed to determine whether a standard right-of-way (20 m) could produce sufficient waste wood to surface a road. The stand considered in this study was quite variable. However, our preliminary results indicate that increasing the right-of-way width increased the amount of waste wood generated. In fact, the large amounts of waste wood generated from the wider right-of-way may have produced more mulched material than would be required, while increasing the time and cost of mulching. In practice it will require experience to manage the amount of waste material in the windrows, in order to optimize the mulching process while ensuring sufficient surfacing material.

The next stage in this project is to run a loaded gravel truck, (with axle loads equivalent to a loaded log truck), repeatedly along the spurs during a period when rain normally limits truck passage on roads made from the local soil. The objective of the trafficking trials is to determine if the mulched wood roads can support a greater number of truck passes than the soil roads, and to determine if the mulched wood roads can support a sufficient number of truck passes to be useful as in-block roads.

We are currently looking for support to continue research on these biodegradable roads. We anticipate a significant amount of mixing between the subgrade and the mulched wood during the trafficking tests. We intend to plant the spurs and the cutblock, and track the survival and growth of the seedlings over the next few years to determine if the mulched wood roads can be reforested without site preparation.

For further information contact Kevin Lyons, Department of Forest Resources Management, at kevlyons@interchange.ubc.ca or Ken Day, Manager, Alex Fraser Research Forest, at Ken.Day@ubc.ca. This project has been assisted by the FIA Forest Sciences Program.

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