GROWTH AND YIELD **INNOVATIONS CONFERENCE**

June 18-21, 2023 Canmore, Alberta

Acknowledgements

The organizing committee would like to thank the many people who have contributed information and provided assistance in putting this conference together. In particular, the committee would like to thank the Government of Alberta for supporting Katrina Froese's role as conference organizer. We would also like to thank Bogdan Strimbu for providing guidance and for leading the charge on ensuring that Western Mensurationist traditions (old and new) are represented at this event. Lastly, the conference committee would like to recognize the role of Sharon Meredith in providing the original vision and inspiration for this conference during her tenure as Director of FGrOW, and for her continued assistance during the planning of this event.

We hope you enjoy the conference.

Your organizing committee: Katrina Froese, Mike Bokalo, Dave Cheyne, Robert Froese and Juha Metsaranta.

OUR **SPONSORS**

Forest Growth Organization of Western Canada

The Forest Growth Organization of Western Canada (FGrOW) started operating in April 2015. FGrOW's vision is to be the leader in cooperative growth and yield research, model development and data management in western Canada. FGrOW seeks to drive the advancement of the science of forest growth and provide information to support policy development and changes in forestry practices. FGrOW serves its members by providing access to better forest growth data and knowledge, and to tools that support forest management decision-making. The organization has members from British Columbia, Alberta, Saskatchewan and Manitoba, with representatives from industry, government and academia collaborating to advance member-defined priorities.

Forest Resource Improvement Association of Alberta

Funding for this conference was provided through the Forest Resource Improvement Association of Alberta (FRIAA). FRIAA's mandate is to enhance Alberta's forest resource for the benefit of Albertans. FRIAA was created in 1997 and tasked with ensuring that a portion of stumpage fees collected by the Government were put to use supporting practical and applied research, on-the-ground improvement strategies as well as innovative approaches to help Alberta manage its forest resources in a sustainable manner.

mensuration (mèn´se-râ´shen):

1. the act, process, or art of measuring
2. the branch of mathematics dealing with the determination of length, area, or volume

Western Mensurationists

The Western Mensurationists are an informal group of mensurationists, biometricians and growth and yield professionals that meet annually to discuss issues relating to the measurement of forest resources. This group is mostly comprised of interested individuals from the western United States and from the western Canadian provinces, although all are welcome to attend. The Western Mensurationists' annual meetings generally last 2 to 3 days, and provide an opportunity for some of those attending to present current work and get informal feedback. The group mentors young mensurationists by giving graduate students a chance to present their research and by providing opportunities to meet with their more experienced peers in an informal setting. The group has been meeting for approximately 40 years, with the location of the meeting moving around the western region from year to year.

Land Acknowledgement

This meeting in being held on Treaty 7 territory. We would like to recognize those First Nations as well as Métis and Inuit people across Alberta who share a deep relationship with the land and who have lived in and cared for these lands for generations.

GROWTH AND YIELD
INNOVATIONS CONFERENCE

June 18-21, 2023 Canmore, Alberta

Conference Event Overview

Sunday, June 18		
Time	**Activity**	**Location**
5:00 pm – 8:00 pm	Registration	Concourse
5:00 pm – 10:00 pm	Icebreaker (Cash Bar)	Ladyslipper Arnica Room
Monday June 19		
7:00 am – 8:00 am	Registration	Concourse
7:00 am – 7:45 am	Hot Breakfast Buffet	Ladyslipper Arnica Room
8:00 am – 4:30 pm	Conference Events	Ladyslipper Arnica Room, Orchid Room
6:30 pm – 9:30 pm	Banquet Dinner (Cash Bar)	Ladyslipper Arnica Room
Tuesday June 20		
7:00 am – 7:45 am	Hot Breakfast Buffet	Ladyslipper Arnica Room
8:00 am – 4:15 pm	Conference Events	Ladyslipper Arnica Room, Orchid Room
Wednesday June 21 - Optional Field Tour		
7:00 am – 7:45 am	Continental Breakfast Buffet	Crocus Room
7:45 am – 8:00 am	Health and Safety, Forecast	Crocus Room
8:00 am – 8:15 am	Bus Loading and Departure	Muster Point
8:15 am – 4:45 pm	Field Tour	Kananaskis and Surrounds

Monday, June 19 – Day 1 Conference

Time	Ladyslipper Arnica	Orchid
8:00-8:30	**Introduction and Housekeeping** Katrina Froese	
8:30-9:30	**Keynote Address: Can we meet increasing demands for forest growth and yield information under increased scope, changing inventory technologies, and uncertain climate and disturbance regimes?** Dr. Valerie LeMay, RPF, Professor, Forest Biometrics and Forest Measurements, University of British Columbia	
9:30-10:00	**Tablet app for visualizing individual tree parameters with person-carried laser scanning (PLS) in forest inventory** Andreas Tockner, Dipl.-Ing., PhD Candidate, Institute of Forest Growth, University of Natural Resources and Life Sciences, Vienna	**Alternative subsampling designs derived from aerial and terrestrial remote sensing technology** Dr. John Kershaw, Professor, Forest Mensuration, University of New Brunswick
10:00-10:30	**Health Break**	
10:30-11:00	**Species identification from LiDAR** David Campbell, MScF, RPF, ForCorp Solutions Inc.	**Generalizing DBH and height prediction in coast Douglas-fir and red alder** Dr. Bogdan Strimbu, Associate Professor, Oregon State University
11:00-11:30	**Modeling aboveground carbon dynamics under different silvicultural treatments** Catherine Carlisle, Master of Forestry Candidate, Oregon State University	**Climate-sensitive mortality models in Ontario, Canada** Dr. José Riofrío, Department of Forest Resources Management, University of British Columbia
11:30-12:00	**Carbon budget of loblolly pine plantations in the southern US** Dr. Dehai Zhao, Senior Research Scientist, Warnell School of Forestry and Natural Resources, University of Georgia	**Census growth and yield models using only LiDAR and EFI data - no field data required** John Nash, Forest Ecologist, GreenLink Forestry Inc.
12:00-1:00	**Lunch and Group Photo**	
1:00-1:30	**5-Minute Lightning Talks *** - Noel Daugherty, U of Idaho - Surabhi Lukose, U of Alberta - Liam Gilson, U of BC - Dr. Mostarin Ara, U of Alberta - Yung-Han Hsu, U of New Brunswick - Christina Howard, U of BC - Benjamin Strelkov, U of Alberta - Dr. Sarita Bassil, U of Alberta	**Modelling tree-level western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) responses to fertilization** Dr. Woongsoon Jang, Research Scientist, BC Ministry of Forests
1:30-2:00		**Tree list growth and yield models for planted loblolly pine** Dr. Corey Green, Assistant Professor of Forest Biometrics, Virginia Tech
2:00-2:30	**Why you should NOT use site index** Greg Johnson, Greg Johnson Biometrics LLC and Dave Hamlin, Mt. Hood Biometrics LLC	**Estimating changes in forest attributes with 3D remote sensing** Dr. Piotr Tompalski, Research Scientist, Pacific Forestry Centre, Canadian Forest Service
2:30-3:00	**Health Break**	
3:00-4:00	**Keynote Address: Incorporating regeneration dynamics and reforestation treatment effects into growth and yield models** Dr. Dick Dempster, Forest Growth Organization of Western Canada (Retired)	
4:00-4:30	**Day 1 Meeting Wrap Up** Katrina Froese	

Tuesday, June 20 – Day 2 Conference

Time	Ladyslipper Arnica	Orchid
8:00-9:00	**Keynote Address: A paradigm shift in empirical growth and yield modelling: towards climate-sensitive models and large area predictions** Dr. Mathieu Fortin, Research Scientist, Canadian Wood Fibre Centre, Canadian Forest Service	
9:00-9:30	**Taper modeling for various genetic origins of Scots pine from Poland** Dr. hab Karol Bronisz, Warsaw University of Life Sciences, Institute of Forest Sciences, Department of Forest Management Planning, Dendrometry and Forest Economics	**Growth response to pre-commercial thinning of lodgepole pine is short-term but the effects on size distribution persist for decades** Dr. Shes Kanta Bhandari, Postdoctoral Fellow, Department of Renewable Resources, University of Alberta
9:30-10:00	**Assessing uncertainty in k-most similar neighbor imputations for sustainable forest management: a conformal inference approach** Dr. Liviu Ene, Researcher, Value Chains Program, Forestry Research Institute of Sweden	**Application results of handheld mobile LiDAR study in Turkey** Ergin Çankaya, PhD Candidate, Forest Growth & Yield Lab, University of Alberta
10:00-10:30	**Health Break**	
10:30-11:00	**Ecological forecasting of forest biomass with tree-ring and forest inventory networks** Dr. Kelly Heilman, Postdoctoral Research Specialist, ORAU/USDA Forest Service	**A stand-level evaluation of FVS growth projections for a LiDAR forest inventory** Dr. Jacob Strunk, US Forest Service and Dr. Peter Gould, Mason Bruce & Girard
11:00-11:30	**Revisiting stand density development of loblolly pine plantations in western gulf region, USA** Dr. Yuhui Weng, Associate Professor, Stephen F. Austin State University	**Commercial thinning and nitrogen fertilization increase merchantability in lodgepole pine: 20-year result** Apsana Kafle, MSc Candidate, Department of Renewable Resources, University of Alberta
11:30-12:00	**The Tree and Stand Simulator (TASS): still providing understanding after 6 decades** Jeff Stone, Stand Development Modelling Research Scientist, British Columbia Ministry of Forests	**Using machine learning and contemporary computational statistical techniques to improve forest management decisions** Dr. Cristian Montes, Associate Professor, Warnell School of Forestry and Natural Resources, University of Georgia
12:00-1:15	**Lunch**	12:45 Western Mens Business Meeting
1:15-1:45	**Climatic sensitivities derived from tree rings improve predictions of the Forest Vegetation Simulator growth and yield model** Courtney Giebink, Oak Ridge Associated Universities; USDA Forest Service, Northern Research Station, Forest Inventory and Analysis	**Machine learning approaches for estimating forest stand height using airborne LiDAR data in New Brunswick forests** Elham Behroozi, PhD Candidate, Faculty of Forestry and Environmental Management, University of New Brunswick
1:45-2:15	**Stand structure classification and the indexing of diameter and height distributions** Dr. Ian S. Moss, RPF, Forest Inventory & Growth and Yield Consultant, Forestree Dynamics Ltd.	**Putting stereo glasses on data scientists: EFI to AVI** Kat Gunion, Senior Forest Analyst, Forsite Consultants Ltd.
2:15-2:45	**Health Break**	
2:45-3:45	**Keynote Address: The digital forest: opportunities for improved forest management through improved information** Dr. Rasmus Astrup, Head of Research, Division of Forest and Forest Resources, Norwegian Institute of Bioeconomy Research	
3:45-4:05	**Day 2 Meeting Wrap Up** Paul LeBlanc	
4:05-4:15	**Best Student Awards & Adjourn** Katrina Froese	

Lightning Talk Speakers and Titles

Speaker	Title
Noel Daugherty, MSc Candidate, Forest Biometrics, University of Idaho	Defining and identifying site trees from LiDAR
Surabhi Lukose, MSc Candidate, University of Alberta	Mixing tree species along with density management to reduce drought susceptibility in coastal plantation forests of British Columbia
Liam Gilson, PhD Candidate, University of British Columbia	Causality and forest modelling: causal insights into predictive methods
Dr. Mostarin Ara, Postdoctoral Research Scientist, Forest Growth & Yield Lab, University of Alberta	Growth and yield models of Alberta: Can they predict commercial thinning response?
Yung-Han Hsu, PhD Candidate, University of New Brunswick	Modeling complexity in long-term stand dynamics using an imputation/copula individual tree growth model
Christina Howard, PhD Candidate, University of British Columbia	Climate sensitive mortality modelling of Québec tree species
Benjamin Strelkov, MSc Candidate, Department of Renewable Resources, University of Alberta	Effects of vegetation management on Leaf Area Index (LAI) and drought tolerance in a regenerating boreal mixedwood
Dr. Sarita Bassil, Postdoctoral Research Scientist, Forest Growth & Yield Lab, University of Alberta	Opportunities for long-term monitoring of mountain pine beetle effects using PSPs in Alberta

Poster Presentations

Presenter	Title
Jéssica Chaves Cardoso, PhD Candidate, Department of Renewable Resources, University of Alberta, Forest Biology And Management	Effects of density and site quality on growth resilience in aspen-spruce mixtures and pure stands using dendrometers
Mihai Voicu, Forest Research Officer, Northern Forestry Centre, Canadian Forest Service, Natural Resources Canada	New volume-to-biomass equations for small black spruce trees
Francis Scaria, MSc Student, Department of Renewable Resources, University of Alberta	Effects of stand age at pre-commercial thinning on merchantability and western gall rust infections in Lodgepole pine
Ethan Ramsfield, MSc Student, Department of Renewable Resources, University of Alberta	Silviculture intensification and structural diversity in boreal mixedwoods

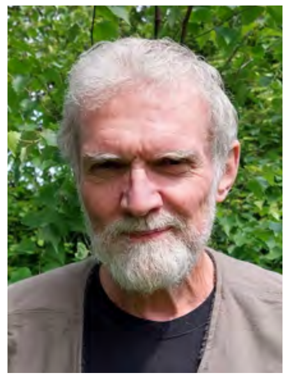
KEYNOTE ABSTRACTS

Can we meet increasing demands for forest growth and yield information under increased scope, changing inventory technologies, and uncertain climate and disturbance regimes?

Dr. Valerie LeMay, RPF, Professor, Forest Biometrics and Forest Measurements, University of British Columbia

Forecasts of forest ecosystems are critical for managing these ecosystems under natural and human disturbances, as well as for satisfying human curiosity. Growth and yield (GY) models have been developed for more than 100 years, and yield records of harvests from plantations and other forest areas have been passed down to foresters and managers for centuries. Using the fairly simple computer technologies of the 1970s and 80s coupled with remeasured permanent sample plots, complex GY models were developed in research facilities and universities. These models were connected to forest inventory maps and successfully used to forecast forest ecosystems under assumed past climate, natural disturbance, and human disturbance regimes. However, a number of changes have occurred, notably: 1) The demand for information on forest and other ecosystems around the globe has been exponentially increasing; 2) The variety of remotely sensed data sources has greatly increased, along with some increases in accessibility; 3) Accessibility of acquired data (e.g., plots, Landsat imagery, animal tracking, etc.) as well as derived data (e.g., maps, reports, Wikipages, etc.) has increased in response to demands; 4) New climate and natural disturbance regimes have been presenting around the globe; and 5) Human uses of forest ecosystems have increased in both amount (i.e., population pressures) and scope (e.g., new biofuels, biodiversity reserves, etc.). The question then arises: Can we meet demands for increasing demands for forest growth and yield information under these new conditions? In this talk, I will provide a brief overview of past GY models primarily using examples from western USA and Canada, with some connections to my own research. I will then talk about some of the latest developments in GY research, along with improved accessibility. Finally, I will provide my insights on the changes in GY models scope of conditions, connectivit with new data sources, and accessibility to models and information that will be needed to meet this increased demand.

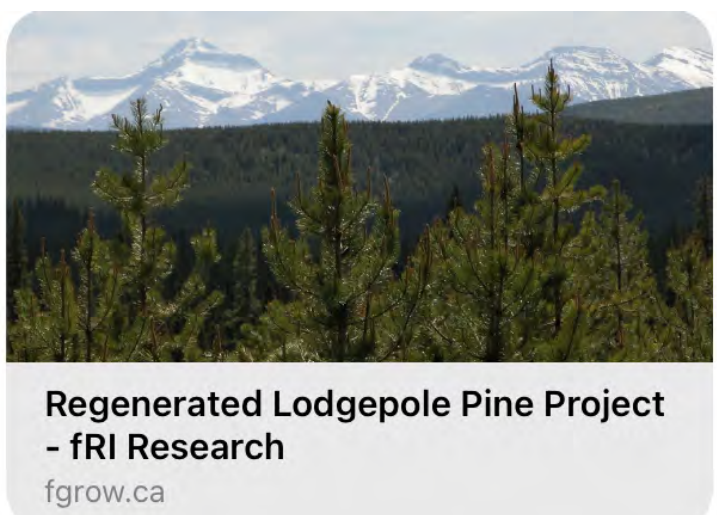
Incorporating regeneration dynamics and reforestation treatment effects into growth and yield models



Dr. Dick Dempster, Forest Growth Organization of Western Canada (Retired)

Modelling of forest regeneration dynamics has generally received far less attention than that of growth and mortality later in the rotation, in spite of the critical role of regeneration processes in maintaining forest ecosystems. The FGrOW Regenerated Lodgepole Pine (RLP) Project has over the last 20 years addressed challenges to forecasting development of forest stands regenerating in Alberta after harvesting, including uncertainty about their responses to reforestation treatments, and limitations of available data and models.

A large replicated field trial was established to investigate the effects of planting, vegetation management, and pre-commercial thinning across a wide range of site conditions. Data acquired from the trial and other sources were analysed to model the regeneration phase of stand development. The RLP Project has demonstrated additional opportunities and needs for innovation in regeneration modelling, including extension to other species and ecotypes, incorporation of climatic variables, the use of remote sensing as an alternative to ground sampling, and application of machine learning methods.



https://fgrow.ca/project/regenerated-lodgepole-pine-project

KEYNOTE ABSTRACTS

A paradigm shift in empirical growth and yield modelling: towards climate-sensitive models and large area predictions

Dr. Mathieu Fortin, Research Scientist, Canadian Wood Fibre Centre, Canadian Forest Service

Empirical growth and yield models play an important role in forestry as they provide insights into the future forest conditions. They have been traditionally developed to support management decision at the stand level. With the international agreements on biodiversity and greenhouse gas emissions, there is now a need for empirical growth models that can provide large-area predictions. Moreover, it is crucial that these models account for the ongoing climate change in their predictions.

This presentation addresses the issues of climate change in empirical growth modelling and how the model predictions can be scaled up at the regional and national levels. Firstly, we will review how climate change might affect the disturbance regime and the demographic processes of mortality, survivor growth and recruitment. Examples of climate integration into different Canadian models will be presented.

Secondly, we will look at different upscaling techniques with the objective of providing regional or national predictions of forest growth. The advantages and shortcomings of these different techniques will be highlighted. In most cases, the lack of consideration for error propagation induces a bias in large-area predictions.

The digital forest: opportunities for improved forest management through improved information

Dr. Rasmus Astrup, Head of Research, Division of Forest and Forest Resources, Norwegian Institute of Bioeconomy Research

Forest information on the current state of the forest and forecasts of the future forest development are a central component for sustainable forest management. In recent years, technology and method developments have resulted in: (1) improved information on the current state of the forest with remote sensing-based approaches; (2) improved forest Growth and yield models; and (3) increased digitalization and mechanization of silviculture and forest operations. Individually these advances are important but, in the context of improving sustainable management, the full benefits are only realized when these advances are connected. This occurs when information from remote sensing is fully utilized in modelling and form the basis for implementation of silviculture and forest operations. At the same time the information and data from silviculture and operations are captured and used to update inventories and to improve modelling.

This presentation will first highlight key individual advances in remote sensing, modelling and digitally enabled silviculture and operations. Secondly, we will look at how these advances can be connected to improve sustainable forest management.

PRESENTER ABSTRACTS

Tablet app for visualizing individual tree parameters with person-carried laser scanning (PLS) in forest inventory

Andreas Tockner, Dipl.-Ing., PhD Candidate, Institute of Forest Growth, University of Natural Resources and Life Sciences, Vienna

Improving growth and yield information for sustainable forest management needs a way of cheap and accurate data collection and prediction. Traditional data collection methods (e.g. relascope, calliper and electronic clinometers) send skilled persons out in the forest for a long time and allow only a rough conclusion about all trees in the forest. Therefore, 3D laser scanning has evolved over the last decade in forest inventory research.

One of the most promising systems on the individual tree scale is Person-Carried Laser Scanning (PLS). A human operator walks through the forest and carries the laser scanning system which acquires 3D-points in motion. The digital twin of the forest clearly resolves the stem shape, branches and tree crowns up to the top. In our study we extracted individual tree parameters from PLS data and compared them to traditional manual measurements. Diameter at breast height (DBH) and tree height could be accurately obtained from the point cloud (root mean square deviation of 2.32 cm DBH, and 1.21 m height).

For an interactive visualization of the tree positions and the individual tree parameters we designed a tablet app. The app was used for thinning simulations in cooperation with the Austrian federal forests. Four sample plots (each one hectare) were installed in middle-aged commercial forest stands, scanned with PLS and the data was analysed. Taking the app back into the forest we selected potential trees to be cut for thinning. The app reported the total volume of the selected trees and the impact on the stand's future diameter distribution. The potentially thinned forest stands were visualized in 3D on the computer and different thinning alternatives could be compared.

Data capture with PLS is fast, simple and provides reliable inventory data for complete forest stands. The tablet app provides a digital map of tree coordinates and thereby assists forest inventory on-site in collecting reference data and simulating the effect of harvesting operations. Possible future applications include localizing trees with a desired wood quality, analysing automatic thinning schemes or assessing deadwood volumes or forest regeneration.

Alternative subsampling designs derived from aerial and terrestrial remote sensing technology

Dr. John Kershaw, Professor, Forest Mensuration, University of New Brunswick

Much recent remote sensing forest inventory work has tossed aside decades of forest inventory sample design research. Remote sensing provides a wealth of covariates that can be used to design efficient, robust subsampling schemes. This presentation will highlight some of the results from my lab over the last 5 years.

Species identification from LiDAR

David Campbell, MScF, RPF, ForCorp Solutions Inc.

The use of remote sensing technologies to generate individual locations, heights, diameters, and species of trees in the forest has been a research objective for many years. To achieve results, remotely sensed data is typically summarized into polygons or rasters at a defined level of precision. Polygons and rasters are representative of the data underneath but rely on statistics to generate summaries of tree counts, species, and heights. These inventories and data descriptions are useful but do not provide accurate 1-to-1 assessments of knowing every tree and its physical properties.

We will present our methods for defining two of the more complex pieces to complete the description of a tree from remotely sensed data: (i) the geographic position of each tree, and (ii) the species of each tree. Our unique approach employs a highly precise, one-of-a-kind dataset, existing as a 10 cm^n inter-connected virtual landscape. This process has currently identified 105% of all trees, predicting their species correctly 85% of the time.

This presentation reviews the science and methods behind tree geolocating and species assignment, including the research, results, and their role within a production system to access landscape information. Application of this data within a growth and yield context will be reviewed.

PRESENTER ABSTRACTS

Generalizing DBH and height prediction in coast Douglas-fir and red alder

Dr. Bogdan Strimbu, Associate Professor, Oregon State University

Little attention has been given to regression models for predicting diameter at breast height (DBH) from tree heights obtained from aerial LiDAR or other datasets. We fit 31 base and generalized DBH regression forms to coast Douglas-fir (Pseudotsuga menziesii var menziesii, n = 20,020) and red alder (Alnus rubra, n = 3307) cruise data alongside 27 base and generalized height forms. The most accurate DBH models lacked the asymptoticity found in height models and, for red alder, were concave upwards rather than downwards. DBH prediction selected different model forms than height prediction, exhibited larger error due to greater variance, and DBH regressions underperformed nonparametric controls rather than outperforming them as height regressions did. Height and diameter predictions are therefore not duals of each other and simply inverting existing height models to predict diameter most likely limits accuracy. Further investigation of DBH model forms appears valuable, particularly where stem mapped datasets facilitate use of point cloud predictors.

Modeling aboveground carbon dynamics under different silvicultural treatments

Catherine Carlisle, Master of Forestry Candidate, Oregon State University

Forest management decisions affect carbon stock and rates of sequestration. The rotation age that will optimize sequestration over extended periods is the subject of debate. Some argue that shorter rotations facilitate faster sequestration rates due to the accelerated growth rates of younger trees compared to mature or old-growth trees. Others maintain that frequent harvesting will not allow forest carbon to rebound after each subsequent rotation, and thus more extended periods between clearcutting is the superior choice. These contrasting viewpoints are mirrored regarding the impact of silvicultural treatments, that either thinning will enhance the uptake of forest carbon by facilitating faster growth of residual trees or that the removal of any above-ground biomass will outweigh the yields.

This study aims to compare the different suites of management decisions and identify practical combinations of rotation ages and thinning applications that will optimize carbon sequestration while meeting other objectives. Stand development under different harvest intervals, and thinning specifications was modeled using a forest vegetation simulator (FVS). We found that site productivity was the major determinant in stand-above-ground carbon dynamics under the scenarios. Thus, the optimal rotation age/thinning treatment combinations differed between site classes. Site classes I, III, and IV were estimated to sequester the most above-ground live carbon under either a single 120-year or 80-year rotation with or without thinning treatments rather than multiple 40- or 60-year rotations. Site class II sequestered the most carbon at a faster rate under an 80-year rotation schedule (0.918 T C/ac/year). For all site classes, one or two low to moderate-intensity commercial thinning applications facilitated faster carbon uptake than they did under a "no thin" scenario for 120-year rotations. 80-year rotations sequestered the most carbon when either zero, one, or two thinning treatments were applied, depending on the site class. For all four site classes, high-intensity thinning applications defined by a residual stand density index of 130 were found to negatively impact total sequestration for all four site classes.

Climate-sensitive mortality models in Ontario, Canada

Dr. José Riofrío, Department of Forest Resources Management, University of British Columbia

Tree mortality is a complex, multifactorial process with short- and long-term impacts on different forest dynamics. Empirical mortality models integrated in individual-based forest growth simulators make it possible to predict the probability of mortality of individual trees as a function of tree, stand, and site characteristics. However, in most empirical simulators, mortality is predicted without consideration for climate variables.

We developed climate-sensitive tree mortality models for thirty species in Ontario using ~400,000 tree observations over successive measurements between 1961-2020 from ~6,000 permanent sample plots. We used a logistic regression approach that considers the effect of period length in the model structure. A large array of tree, stand, site and climate variables were tested in the mortality models. Models with all the coefficients being significant ($p < 0.05$) were first selected, then we used BIC weights for selecting the best final model by species.

Our results showed that, in general, expressions of competition status and tree size were present in the models for all species and had stronger effects on tree mortality than the mean climate conditions. The best final models for four out of thirty species did not include any climate variable. Also, there was no common climate variable in all twenty-six models with climate variables. Our findings highlight the importance of considering not only tree- and stand-level variables but also climate conditions in tree mortality models. Given the ongoing climate change, having climate-sensitive mortality models will help understand and predict the functioning and dynamics of forest ecosystems under changing environmental conditions.

PRESENTER ABSTRACTS

Carbon budget of loblolly pine plantations in the southern US

Dr. Dehai Zhao, Senior Research Scientist, Warnell School of Forestry and Natural Resources, University of Georgia

Intensively managed pine plantations in the southeastern US could not only meet the increasing demand for traditional wood products and biomass for energy, but also play a critical role in meeting US GHG emission reduction goals through additional carbon sequestration. Adapting forest management to mitigate climate change requires an understanding of the long-term effects of silvicultural treatments on forest production and carbon sequestration.

A loblolly pine (Pinus taeda L.) silviculture-by-density study was initiated in 1995/96 with 40 installations across the southern US. Each installation contains 12 large plots planted at six levels of planting density (ranging from 740 – 4448 trees/ha) in combination with two levels of silvicultural intensity (operational vs. intensive management). With the long-term data from this study, we assessed the impact of site quality, cultural intensity, and planting density on temporal dynamics of aboveground net primary production in carbon (ANPPC), total carbon uptake, aboveground living tree biomass carbon (AGC) stocks, and cumulative carbon released back to the atmosphere.

Silvicultural intensity and planting density significantly affected ANPPC before age 15 years. Total carbon uptake was significantly affected by site quality at early ages, and by both culture and planting density over the study period. Carbon released back was significantly affected by site quality during mid-rotation, by planting density after age 6, and by silvicultural intensity over time. AGC stocks were significantly affected by site quality at early and late ages, by silviculture intensity before age 15, and by planting density over time. After age 20, stands on higher quality sites stored higher amounts of carbon, but higher-planting density stands might store less carbon, with no significant differences between silvicultural intensities.

Our results indicate that management practices that enhance growth and carbon absorption in young stands do not necessarily result in more carbon storage at later developmental stages. The relationship between management practices and carbon sequestration in plantations needs more research to further develop climate-smart forest management practices.

Census growth and yield models using only LiDAR and EFI data - no field data required

John Nash, Forest Ecologist, GreenLink Forestry Inc.

'Census' growth-and-yield curves were developed from coniferous cubic-meters-per-hectare estimated from a LiDAR derived landscape forest-metrics model and compared to curves generated from TSP data. For the landscape forest-metrics model, each applicable AVI polygon is sampled uniquely for merchantable tree volume (m3) in an automated way using LiDAR data, a stem-mapping algorithm, AVI attributes, orthophoto data as well as provincial site-index, height to diameter and individual tree models. No field data was used in its development. Each AVI polygon in the net-landbase is now part of the sample driving the growth and yield model and thus the sample size is greatly increased.

Comparison of census versus plot-based growth and yield modeling was conducted in FMU S17. The stratification used was 9 of the 10 provincial base strata. The total sample size for the TSP driven model was 937 plots. The total sample size for the census driven model was 51,080 polygons. Perfect, to near perfect one-to-one relationships were realized in the white-spruce and white-spruce mixedwood base-strata. In the pine base-stratum however, the census model significantly underestimated coniferous volume compared to the TSP model. It was theorized that this was due to the generally undersized and higher density condition of pine stands in FMU S17 coupled with the fact that the LiDAR data used was of relatively low resolution (1.1 PPM) and over 10-years old.

A second study was carried out in FMU R10. In this case, the landscape forest-metrics model was based on more recent higher resolution LiDAR data (12 PPM). For the pine base-stratum, a near perfect relationship was realized with the census-based model having a more ecologically reasonable representation of volume past 130 years.

The two case studies indicate that census-based data used in growth and yield modeling can be as robust if not more robust then field sampling. Because the entire landbase and hence, stand age distribution is sampled there is no: 1) sampling error; 2) theoretical adjustment of the curves due to lack of data; 3) sampling bias from issues such as access constraints.

Modelling tree-level western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) responses to fertilization

Dr. Woongsoon Jang, Research Scientist,
BC Ministry of Forests

The fertilization response of western hemlock (Tsuga heterophylla (Raf.) Sarg.) varies greatly according to environmental factors such as climate, stand and soil conditions, and fertilization type. Therefore, accurate fertilization response assessment is critical for effective

forest management and carbon sequestration. Extensive and high-quality datasets from the Stand Management Cooperative in the United States and Experiment Project 703 in Canada are available to create individual tree-level fertilization response models for western hemlock.

We modelled height and dbh growth responses with non-linear mixed effects models. The fertilization effect was accounted for multiplicatively on the base growth models. A Weibull probability density function quantified the magnitude of the fertilization effect over time. In addition, the mortality model was constructed using a generalized linear mixed effects model with a logit link.

The results showed that western hemlock growth was influenced not only by stand-level parameters (e.g., stand density, site index) but also by the basal area in larger trees crown ratio. Dominant trees and those with larger crown ratios had positive height growth responses, but negative dbh growth after fertilization. Fertilization had the highest dbh growth effect three years after application and the largest height growth after six years. Fertilization increased the overall mortality rate but ameliorated it for slower-growing, more suppressed trees. These complicated fertilization responses of western hemlock may imply its physiological characteristics (e.g., shade tolerance) and resource allocation strategy at a given size and social standing. The results suggest that the tree-level modelling approach improves understanding of the fertilization response and growth and yield modelling accuracy.

Tree list growth and yield models for planted loblolly pine

Dr. Corey Green, Assistant Professor of Forest Biometrics, Virginia Tech

Whole-stand growth and yield models have been the primary modeling approach for loblolly pine in the southeastern United States. Stand-table projection has been commonly used to grow tree lists while remaining consistent with whole-stand attributes. Distance-independent, individual tree models are less frequently used to project attributes in loblolly pine plantations but are common in other regions such as the Pacific Northwest. We present results of a comparison between stand-table projection (FASTLOB), and two distance-independent individual tree models, TRULOB and an adapted version of ORGANON. All models have unique structures and were fit using the same data for the primary model components and validated using an independent dataset representative of operational loblolly pine plantations. In addition to modeling results, challenges and future opportunities will be discussed.

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Why you should NOT use site index

Greg Johnson, Greg Johnson Biometrics LLC and **Dave Hamlin**, Mt. Hood Biometrics LLC

Site index is widely used in forestry and is seen as an important tool for effective forest management. Starting with a recognition that productivity varied, sometimes substantially, across the landscape site index provided a simple, measurable way to classify the underlying productivity of the forest. Site index's simple beginnings hide a wide variety of complexities that render it impotent to answer today's management questions and perhaps more concerning its potential to misdirect silvicultural decision-making. We explain the original motivations for site index, the issues that arise in its development and use, and propose some alternatives.

Estimating changes in forest attributes with 3D remote sensing

Dr. Piotr Tompalski, Research Scientist,
Pacific Forestry Centre, Canadian Forest Service

The increasing availability of three-dimensional point clouds allows for accurate and detailed forest inventory information, and analysis of forest structure changes. Bi- and multi-temporal point cloud datasets offer potential for enhanced analysis of forest growth, with different approaches and levels of detail used across different forest types. Exciting research shows that the analysis of change can be performed using different approaches, levels of detail, or source data. The presentation divides the existing approaches into two broad categories and explains how multi-temporal point clouds can be used for estimating change as well as for forecasting forest inventory attributes. Possible integration with growth simulators, and ultimately, the development of growth models driven entirely with point cloud data is also discussed.

Taper modeling for various genetic origins of Scots pine from Poland

Dr. hab Karol Bronisz, Warsaw University of Life Sciences, Institute of Forest Sciences, Department of Forest Management Planning, Dendrometry and Forest Economics

Scots pine is the main forest-forming species in Poland. It covers 5367 thousand hectares, which translates into a 58.2% share of this tree species in Polish forests. Growing stock equals 1598 million cubic meters (61.2%).

Information about the tree stem shape, as well as the volume (whole stem and its various assortments), is one of the most important factors used in forest management planning, forest operations, and the timber industry. One of the possibilities for defining the shapes of trees is to develop taper models, which allow the diameter to be determined at any place on the stem. This information then enables the calculation of volume, biomass, and the amounts of various wood products, and using growth models is a basis for reasonable decisions.

Forest inventory data, including diameter measurements along the stem used as a basis for taper models, are often characterized by a hierarchical structure, which contains information about individual diameters, trees, or plots. The mixed-effects models, where the fixed and random effects are distinguished, are possible solutions for these types of data.

The data used for modeling consisted of information and measurements collected from Scots pine trees of diverse genetic origin (16 parent populations, 151 felled trees) grown at the Rogów Forest Experimental Station in central Poland.

Ten taper models with different numbers of estimated parameters were analyzed using fixed and mixed-effects modeling approaches. Fitted taper models were compared based on goodness-of-fit *measures such as coefficient of determination, mean error, and Akaike Information Criterion. The variable-form taper model parameters fitted the data the best and the inclusion of the origin and the tree as a random effect allows us to obtain greater accuracy of the created models.*

Growth response to pre-commercial thinning of lodgepole pine is short-term but the effects on size distribution persist for decades

Dr. Shes Kanta Bhandari, Post Doctoral Fellow, Department of Renewable Resources, University of Alberta

Pre-commercial thinning in Alberta has been considered as a potential option for increasing the growth rate and shortening the rotation age of regenerating forests. Previous studies have focused on the evaluation of either the immediate or long-term response of thinning many decades after thinning. This study compared the thinning response in lodgepole pine for a 10-year period immediately after thinning and again 38-45 years after thinning based on 22 paired plots of pre-commercial thinned trials in Alberta. The first group of plots was thinned in 1984 and measured in 1985 and 1995 (short-term) and the second group of plots was thinned between 1962 and 1969 and measured in 2007 and 2017 (long-term).

In the short-term, individual tree DBH growth was 56% greater in thinned plots, while in the long-term, there were no differences between thinned and unthinned plots. Small and medium-sized trees benefited more from thinning than large trees. At the stand level, the number and volume of merchantable-sized trees (≥13.5 cm DBH) were higher in thinned plots than in unthinned plots in both the short and long-term. Although the growth response of thinning appeared to be a short-term response, yield (number and volume of larger trees) at the end of the long-term measurement period is still higher in thinned plots than in unthinned plots.

Assessing uncertainty in k-most similar neighbor imputations for sustainable forest management: a conformal inference approach

Dr. Liviu Ene, Researcher, Value Chains Program, Forestry Research Institute of Sweden

Product recovery predictions are critical tools in forest planning to ensure sustainable management of forest resources and optimize wood flows in the forest industry. In this study, we examine the possibility of quantifying the uncertainty of k-Most Similar Neighbor (k-MSN) imputations, which are custom product recovery prediction systems implemented by most of Swedish forest companies. These imputations combine standardized harvester production files, forest register information, and various types of GIS products.

The study objective is twofold: (1) to predict species-specific volumes and diameter distribution predictions, and (2) to assess the prediction accuracy for species-specific volumes using locally adaptive split conformal inference. The uncertainty of kMSN predictions will be assessed using simulations on a dataset containing standardized harvester production files and multi-source, multi-temporal GIS data from over 3800 forest tracts located in Southern Sweden. To address heteroskedasticity, multivariate quantile random forests will be used for constructing the conformal prediction intervals. The numerical properties of conditional and unconditional coverage probability be examined using simulations.

Preliminary results indicate that the conformal inference approach produced coverage rate estimates that are very close to the desired nominal levels. The work will provide a valuable framework for forest planners and managers to make informed decisions based on risk value of information assessments about the sustainable management of forest resources and efficient planning of forest operations.

Application results of handheld mobile LiDAR study in Turkey

Ergin Çankaya, PhD Candidate, University of Alberta

Turkey has been collecting forest inventory since 1960, and the "Ecosystem-based Multi-Functional Planning" approach was adopted in 2008. Light detection and ranging (LiDAR) technology has become increasingly popular as a low-cost data-collecting approach for forest inventories in Turkey. The study was conducted in the Karagöl Sahara National Park - Northeastern part of Turkey, which is one of the toughest conditions having a dense understory, high slope, stony-rocky and unique conditions having rich, diverse species and transition-type climate. The selection criterion for this challenging field of study is that if the results of accuracy and reliability levels obtained with LiDAR-derived metrics are given with a reasonable margin of error, this method will probably be suitable for use anywhere in Turkey. The purpose of this research is threefold: (1) to offer an automated technique for generating critical inventory data for individual tree parameters utilizing the handheld mobile LiDAR data method since much research included additional data processing processes that are difficult to complete manually, (2) to demonstrate how handheld LiDAR technology can be used in forest inventories, and (3) to compare the measurements obtained through LiDAR with traditional methods.

In the study area, a total of 1290 tree measurements were made in 39 sample plots, and LiDAR was used to scan sample plots and trees when measuring ground surveying. The main targets of inventory parameters were diameter at breast height (DBH), number of trees (N), total height (H), crown closure (CC), and total volume (V). The results showed that there was no significant difference between

measured by LiDAR and ground surveying at the individual, plot level and stand level (P < 0.05). There were also robust correlations between LiDAR and field-derived measurements, including DBH: r=0.998, R2=99.5%, ME=0.68cm, N: r=0.980, R2=96%, ME=2.8 trees/ha, H: r=0.940, R2=91%, ME=1.2m, and V: r=0.850, R2=86%, ME=14.6 m3/ha. However, the mean error rate for tree volume was high, which was attributed to the reference data obtained from existing single-tree volume tables. To address this, twelve standing trees were scanned by LiDAR, and then felled and volumized using the section method, which showed that LiDAR calculated volumes with a ME of 0.061 m3 (R2=94.9%) at the tree level. In the forest inventory protocol in Turkey, the plots taken in the form of circles, generally 400 m2, 600 m2 and 800 m2 in size according to the CC, and only three of the 39 plots differed between the LiDAR and ground truth datasets, correctly estimated occlusion of 92% of the plots.

In conclusion, handheld mobile LiDAR technology can efficiently and accurately calculate tree and stand parameters. The proposed approach has the potential to significantly improve the cost efficiencies and accuracy of the individual and stand inventory, which is essential for effective forest management and planning. Refinement of these results will lead to further benefits and will be explored in new research here in Alberta.

Ecological forecasting of forest biomass with tree-ring and forest inventory networks

Dr. Kelly Heilman, Postdoctoral Research Specialist, ORAU/USDA Forest Service

Forest responses to future climate change are highly uncertain, but critical for forecasting and managing forest carbon dynamics. Repeat forest inventories, such as the US Forest Service Forest Inventory and Analysis (FIA) program, currently provide 5-year or decadal estimates of standing forest Carbon stocks across space, but lack detail about how annual climate variation affects Carbon uptake. Tree-ring time series data can fill this gap, providing annually-resolved growth responses to climate. By combining these two data sources, tree-ring time series and repeat forest inventory measurements, provides an opportunity to estimate the effects of changing climate on tree growth and quantify uncertainties around forest carbon.

We use a Bayesian state-space model to fuse information from >1000 ponderosa pine tree-ring time series and repeat measurements of diameters in the intermountain west US. This modeling approach estimates annual tree growth and diameter, and allows us to statistically parse the effects of annually varying climate, density-dependent competition, site quality, and their interactions on annual tree growth. To scale these estimates up to future forecasts of stand-level aboveground forest C, we simulate tree mortality, and estimate tree-level aboveground Carbon with a Bayesian allometric model for ponderosa pine.

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This data fusion approach advances forecasting of forest carbon in two ways – first, it provides empirically-constrained forecasts of how climate change will influence both tree-level and stand scale growth and biomass, which can be validated with incoming forest inventory data. Second, this data fusion approach, and the routine remeasurement of forest inventory plots sets the stage for an iterative forecasting system of forest carbon, and expansion of this approach across the US FIA network.

A stand-level evaluation of FVS growth projections for a LiDAR forest inventory

Dr. Jacob Strunk, US Forest Service and
Dr. Peter Gould, Mason Bruce & Girard

In this presentation we evaluate stand-level growth trends for a lidar forest inventory at the Savannah River site in South Carolina. Tree lists for a sample of 50 stands were produced with both on-the-ground measurements and a kNN lidar-based imputation forest inventory. Stands were projected into the future for 6 levels of management intensity. We demonstrate the agreement in growth projections between field-based and lidar-based forest inventory projections. Volume, carbon, and value are summarized by species and merchandising groups. We also present our assessment of contributing factors for deviations between field-measurement-based projections and lidar-based projections.

Revisiting stand density development of loblolly pine plantations in western gulf region, USA

Dr. Yuhui Weng, Associate Professor,
Stephen F. Austin State University

Site quality and stand density, together, are strong indicators of potential timber productivity of loblolly pine plantations. Therefore, stand density management decisions are critical for managing loblolly pine plantations. The East Texas Pine Plantation Research Project (ETPPRP), a long-term, comprehensive research program, installed and managed numerous permanent plots in loblolly pine plantations across east Texas between 1982 and 2015. During the period, many of these plots were maintained untreated (e.g., no silvicultural activities were applied) and remeasured on a 3-year cycle, providing a unique opportunity to investigate density trends as stands developed. Temporal trends of key stand density measures such as per-hectare trees and basal area, stand density index and relative density and their relationships with periodic and mean annual increments will be discussed.

Commercial thinning and nitrogen fertilization increase merchantability in lodgepole pine: 20-year result

Apsana Kafle, MSc Candidate, Department of Renewable Resources, University of Alberta

Impacts of climate change like drought, wildfire, and pest infestations have raised concerns for forest timber supply globally. Boreal forests of Alberta, Canada are also witnessing decrease in Annual Allowable Cuts (AAC) that has raised concerns for sustainable timber supply. Past research suggests intensive silviculture treatments like commercial thinning and nitrogen fertilization as a possible strategy to boost stand and tree-level growth and productivity in commercial species like lodgepole pine and other conifers. However, concreate information on how natural lodgepole pine stands respond to these treatments at the late rotation stage is missing.

This study was conducted to address stand and individual tree-level growth effects of commercial thinning and fertilization on a 68-year-old lodgepole pine stand in the upper foothills of Alberta. A 2×6 factorial experiment with commercial thinning at two levels (thinning and unthinned) and nitrogen fertilizers at six levels (No fertilizer, 200 kg/ha N+Boron, 200 kg/ha N+blend, 400 kg/ha N+Boron, 400 kg/ha N+blend and 400 kg/ha N+Ammonium nitrate) was established in 2000 and then re-measured 20 years later.

At the stand level, commercial thinning alone increased the cumulative merchantable volume (volume removed at time of thinning + final standing volume). Individual diameter growth response was size and treatment dependent with thinning favoring medium-sized trees (10.1-15 cm) but fertilizer increasing the growth of larger trees (15.1-20 cm). Increasing amount of fertilizer (400 kg/ha N> 200 kg/ha N> Control) increased individual growth and density-dependent mortality of small-size trees (<10 cm). Thinning and fertilization combined had an additive effect and produced more good saw logs per hectare than individual treatments. Overall, commercial thinning and fertilization can be used to increase merchantability on natural lodgepole pine stands even during later rotation.

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The Tree and Stand Simulator (TASS): still providing understanding after 6 decades

Jeff Stone, Stand Development Modelling Research Scientist, British Columbia Ministry of Forests

The Tree and Stand Simulator (TASS) was envisioned to be a biologically oriented model designed to assess the effects of cultural practices and environmental factors on stand development for use in forest management, teaching, and research. From this early 1960s vision, Ken Mitchell developed the Tree and Stand Simulator (TASS) for his Ph.D., a spatially explicit individual tree model for the simulation of even-aged stands of white spruce (TASS I). In the 1970s, with increased computing resources, TASS changed to a 3D crown structure (TASS II) and was used to explore Douglas-fir management. In 1980 Ken Mitchell and TASS II moved to the British Columbia Ministry of Forests where TASS II matured and expanded in species, treatment options, and supporting tools. While TASS II has capably addressed changing provincial forest management needs, TASS has continued to evolve by incorporating a light model (TASS III) in order to address and be prepared for current and emerging needs. In this presentation, I will provide a brief overview of TASS's distinctive structure and discuss how this structure continues to be relevant for emerging needs, technology, and understanding in British Columbia.

Using machine learning and contemporary computational statistical techniques to improve forest management decisions

Dr. Cristian Montes, Associate Professor, Warnell School of Forestry and Natural Resources, University of Georgia

The amount of environmental information available to forest managers has increased exponentially over the last few decades due to ongoing efforts to remotely sense many aspects of terrain, soil, and weather. This availability has led to more opportunities for better forecasting and management of forests, as well as posed some challenges that need to be carefully addressed to ensure proper systems. In this talk, I will address these challenges and present how scientists at the Plantation Management Research Cooperative (PMRC) are incorporating a new set of environmental predictors using sound statistical techniques to improve decision-making. Examples will be given of using climate aggregators like water deficit, excess water, and available water, as well as their uncertainty, as part of interpolation methods for forecasting, taper estimation, insect risk evaluation, and estimating hurricane and tornado probabilities. Many of these products result from using computationally intensive methods that ensure calibration for models with thousands of parameters. During this presentation I will highlight the methods we are introducing in forest biometrics, the pitfalls of using machine learning techniques and possible solutions to further improve inventory estimation, stand forecasting and management decisions.

Climatic sensitivities derived from tree rings improve predictions of the Forest Vegetation Simulator growth and yield model

Courtney Giebink, Oak Ridge Associated Universities; USDA Forest Service, Northern Research Station, Forest Inventory and Analysis

Forest simulation models can be useful for anticipating forest change and testing alternative management scenarios, but models must accurately and precisely represent forest responses to changing climate. The most widely used growth and yield model in the United States (U.S.), the Forest Vegetation Simulator (FVS), which also forms the basis for several forest carbon calculators, does not currently include the direct effect of climate variation on tree growth. We incorporated the direct effect of climate variation on tree diameter growth by combining tree-ring data with forest inventory data to parameterize a suite of alternative models. The alternative models we considered differed progressively from the current FVS large-tree diameter growth model, first by changing to an annual time step, then by adding interannual climate effects, followed by model simplification (removal of predictors), and finally, complexification, including effects of spatial variation in climate and two-way interactions between predictors.

We validated diameter growth predictions from these models with independent observations, and evaluated model performance in terms of accuracy, precision, and bias. We then compared predictions of future growth made by the existing large-tree diameter growth model used in FVS, i.e., without climate effects, to those of our updated models, including those with climate effects. We found that simpler models of tree growth outperform the current FVS model, and that the incorporation of climate effects improves model performance, in which growth is currently overpredicted by FVS. Diameter growth projected with improved, climate-sensitive models is less than the future tree growth projected by the current climate-insensitive FVS model. Tree rings can be used to identify and incorporate drivers of growth variation into a stand-level growth and yield model, giving more accurate predictions under climate change.

Machine learning approaches for estimating forest stand height using airborne LiDAR data in New Brunswick forests

Elham Behroozi, PhD Candidate, Faculty of Forestry and Environmental Management, University of New Brunswick

There are many ways to express stand-level height (maximum, dominant, top, average, and so on). The different expressions of height are useful for estimating area-based volume, height distribution parameters, and other measures of importance to forest

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managers and ecologists. Understanding how LiDAR "sees" these different values of stand height is important for further development of LiDAR-derived forest inventory estimates and for individual tree segmentation, especially in mixed species stands with complex vertical structures, such as is typical in the forests of Atlantic Canada. In this presentation, we will explore the effectiveness of different machine learning algorithms on the estimation of various stand-level height expressions and the effect on area-based volume estimation and individual tree segmentation.

Stand structure classification and the indexing of diameter and height distributions

Dr. Ian S. Moss, RPF, Forest Inventory & Growth and Yield Consultant, Forestree Dynamics Ltd.

Diameter (and associated species, height, and spatial) distributions are used for: (1) habitat assessment, (2) fire risk rating, (3) timber valuation, and (4) evaluating species interactions and forecasting stand dynamics and patterns of succession. Given the wide variety of distributions it is useful to have a system of stand structure classification nomenclature that clearly separate plots and stands in relation to similarities and differences in their distributions, and that in turn can be used to describe expected patterns of forest succession with and without different kinds of (natural) disturbances. From a broader perspective, ideally each individual distribution can be uniquely identified, and recovered using a few simple non-parametric indices (e.g., Hosking's et al. 1961 L-moments). I present a new system for indexing diameter distributions and associated system of stand structure classification using mean tree diameter, quadratic mean tree diameter, and mean basal area weighted diameter. These indices and associated system of classification are extended to include analogous height, and height-diameter indices as part of the indexing and classification process. The data used as input includes over 1000 ground samples from interior and coastal British Columbia, southern Alberta, Saskatchewan, and Newfoundland.

Putting stereo glasses on data scientists: EFI to AVI

Kat Gunion, Senior Forest Analyst, Forsite Consultants Ltd.

Through a contribution agreement from Canadian Wood Fibre Centre (NRCAN), Forsite has been working on an approach to convert highly detailed forest inventory data (individual tree + EFI tiles) into a jurisdictionally specific, government approved forest inventory (i.e. AVI in Alberta). This involves taking operational scale inventory data and aggregating it to 'stand' polygons (problem 1). Then attributes must be assigned to the polygons in a manner consistent with what a photo interpreter would do (problem #2). This presentation will discuss the approaches taken and results achieved. Hint – it's hard to get computers to act like human interpreters, but that might just be ok.

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