2nd IUFRO Conference on Complex Forest Ecosystems

from tree to landscape

Southern Mensurationists Annual Meeting

2013

IUFRO

New Orleans, LA- Oct 7-9, 2013

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Introduction

A forest is the most complex of the terrestrial ecosystems, and significant efforts have been made to understand and model the mechanisms underlying its behavior. The technological advancements of the last two decades have allowed development of sophisticated approaches to assessing complexity as well as integrating scale, measurements and accuracy into the understanding of response of the forest to different stimuli. The purpose of this conference is to introduce the latest advances in representation, quantification, measurement, analysis, and modeling of forest cover "from tree to landscape".

In 2005 the then 4.11 IUFRO Group, under the enthusiasm of Dr. Rennolls from University of Greenwich and support of Dr. Biing, initiated the first conference on Complex Forest Ecosystem. The event took place in Cairns, Australia, the gate to the Great Barrier Reef, and gathered some of the most active and prolific scientists in the statistics and mathematical modeling focused on the forested ecosystem at that time, such as Dr. Gertner (University of Illinois), Dr. Guan (National Taiwan University), Dr. Condit, (Smithsonian Tropical Research Institute), Dr. Monserud (USDA Forest Service), and Dr. Fleming (Canadian Forest Service). The first conference did not have a focus underlying the event, but considered all aspects related to the forest, as a complex ecosystem. After almost one decade, under the umbrella of the same IUFRO group, now called 4.03, the second conference is organized. The conference is a joint event with the Annual meeting of the Southern Mensurationist organization, a non-formal group of enthusiasts spanning the southern forest region of the USA, or people related or who sometimes during their life have intersected the group.

The IUFRO unit 4.03, ***Informatics, Modeling and Statistics***, joined its resources with the Southern Mensurationists Group to bring together and to share knowledge among some of the most active scientists in the area of growth and yield, measurements, statistics, and informatics. The 2nd IUFRO Conference on Complex Forest Ecosystem and the 2013 Annual Meeting of the Southern Mensurationist group is focused on the forest understood as a set of interacting elements, namely trees, that is subject to forces acting on scales beyond stands, namely landscape. Considering these perspectives on the forest, the current event has three themes:

1. Measurement and assessment of forest resources
2. Growth and yield models for forest ecosystems
3. Integrating data and models of varying scales.

The themes are a natural extension of the dramatic changes from the last two decades that were and still are impacting the forestry profession, and the forest as a whole. The conference aims in placing the past of forestry in a dynamic perspective, as well as raising, if possible, a corner of the curtain that covers the future of forestry.

Venue

The 2nd IUFRO Conference on Complex Forest ecosystems and the 2013 Annual meeting of the Southern Mensurationist group is hosted by the Le Pavillon Hotel. The Le Pavillon Hotel is a luxury hotel, originally named the Denechaud, which has its current name since 1970, following major restoration. On June 24, 1991 Le Pavillon was placed on the National Register of Historic Places by the U.S. Department of the Interior. The hotel is located at 833 Poydras Street, New Orleans, LA 70112, minutes away from the Canal St. and the famous Bourbon St.

The main activities of the conference occur at the second floor, in two complexes of rooms: Bienville Complex and Gravier Complex (Fig.1). The Granvier Complex is the room that will host the plenary presentations and half of the conference talks, while the Bienville complex will host the posters and the other half of the conference talks. On Monday, the breakfast, lunch and the social evening (at the end of the first day) will take place in the Denechaud Room, located next to the two rooms hosting the conference talks. Tuesday and Wednesday the breakfast will be served in the Bienville complex.

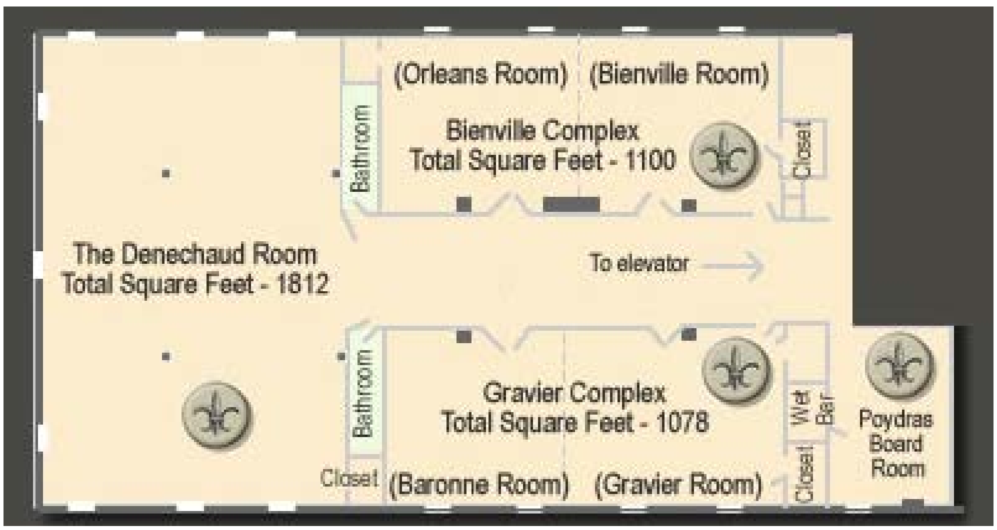

Fig.1 Second floor meeting space

The banquet that will be provided on the second day of the conference will be hosted in the Versaille room, located at the lower level of the Hotel (Fig. 2)

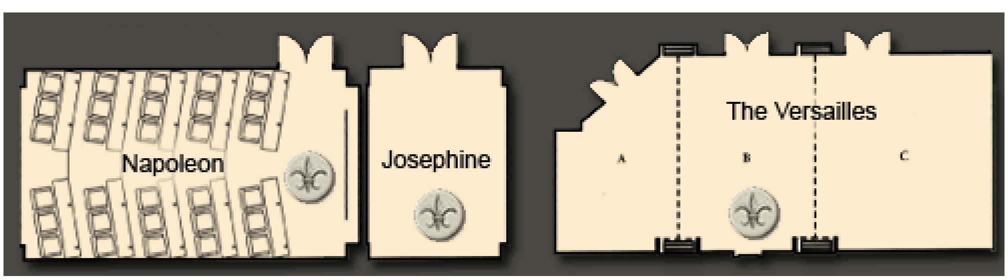

Fig. 2. Banquet room and its location within the hotel lower level floor.

Presenters

Oral presentations

Oral presentations are limited to 20 minutes with 5 minutes for questions and 5 minutes to transition between sessions (a total of 30 min). Session moderators will be instructed to stay on schedule to reduce problems with the timing of concurrent sessions. Presenters should use MS PowerPoint that is PC compatible. Other presentation file types such as video, DVD, mp3, or mp4, should be cleared with Dr. Strimbu (strimbu@latech.edu) in advance. Wireless Internet connection IS FREE AND AVAILABLE for presentation content.

Presenters are responsible for getting to their session early enough to have their file loaded onto the provided computer. Please bring your presentation in PowerPoint format to the speaker ready room prior to the conference, or to the moderator of your session prior to the beginning of the session. Laptops at the conference will have USB ports for the purpose of transferring your presentation file. To avoid time problems, do not attempt to present using your own computer (special arrangements may be possible under very limited circumstance by contacting Dr. Strimbu). Please notify Dr. Strimbu regarding any special needs.

Poster presentations

Posters should be printed on paper that can be attached using pushpins (provided) or Velcro (provided). Dimensions of the posters should be limited to 42 inches wide by 56 inches tall. Poster locations will be identified by a number assigned to them. Poster presenters should not bring any electronic audio/visual aids to their posters, as we cannot guarantee power access. Presenters will be allowed to post handouts or other publications related to their poster in the space provided. Please note that the lighting in the poster area is somewhat subdued so you should prepare your poster accordingly with appropriate backgrounds and colors. Posters should be removed before 12:00 AM Oct 9, 2013. All posters not removed by 1:00 PM on Oct 9, 2013, will be discarded.

Publication

The editor-in-chief of the journal Forest Science, the leading professional journal from the USA, agreed to dedicate a special number to the joint 2nd IUFRO Conference on Complex Forest Ecosystems - 2013 Southern Mensurationists Annual Meeting. All the presentations from the event can be considered for publication in the journal, regardless the medium of delivery: oral or poster. The submission and review process will strictly follow the journal's guidelines, including formatting and decision process. The guidelines for preparing and submitting the article to be considered for publication can be found on the Society of American Foresters website.

To identify the article as being a part of the allocated special issue, please includes in the introductory paragraph of the cover letter accompanying the submission a statement indicating that “the paper is for the special issue on Complex Forest Ecosystems”. For this special issue of the Forest Science two associate guest editors were assigned: Dr. Burkhart, from Virginia Tech, and Dr. Strimbu, from Louisiana Tech.

Awards

In 2009 Lewis Jordan and Ray Souter started the Mike Strub Challenge contest, to honor Mike Strub's inquisitory mind, tenacity in pursuing forest related questions, and not the least, its kindness. In 2012, John-Paul McTague introduced two awards aiming at the presenters who impressed the Southern Mensurationists Annual Meeting audience. The two awards are dedicated to the best presentation of a student, and the best presentation of a researcher. This year a new award is proposed "SOMENS Achievement Award", which will honor people that contributed significantly to quantitative southern forestry. The award aims at senior researchers that are associated with the Southern Mensurationists group and have shaped the forest research of/from the southern region of the USA.

Mike Strub Challenge

The Award is given to the scientist that supplied the solution having the smallest MSE and fulfilling the modeling conditions.

The Best Presentation Award: student and researcher

The best presentations are established by the audience, who is asked to either fill in a form for each presentation considered of interest, supplied by the organizers, or by entering their evaluation online at http://gis.latech.edu/cfe/awards.html. The criteria for judging are:

- **Introduction/Background** (Sufficient background into research field and the scope of the project are provided)
- **Experimental Design/Data Analysis** (Experimental design/ methods of analyzing data are clearly outlined with stated hypotheses.)
- **Conclusions** (Summary the findings within the context of the field and significance to the work are presented)
- **Vocal delivery** (The presenter speaks clearly and at an appropriate volume)
- **Visual presentation** (The presentation display and slide layout is logical and aesthetically pleasing)

Each criterion is worth 10 points, ranked as 1 the lowest (i.e., reduced attainment of the criterion), and 10 the largest (i.e., maximum fulfillment of the criterion).

The SOMENS Achievement Award

The award is given only once to an individual. A committee of at least five scientist associated with the Southern Mensurationists group is considering the nominations that were made anonymously. The evaluation and voting are anonymously, and based on the experience and knowledge of each committee member. No material is asked from a nominee, to keep the process as secretly as possible. The nominees of the first edition of the SOMENS Achievement Award were (in alphabetical order):

1. Harold Burkhart – Virginia Tech
2. Chris Cieszewski – University of Georgia
3. Dean Coble – Stephen F. Austin
4. Mike Strub – retired, Weyerhaeuser

Program outline

Sunday, October 6

17:00 – 18:00	Registration	Bienville Complex
17:00 – onward	Icebreaker	Room 330

Monday, October 7

7:00 – 8:00	Breakfast/Registration	Denechaud Room/Bienville Complex
8:00 – 10:00	Technical sessions	Gravier Complex and Bienville Complex
10:00 – 10:30	Break	
10:30 – 12:30	Technical sessions	Gravier Complex and Bienville Complex
12:30 – 13:30	Lunch	Denechaud Room
13:30 – 15:00	Technical sessions	Gravier Complex and Bienville Complex
15:00 – 15:30	Break	
15:30 – 17:00	Technical sessions	Gravier Complex and Bienville Complex
18:00 – 20:00	Reception	Denechaud Room
21:00 – onward	Social	Room 330

Tuesday, October 8

7:00 – 8:00	Breakfast	Denechaud Room
8:00 – 10:00	Technical sessions	Gravier Complex
10:00 – 10:30	Break	
10:30 – onward	Field trips / Lunch	
19:00 – 21:00	Banquet	Versailles Room
21:00 – onward	Social	Room 330

Wednesday, October 9

7:00 – 8:00	Breakfast	Denechaud Room
8:00 – 10:00	Technical sessions	Gravier Complex
10:00 – 10:30	Break	
10:30 – 11:30	Awards	Gravier Complex
11:30 – onward	Lunch / Field trips	

Organizers

Conference chairs

Chris Ciezewski, University of Georgia

Bogdan Strimbu, Louisiana Tech University

Scientific Committee

Harold Burkhart, Virginia Tech

Chris Ciezewski, University of Georgia

George Gertner, University of Illinois

Biing Guan, National Taiwan University

Simona Ionescu, Telecomunication Technical College

Thomas Knoke, Technical University of Munich

Peter Marshal, University of British Columbia

Ronald McRoberts, US Forest Service

Craig Nitschke, University of Melbourne

Christina Staudhammer, University of Alabama

Bogdan Strimbu, Louisiana Tech University

Implementation

Nevine Guiname, Louisiana Tech University

Victor Strimbu, Louisiana Tech University

Timeline and Presenters

Sunday, October 6		
Time	**Gravier Complex**	**Bienville Complex**
17:00	**Registration**	
18:00	**Icebreaker (free drinks) in Room 330**	
Monday, October 7		
7:00	***Breakfast and Registration***	
8:00	Keynote Speaker: Harold Burkhart	
9:00	Christina Staudhammer	Arthur Groot
9:30	Edwin Green	Emma Holmstrom
10:00	***Break***	
10:30	Thomas Lynch	Aaron Weiskittel
11:00	Taek Kim	David MacFarlane
11:30	Erez Diamant	Mike Strub
12:00	Matthew Russell	Mingliang Wang
12:30	***Lunch***	
13:30	Charles Sabatia	Quang Cao
14:00	Stanko Trifkovic	Samuel Egbäck
14:30	Josh Steiger	Travis Norman
15:00	***Break***	
15:30	Nan Pond	Ilya Potapov
16:00	Shaaban Ghalandarayeshi	Narayanan Subramanian
16:30	SS Singh	Don Bragg
18:00	**Reception in Denechaud Room (free drinks)**	
21:00	**Social in Room 330 (free drinks)**	
Tuesday, October 8		
7:00	***Breakfast***	
8:00	Keynote Speaker: Peter Marshall	
9:00	Matthew Russell	
9:30	Ernst-Detlef Schulze	
10:00	***Break***	
10:30	Field trips	
19:00	**Banquet in Versailles Room**	
21:00	**Social in Room 330 (free drinks)**	
Wednesday, October 9		
7:00	***Breakfast***	
8:00	Keynote Speaker: Biing Guan	
9:00	David MacLean	
9:30	Chris Cieszewski	
10:00	***Break***	
10:30	Awards	
11:00	Field trips	

Presentations and posters

Oral presentations

Monday, October 7		
Time	**Presenter**	**Title**
Gravier Complex: Measurements and Assessment of Forest Resources — **Moderator: David MacFarlane**		
8:00	Keynote Speaker: Harold Burkhart	Forest Modeling and Prediction in the Information Age
9:00	Christina Staudhammer	Assessment of model uncertainty via bootstrap methods: procedures for evaluating ill-fitting models
9:30	Edwin Green	Assessing Sampling and Model Error in Standing Green Weight Estimation for a Loblolly Pine Plantation
10:30	Thomas Lynch	Plantation row sampling and design unbiased point-to - particle sampling on lines.
11:00	Taek Kim	Spatial Autocorrelation among Different Levels of Genetic Control in Loblolly Pine
11:30	Erez Diamant	Sampling Stem Density from Aerial Imagery: Comparison of Circular/Rectangular vs. Linear Row Plots
12:00	Matthew Russell	Modeling the residence time and decay rate of downed woody debris across eastern US forests
Gravier Complex: Measurements and Assessment of Forest Resources — **Moderator: Ralph Amateis**		
13:30	Charles Sabatia	Use of upper stem diameters to calibrate a segmented taper equation to new trees: An evaluation of some of the approaches
14:00	Stanko Trifkovic	Bitterlich's Angle-Count Sampling (Horizontal Point Sampling) and Spatial Distribution of Trees
14:30	Joshua Steiger	Impacts of Genetics on Juvenile Stem Characteristics and Potential Stand-level Value in Loblolly Pine
15:30	Nan Pond	New methods for (mis)representation of diameter distributions at multiple scales
16:00	Shaaban Ghalandarayeshi	Spatial pattern of oriental beech in undisturbed old growth stands in Northern Iran
16:30	SS Singh	Radio-sensitivity of Albizia chinensis (Obsbeck) Merr. seeds to Gamma rays

Bienville Complex: Growth and yield models for forest ecosystems **Moderator: John Paul McTague**		
9:00	Arthur Groot	The IVY tree growth and wood quality model for complex structured stands
9:30	Emma Holmstrom	Combination of regeneration methods and multiple scenario analysis in order to achieve mixed stands.
10:30	Aaron Weiskittel	Development of a regional growth and yield model for complex, managed stands of the Acadian Forest
11:00	David MacFarlane	Reforming simple allometric scaling models to accommodate the complexity of diverse tree forms
11:30	Mike Strub	The Comparative R-square and its application to Mortality Models
12:00	Mingliang Wang	Understanding autocorrelation (marginal vs. conditional) within the context of dominant height modeling
Bienville Complex: Growth and yield models for forest ecosystems **Moderator: Christina Staudhammer**		
13:30	Quang Cao	Parameter Estimation of Height-Age Models
14:00	Samuel Egbäck	Height-diameter relationships of genetically improved loblolly pine
14:30	Travis Norman	Interplanting Loblolly Pine - Impacts on Growth Characteristics
15:30	Ilya Potapov	Bayes forest: combining measurements and models to understand biological diversity
16:00	Narayanan Subramanian	Impact of Ozone on Carbon sequestration by Swedish Forests: A modelling study
16:30	Don Bragg	A non-absurd justification for extrapolation of regression models: constraining loblolly pine biomass predictions

October 8		
Gravier complex: Measurements and Assessment of Forest Resources **Moderator: Mingliang Wang**		
8:00	Keynote Speaker: Peter Marshall	25 Years Studying the Dynamics of Uneven-Aged Douglas-fir: A Useful Pursuit or a Waste of Time?
9:00	Matthew Russell	Seeing the forest from the wood: What can wood density attributes tell us about forest stand dynamics?
9:30	Ernst-Detlef Schulze	Parameters describing the topology of forest canopies

October 9		
Gravier Complex: Integrating data and models of varying scales		
		Moderator: Robert Froese
8:00	Keynote speaker: Biing Guan	Extracting Trends from Nonlinear and Nonstationary Data Series
9:00	David MacLean	Variation in spruce budworm natural disturbance increases complexity in Acadian forest ecosystems
9:30	Chris Cieszewski	Spatiotemporal analysis of broken tree signatures on high-resolution satellite imagery

Posters

Author	Title
Ayuni Sena	Modelling self-thinning boundary line in eucalyptus stands: a new stand density index
Ayuni Sena	Forest inventory on landscape scale: the study case of an electric power transmission system environmental licensing
Bogdan Strimbu	Correction for bias of the rotation age
Damodar Gaire	An Assessment of Community-Based Biodiversity Conservation and Rural Livelihood Improvement in the Buffer Zone of Bardia National Park, Ne
Grant Domke	Comparing downed dead wood carbon stock estimates in the U.S. national forest inventory
Juri Fujieda	Socio-environmental sustainability - Natural forest resources for wooden heritage building - the case study of Japanese cypress in Kiso area, Japan
Mohammad Bataineh	Long-term response of spruce-fir stands to herbicide and precommercial thinning: Observed and projected growth, yield, and financial returns in central Maine, USA
Nevine Giuname	Impact of algorithm implementation and usage on time series data analysis
Victor Strimbu	Individual tree crown segmentation using a hierarchical data structure on rasterized LiDAR data

Abstracts

Forest Modeling and Prediction in the Information Age

Monday, Oct 7 8:00 AM - Gravier Complex

Harold E. Burkhart
Department of Forest Resources and Environmental Conservation, Virginia Tech, USA

Models of forest stand dynamics, growth and yield rest on three primary underpinnings: data, analytical methods, and computing technology. The computing revolution has profoundly impacted all aspects of empirical modeling from the way measurement data are collected, manipulated, analyzed, and stored to the way the resulting models are made available to users.

Models are abstractions of reality; they include essential elements of the real world system that are to be mimicked to meet some specified objective. Data from forest ecosystems are inherently variable. Hence, the fundamental challenge is to extract the population trend (pattern or signal) from highly variable (noisy or messy) data.

Model accuracy can be improved by increasing the size of the data set and/or by applying more sophisticated analytical/modeling methods. As the level of complexity increases, the pattern in the data set is generally recovered quickly with relatively simple models. Noise, on the other hand, is recovered slowly as a model's complexity increases. The accuracy of prediction tends to peak rather quickly and then to decrease with increasing model complexity.

Computing technology has continued to fuel rapid development in the information age that was launched with the invention of the printing press and greatly accelerated with the advent of the World Wide Web. Big data sets can now be readily accessed, manipulated, and analyzed by a variety of parametric and nonparametric techniques. Large amounts of information, if not well understood, can, however, lead to erroneous results and conclusions. The contemporary challenge for forest modelers is to couple human intuition, creativity and ingenuity with the tremendous data handling and computational power that computers offer to make true progress in developing enhanced models of forest ecosystems.

25 Years Studying the Dynamics of Uneven-Aged Douglas-fir: A Useful Pursuit or a Waste of Time?

Tuesday, Oct 8 8:00 AM - Gravier Complex

Peter Marshall
Faculty of Forestry, University of British Columbia, Canada

Extracting Trends from Nonlinear and Nonstationary Data Series

Wednesday, Oct 9 8:00 AM - Gravier Complex

Biing T. Guan
School of Forestry & Resource Conservation, National Taiwan University, Taiwan

A key concern over the past two decades in forest research is to assess the likely impacts of climate change on forest ecosystems. To address such a concern requires the identifications of trends based on longitudinal data. Because nature does not impose either a linear or stationary constraint on tree growth or responses to the environments, our data are quintessentially nonlinear and nonstationary. It is also these two characteristics that make forest ecosystems so complex and interesting. On the other hand, the classical time series methods for trend extractions strongly contingent upon the linearity and stationarity assumptions. Another often contested issue in establishing a baseline or extracting a trend is the injection of an *a priori* model structure.

Recent advances in signal processing allow us to address the above issues concurrently in an adaptive manner. I will briefly introduce one such method, the Ensemble Empirical Mode Decomposition (EEMD), and its application in identifying the trends in the first flowering dates (FFD) of two European species, as well as in two regional temperature series.

EEMD is an improvement of empirical mode decomposition (EMD), an empirical but highly efficient and adaptive method for processing non-linear and non-stationary signals. As a spline-based iterative sifting process, EMD extracts signals from high to low frequencies into a finite number of intrinsic mode functions (IMFs) and a trend (residual) component, which is either constant, monotonic, or contains only one extremum over the data span considered. EEMD, which was developed to alleviate the signal intermittence problem in EMD, is a Monte Carlo approach in which zero-mean Gaussian white noise is added to each EMD process to achieve better signal separation. An EEMD IMF or trend is the ensemble mean of the corresponding EMD IMFs or trends. One particularly relevant and important property of EMD/EEMD is that the extracted trend is derived intrinsically and adaptively.

The example applied the EEMD to two long-term European FFD series from the PEP725 Pan European Phenology Project archive. To establish the relationships between the FFDs and early spring (February to April, FMA) average maximum temperature, I also applied the EEMD to two gridded temperature data sets from the EU-FP6 ENSEMBLES project.

The results showed that, over the past 30 years, the advancing trends in the FFDs of the two species unequivocally correspond to the respective regional winter/spring warming trends. The variability of both FFD series before 1981 was almost entirely due to natural variability. In contrast, after 1981 the variability explained by the warming trend increased to 4% and 21% for the two species. Furthermore, while contributing to both the temperature and phenophase overall variability, recent warming also lowers the phenophase natural variability by modulating the temperature natural oscillation amplitudes.

Assessment of model uncertainty via Bootstrap methods: procedures for evaluating ill-fitting models

Monday, Oct 7 9:00 AM - Gravier Complex

Christina L. Staudhammer[1*], Francisco Escobedo[2], Nate M. Holt[3], Linda J. Young[3], Thomas Brandeis[4]
[1]University of Alabama, Department of Biological Sciences
[2]University of Florida, School of Forest Resources and Conservation
[3]University of Florida, Department of Statistics
[4]USDA Forest Service, Forest Inventory and Analysis

Generalized linear models (GzLMs) have been widely used to identify significant effects related to non-normal response variables, such as the presence/absence of a particular forest or tree characteristic. When data are sparse or have high variability, these models often exhibit only minimally acceptable fit, as described by the value of the area under the receiver operating characteristic curve or other criteria. However, inference following the fitting of statistical models traditionally assumes that the selected model represents the true state of nature. As such, a model is estimated and inferential statistics (e.g. confidence intervals and predictions) are calculated. This practice ignores uncertainty arising due to model choice, and can lead to over-confident inferences and predictions. Thus, to appropriately account for model uncertainty, bootstrap methods can be used to construct confidence intervals for each potential covariates considered in the model development. We outline procedures for conducting a sensitivity analysis via bootstrap methods and discuss differing results using an example with woody invasive plant (WIP) occurrence and abundance data from two subtropical coastal urban ecosystems: San Juan, Puerto Rico and Miami-Dade, Florida. While GzLMs showed that WIP occurrence was significantly related to the proportional area in residential land uses, median income, and grass cover, the only covariate in the boostrap sensitivity analysis that was a consistent significant predictor of WIP occurrence was percent residential land use cover. This analysis and findings suggest that when model fit is marginal via traditional methods, the sensitivity of significant effects should be tested via alternative methods in order to obtain more accurate uncertainty estimates.

Assessing Sampling and Model Error in Standing Green Weight Estimation for a Loblolly Pine Plantation

Monday, Oct 7 9:30 AM - Gravier Complex

Edwin Green[1*]
[1]Rutgers University

A simple study was designed to assess the magnitude of model error in estimates of total green weight per acre in a sample loblolly pine plantation. A model was fitted to a large felled-tree data set and used to predict weight per ha in the sample stand. This is a simple case and even here, ignoring model error would result in confidence intervals on the order of 10-40% too narrow.

Plantation row sampling and design unbiased point-to-particle sampling on lines

Monday, Oct 7 10:30 AM – Gravier Complex

Thomas B. Lynch[1*], Mark J. Ducey[2]
[1]Oklahoma State University, Department of Natural Resource Ecology and Management
[2]University of New Hampshire, Department of Natural Resources and the Environment

Recently a design unbiased estimator has been developed by the second author that selects the k nearest particles to a point which is randomly located on a line, where the population of particles is located on that line. Previously, plant density estimators based on selecting the k nearest plants to a randomly located point in a plane or line were not design-unbiased, though some were unbiased given the model-based assumption of a Poisson spatial distribution (or other specific distribution or family of distributions) of plant locations. This new design unbiased estimator has a natural application for trees located in plantation rows, which occur extensively in the southeastern USA as well as many other parts of the world. Trees in plantations are already located in rows which can be modeled by straight or curved lines. To our knowledge, existing plantation row estimators that are based on selection of a fixed number of trees with a random starting point are not design-unbiased (of course some plantation row estimators may be based on fixed line lengths rather than a fixed number of trees). To apply the design unbiased estimator one must know the row lengths, which might be determined by remote sensing. Then a point is randomly-located along the row. It is clear that the probability that the point will fall between any two particular trees in the row is simply the distance between the trees divided by the row length. A design unbiased estimator could then be based on sampling these two trees. The estimator can also be readily expanded to any fixed number of sample trees k, since it will generally be more efficient to sample more than two trees at a given field location. This estimator may be especially useful for plantations that have gaps in spacing within rows due to mortality or thinning.

Spatial autocorrelation among different levels of genetic control in loblolly pine

Monday, Oct 7 11:00 AM - Gravier Complex

Taek Joo Kim[1*], Bronson P. Bullock[1]
[1]North Carolina State University, Department of Forestry and Environmental Resources

Exact characterization on the status of forest is essential for developing proper current and future forest management plans. To characterize the competition effects and the growth pattern of loblolly pine (*Pinus taeda* L.) plantation, we estimated the spatial dependency of six year old juvenile loblolly pine trees to understand the influence of individual stem competition at different levels of spacing and genetic homogeneity. Data of heights and DBH of six year old loblolly pine trees from North Carolina State University's Hofmann Forest was used. The research study site is located at Onslow County, North Carolina and was installed in January 2006 to evaluate the effect of spacing, genetic homogeneity, and thinning on growth, physiological characteristics, and inter-tree competition of loblolly pine. Two different spacings of 5 x 20 ft (1.5 x 6.1 m; 436 TPA) and 10 x 20 ft (3.0 x 6.1 m; 218 TPA) with ten different genetic families were established at three replicates. Types of genetic families include clones, full-sib families, half-sib families, and a seed orchard mix. A regression equation of DBH as a function of height of each genetic family was fitted to Simultaneous Autoregressive Model (SAR) to evaluate spatial autocorrelation of small scale trends of DBH. The spatial autocorrelation of the residuals was also evaluated with Moran's I. The estimated spatial autocorrelation parameters from the SAR models and Moran's I statistics were analyzed to explain the inter-tree competition within each genetic family type and spacing.

Sampling Stem Density from Aerial Imagery: Comparison of Circular/Rectangular vs. Linear Row Plots

Monday, Oct 7 11:30 AM - Gravier Complex

Erez Diamant[1*]
[1]Intelescope Solutions Ltd.

Thinned pine forest stands with relatively straight planting rows were photographed at high resolution of 30cm GSD (1’ per pixel or better) in RGB and/or CIR. A random grid of 200 m2 circular sample plots was created on the orthophotos and trees detected within each plot. The average stem density was calculated and number of trees estimated, per stand area. The grid of samples was then displaced in two perpendicular directions and trees detected again. The resulting stem density was calculated and total number of trees estimated. Random (non-grid) samples of circles were created and the same process of calculating average stem density and estimation of total trees executed. The process was exercised with rectangular sample plots as well. The differences between different area-samplings exceeded the commonly-desired ±5%. This fact implies that the above sampling method(s) are inappropriate for the wood volume estimation in thinned pine stands. Row plots were created at exactly same locations of circular centers. The average trees per length calculated and total number of trees estimated, respectively, according to total length of rows detected in each stand. The differences were far smaller, thereby indicating that row sampling is a superior method for stem density estimation in thinned pine plantations. (Note: the row samples’ size – number of trees – was also much smaller, indicating that the sampling effort could be cut.) Similar examples of stands with curved planting rows and non-thinned Eucalyptus plantation in Brazil are also presented with similar results.

Modeling the residence time and decay rate of downed woody debris across eastern US forests

Monday, Oct 7 12:00 PM - Gravier Complex

Matthew Russell[1*], Christopher Woodall[2], Anthony D’Amato[1], and Shawn Fraver[1]
[1] University of Minnesota, Department of Forest Resources
[2] USDA Forest Service, Northern Research Station

A key component in describing forest landscapes is determining changes in downed woody debris (DWD) populations through time. The empirical assessment of DWD decay rate (*k* constants, based on wood density and mass loss) and residence time (number of years until a DWD piece has left the inventoried population) is complicated by the decay process itself, as decomposing logs undergo not only a reduction in wood density over time, but also reductions in biomass and carbon, shape, and size. Estimates of DWD decay class transitions at the log level, driven by DWD piece length and climate regime, are used in a Monte Carlo simulation-based approach to estimate DWD half-life, residence time, and decay rate for 36 eastern US species. Results showed that estimates of DWD half-life were 18-23 and 10 years for conifers and hardwood species, respectively. Initial results indicate that conifer species located in northern climates would see the largest decreases in DWD residence time using three climate change scenario models. Findings could subsequently be incorporated into dynamic global vegetation models to elucidate the role of DWD across forested landscapes.

Use of upper stem diameters to calibrate a segmented taper equation to new trees: An evaluation of some of the approaches

Monday, Oct 7 1:30 PM - Gravier Complex

Charles O. Sabatia[1*]
[1]Scion, New Zealand

Accuracy of a tree taper model can be improved by incorporating variables that may account for inter-tree taper differences into a tree taper model. Upper stem diameter measurements, dbh to total height (slenderness) ratio, and relative breast height (the ratio of breast height to total height) are some of the variables that have been used. In the current study, I compare three approaches of incorporating the auxiliary variables into a Max and Burkhart (1976) taper equation: 1) calibrating parameters of the taper model by constraining the taper curve to pass through dbh and an upper stem diameter measurement, 2) using upper stem measurements to predict the taper model parameters of an individual tree using a mixed effects model, and 3) incorporating an upper stem diameter or slenderness ratio as a direct predictor in the taper model. Countrywide stem section data for radiata pine in New Zealand and region wide stem section data for loblolly pine in south eastern United States are used in the analysis. Global and stem section-specific statistics are used to compare the performance of the different approaches. The contribution of the auxiliary variables to the overall model fit and the performance and applications of the different incorporation approaches will be discussed.

Bitterlich's Angle-Count Sampling (Horizontal Point Sampling) and Spatial Distribution of Trees

Monday, Oct 7 2:00 PM - Gravier Complex

Stanko Trifković[1*]
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Bitterlich's method which he called angle-count sampling goes by a variety of names, including horizontal point sampling. This method has been extensively studied in the past and is widely used in estimating relative basal-area of trees in forests. Although concerns regarding the use of angle-count sampling in highly diverse forests still remain, our understanding of influences caused by different spatial distributions of trees is still limited. This study presents sampling simulations applying angle-count sampling in virtual forests with regular, random and clustered spatial distributions of trees, and with normal or exponential distributions of tree diameters. The findings suggest that the counts with angle-count sampling fitting to a widely known Poisson distribution can be used to indicate uniformly random spatial distributions of trees. Indices based on the counts do not require any distances to be measured and are likely to be independent from tree diameter distribution or applied basal-area factor. Moreover, this study demonstrates that the clustering induces a significant increase in numbers of the "hidden trees", which usually cause surveyors to move sideways to check whether they should be counted or not. Clustering of the trees is also likely to highly reduce a statistical confidence to basal-area estimates; the estimates are significantly less precise in clustered than in random or in regular populations. Therefore, indexing spatial distributions of trees in forests should be a regular practice in forest inventories. The Bitterlich's angle-count method can be one of the practical choices.

Impacts of Genetics on Juvenile Stem Characteristics and Potential Stand-level Value in Loblolly Pine (*Pinus taeda* L.)

Monday, Oct 7 2:30 PM - Gravier Complex

Joshua Steiger[1*], Bronson P. Bullock, Ross Whetten, Bob Abt
[1]NC State University, Cooperative Tree Improvement Program

The availability of improved genetics in Loblolly pine (*Pinus taeda L.*) coupled with advancement in silvicultural techniques provides land managers many options to optimally managing forest land in the Southeast. However, the interaction of varying levels of genetic diversity in loblolly pine across the landscape is not well understood. The recent, wide-spread deployment of more genetically homogenous genotypes, such as clones and full-sib families, drives the demand for better understanding growth and uniformity in stands with varying levels of genetic diversity. We hypothesized that stands planted with more genetically homogenous genotypes would be more uniform for growth traits and sawtimber potential in juvenile lobololly pine. Our results indicate that less genetically diverse genotypes are not more uniform than the more genetically diverse genotypes, and in most cases genetic homogeneity actually led to more variation in growth traits. Furthermore, we assessed and compared the predicted values of 9 genotypes using a scenario based on growth and yield projections using the LobDSS software package. Although volume is the primary driver of value in loblolly pine plantations today, the quality of stems in a stand also plays a significant role, but is difficult to include in yield projections. By incorporating predicted product class proportions and sawlog quality measures, we aimed to accurately predict and assess the overall stand value over a range of genotypes. Having access to reliable stand value data will play an important role for land managers that aim to increase the value of forested land. Our results show that by incorporating more accurate product class allocation and sawtimber quality measures, the value of stands can change dramatically. These results suggest that if the landowner is paid for the quality of their timber, not just the quantity, then some genotypes are much better options than others.

New methods for (mis)representation of diameter distributions at multiple scales

Monday, Oct 7 3:30 PM - Gravier Complex

Nan C. Pond[1*], Robert E. Froese[1]
[1]Michigan Technological University

Diameter distributions are a quantitative representation of the structures of forested plots, stands, and landscapes. Descriptions of distributions range from named classifications (e.g. negative exponential) to species-specific models of growth and development. A polynomial regression-based classification system has gained traction in recent years, in North America and Europe. This is a rapid, straightforward method of categorizing plot and stand diameter distributions. Multiple polynomial regression equations are fit to binned data using the number of trees per acre at the midpoints of bins as predictors. The signs of significant coefficients in the best-fitting regression equation are used to categorize the distribution shape as one of six discrete options. To assess the sensitivity and flexibility of the regression approach, three data-driven binning algorithms were applied to plot- and stand-level data from 47 managed hardwood stands. The polynomial regression approach was performed using data binned with each algorithm as well as using fixed widths. Nonparametric kernel density estimates of the stand distributions were also developed, and the discrimination among structures and stands based on kernel density estimates was compared to the regression-based classifications. Results showed that two of the three data-driven binning algorithms select average optimal bin widths close to the standard 5 cm already used. More significantly, the comparisons showed that the polynomial regression procedure is highly sensitive to the bin width used, with no patterns related to binning algorithm or bin width. Resultant classifications may misrepresent the shape of the distribution and the underlying stand condition. Tests of the discriminatory abilities of the polynomial regression categorization and kernel density estimation of distributions suggested that the use of predetermined categories oversimplifies the relationships of similarity and dissimilarity among distributions. We explore alternate methods of describing diameter distributions at multiple scales that leverage distribution description and modelling techniques while reflecting ecological knowledge and uncertainty.

Spatial pattern of oriental beech (*Fagus orientalis* Lipsky) in undisturbed old growth stands in Northern Iran

Monday, Oct 7 4:00 PM - Gravier Complex

Shaaban Ghalandarayeshi[1]*, Thomas Nord-Larsen[1], Khosro Sagheb-Talebi[2], Firoozeh Roshanfar
[1]University of Copenhagen
[2]Research Institute of Forest and Rangelands, Iran

This study was carried out in Caspian region - a humid zone in northern Iran- with an annual precipitation of 600 mm in the east and 2000 mm in the west of the region. Oriental beech (*Fagus Orientalis*) is the most valuable wood producing tree species in this region. While considerable efforts has been made in characterizing the stand structure and spatial patterns of temperate old-growth forests in Europe, there is a considerable lack of comparative information for northern Iran deciduous forests, where little researches on stand structures and tree spatial distribution have been made. Our objectives, therefore, was to examine and compare the spatial structure of three undisturbed old-growth beech stands with different climate condition in Northern Iran, using spatial statistics (e.g., Ripley's K function), and other quantitative measurements. The overall univariate analysis showed that trees have a random pattern in the drier site and clustered pattern in two other sites. Spatial pattern of beech in different size classes showed that trees become more randomly or regularly spaced with increasing size and possibly due to competition and self-thinning trees larger than 40 cm dbh exhibit a relatively random or regular distribution. Bivariate analysis indicated shifting from attraction to repulsion with increasing size and the repulsion pattern was consistent for trees with diameter at breast height greater than 40 cm in all plots.

Radiosensitivity of *Albizia chinensis* (Obsbeck) Merr. seeds to Gamma rays

Monday, Oct 7 4:30 PM - Gravier Complex

S. S. Singh[1*] and Vandana[2]
[1]Guru Ghasidas University, Department of Forestry, Wildlife & Environmental Sciences
[2]Garhwal University

The *A. chinensis* tree is commonly found in moist forest region of sub-Himalayan tract and peninsular part of India up to 915- 1370 m elevation. The objective of the study was to observe the radiosensitivity level of *A. chinensis* seeds. The air dried seeds were irradiated with continuous (C) and fractionated (F) doses of gamma rays. The dose rates were 10KR, 20KR, 40KR and 80KR. The germination percent, germination value, germination energy index, growth rate of the radicle and the hypocotyls, cotyledonary area and fresh and dry weight were tested and analyzed under different dose levels. The fractionated dose of 80KR resulted in maximum germination percent, GV and GEI in *A. chinensis*. The fresh and dry weights of hypocotyls are also sensitive towards gamma rays showed reduction in its weight. The treated seeds were also grown in polypots to study the growth pattern. The shoot growth was considered as one of the important characteristics in assessing radiosensitivity level. It was observed that the lower doses of gamma rays (10 and 20KR) enhanced the growth vigor while higher doses decreased the same. The gamma rays had a positive impact on the formation of the number of pinnules per saplings under continuous and fractionated treatment. The root growth and nodulation pattern showed visible variation at different dose levels and nodulation has enhanced by gamma rays treatment. The induced mutants have also been screened.

The IVY tree growth and wood quality model for complex structured stands

Monday, Oct 7 9:00 AM – Bienville Complex

Arthur Groot[1*]
[1]Natural Resources Canada – Canadian Forest Service, Canadian Wood Fiber Centre

The IVY model is an approach to forecasting the growth of complex-structured (mixed species, spatially heterogeneous and uneven-sized) stands. There is also potential to forecast aspects of wood quality using the model. IVY is an individual-tree growth model that relates tree volume growth to the amount of light captured by the crown during the growing season. Crowns are described using stem position, tree height, a crown profile parameter, as well as height to crown base and crown radius in four directions. This allows the description of asymmetric crowns with profiles ranging from neiloidal to cylindrical. A ray-tracing algorithm uses this crown description to compute crown light interception. The finite amount of light available for interception by trees in a stand imposes a constraint on stand-level growth, helping to control error. Volume increment efficiency (VIE), the amount of stem volume growth per unit of intercepted light, is required to translate light interception values into volume growth estimates. VIE estimates have been obtained from field measurements for *Picea mariana* and *Populus tremuloides,* and can also be derived from yield tables. For *P. mariana,* VIE varies strongly among site types and is linearly related to site index. Because the model is driven by crown light interception, modelling crown dynamics (height growth, crown radial growth, and crown rise) is central to the model. This paper outlines the IVY model, describes how it can be calibrated using yield table information, and also presents examples of growth forecasts for complex structured stands.

Combination of regeneration methods and multiple scenario analysis in order to achieve mixed stands

Monday, Oct 7 9:30 AM – Bienville Complex

E. Holmström[1*], K. Johansson, M. Karlsson and U. Nilsson
[1]Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences

Forests in Scandinavia are dominated by homogenous coniferous stands for fast production of pulpwood and timber. Additional ecosystem services such as biodiversity and recreation open up for other management alternatives with heterogeneous forest structures and mixed species stands. Natural regeneration of the two native conifer tree species Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) as well as a handful of broadleaved tree species is expected to be frequent on clear-cuts in Sweden. In this study we test how varying intensity in regeneration treatments affects tree-species composition and stand structure when combining spruce cultivation with natural regeneration of all species. Experimental stands with varying soil scarification and planting intensity were established to create a range of mixtures of planted Norway spruce and natural regeneration. Five years after establishment the regeneration was measured in counts, species and height development along with coverage of competing vegetation and browsing pressure. After simulated pre-commercial thinnings to various tree-species mixtures and stand structures, progress of stand development and individual tree growth were estimated with the Heureka-simulation system. Heights were adjusted to undamaged distributions in parallel scenarios in order to account for heavy browsing of ungulates. Seedling establishment for all present tree species was highly dependent on annual climate conditions, geographic location and surrounding forest structure. Soil scarification showed an overall positive effect even if the magnitude differed. Betula species was the only naturally regenerated species that established in densities high enough for forming forest structures, other species occurred more sparsely. As a conclusion seedling establishment of common Swedish tree species and thereby mixed stands is possible to achieve within the range of traditional regeneration methods. However, regardless of establishment method, heavy browsing of ungulates might affect the natural regeneration and reduce the competitiveness for all species except for Norway spruce.

Development of a regional growth and yield model for complex, managed stands of the Acadian Forest

Monday, Oct 7 10:30 AM – Bienville Complex

Aaron Weiskittel[1*]
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The Acadian Forest of Maine and the Canadian Maritime Provinces is a complex transitional forest that has a long and varied history of active management. The performance of existing regional growth and yield models have been shown to be quite biased, particularly when attempting to project the influence of forest management. Consequently, the development of new regional growth and yield model was pursued. To achieve this task, permanent sampling plots from New Brunswick, Nova Scotia, and Quebec, the US Forest Service Forest Inventory and Analysis plots, and long-term plots at the Penobscot Experimental Forest in Maine were compiled. This resulted in a database of 1,751,798 and 897,384 observations of individual tree diameter at breast height (DBH) and height (HT) from over 60 different species, respectively. This data has been used to fit a variety of individual tree static and dynamics equations. In the process of fitting these equations, a variety of common growth and yield model assumptions such as selection of dependent variables, the need for species-specific parameters, and the differences in model form were tested and evaluated. Key findings include the use of diameter rather than basal area increment for long-term predictions, the value of using species as a random rather than fixed effect, and the limited gain in using potential growth. These findings and the performance of the overall model behavior will be discussed in relation to modeling and projection complex stands.

Reforming simple allometric scaling models to accommodate the complexity of diverse tree forms

Monday, Oct 7 11:00 AM – Bienville Complex

David W. MacFarlane[1*]
[1]Michigan State University, Department of Forestry

Trees are the largest of all individual organisms of the Earth and from smallest seed to massive redwood cover many orders of magnitude in size. Trees are also highly plastic in terms of both their inherent genetic variability and their ability to conform their shape to variable ecological conditions found globally. This plasticity of both tree size and tree shape poses challenges for simple estimation of tree mass and tree volume, despite the advent of universal allometric scaling principles proposed to simplify the complexity of tree form. The standard allometric (power) function which predicts tree mass from stem diameter at breast height has two principle problems: (1) variation in the mass of trees of different girth is a direction reflection of tree growth form, but whole form is treated as a constant within and between species, and (2) the scaling and power coefficients are highly correlated and thus have an ambiguous biological meaning. These latter two problems are interrelated and can be solved simultaneously by deconstructing the standard allometric equation to reveal that a tree is composed of two segments of a disrupted fractal tree filling space in a vertical volume profile with varying mass. Here, a new model is described and compared to the standard allometric equation; both models are confronted with volume and mass profile data from trees of diverse form and size.

The Comparative R-square and its application to Mortality Models

Monday, Oct 7 11:30 AM - – Bienville Complex

Mike Strub[1*]
[1]Retired - Weyerhaeuser

The traditional coefficient of determination or R-square is the proportion of variation explained by a regression model versus the variation explained by the mean. This measure does not apply to modeling of discrete variables such as tree mortality. Additionally comparisons with mean trees per unit area as suggested by the traditional R-square do not discriminate well between alternative mortality models. The traditional R-square compares the variation explained by a model with the variation about the mean dependent variable, a very simple model. A generalized R-square based on the likelihood of the mortality model versus the likelihood of another simpler (yet more complicated than the mean) model provides better discrimination between candidate mortality models. We call this generalized R-square the Comparative Coefficient of Determination or Comparative R-square. Three growth series or plots from the South Africa Correlated Curve Trend Study are used to illustrate the difference between the traditional R-square and the generalized R-square.

Understanding autocorrelation (marginal vs. conditional) within the context of dominant height modeling

Monday, Oct 7 12:00 PM - – Bienville Complex

Mingliang Wang[1], Mike Kane[1], Dehai Zhao[1], Bruce Border[1]
[1]Warnell School of Forestry and Natrural Resources, University of Georgia

Repeated measures of stand variables given any stand/plot are (auto) correlated. Associated with two model specifications, marginal/population-averaged vs. conditional/subject-specific (not necessarily in mixed-effects modeling), autocorrelation can be marginal or conditional. We use repeatedly-measured dominant heights as an example to illustrate the difference between the two kinds of autocorrelation, and to clear-up some confusion surrounding it.

Parameter Estimation of Height-Age Models

Monday, Oct 7 1:30 PM – Bienville Complex

Quang V. Cao[1*]
[1]Louisiana State University Agricultural Center, School of Renewable Natural Resources

Base-age invariant site index models provide a prediction for dominant height H_2 at age A_2, given height H_1 at age A_1. In this study, different methods for estimating parameters of the site index models will be evaluated. The base models considered will be the Chapman-Richards function and Bailey and Cluttter (1974). Three models result from each base model by treating one parameter as varying local (plot) parameter and the remaining two as global parameters. Three approaches for estimating these parameters will be considered: (1) the OLS method, (2) the Error-in-Variable method, and (3) the Mixed Model method, which assumes that the local parameters are random. Simulation results will reveal the "best" method, based on the mean and stand deviation of the difference between observed and predicted heights.

Height-diameter relationships of in 6-years old genetically improved loblolly pine

Monday, Oct 7 2:00 PM – Bienville Complex

Samuel Egbäck[1, 2*], Bronson Bullock[1] and Steve McKeand[1]
[1]North Carolina State University, Department of Forestry and Environmental Resources
[2] Swedish University of Agricultural Sciences, Department of Southern Swedish Forest Research Centre

Data from nine genetic entries of loblolly pine (*Pinus taeda* L.) at two different spacings (1.5×6.1 m – 1076 trees ha^{-1}, 3.0×6.1 m – 538 trees ha^{-1}) were analyzed to evaluate the effect of genetic entry and spacing on the asymptote and slope parameters of commonly used height-diameter functions. The genetic entries ranged in genetic homogeneity from low to high (one seed orchard mix, three open-pollinated (half-sib) families, three full-sib families to two different clones). Genetic entry affected both the asymptote and the slope of the curves, which indicates that growth modeling will likely need to consider both genetic differences in height-age relationships and genetic stem form differences in order to make sound predictions. In addition, there might be a stronger need for more genetically specialized models as genetically more homogenous stands are planted in large blocks. The primary reason for the significant differences in the asymptote and slope parameters was due to the clones that were included in the study. When the clones were excluded from the analyses, no significant effect for the asymptote or the slope parameter was found. Furthermore, spacing affected the slope parameter of the curves, indicating that trees became less slender in wider spacings. No significant interaction between genetic entry and spacing was found for the asymptote or the slope parameter.

Interplanting Loblolly Pine - Impacts on Growth Characteristics

Monday, Oct 7 2:30 PM – Bienville Complex

Travis Norman[1*]
[1]North Carolina State University, Department of Forestry & Environmental Resources

Improvements in timber quality and growth can be made to improve economic value of loblolly pine (Cumbie et al, 2012). Cumbie et al. (2012) showed that by improving sawtimber quality in loblolly pine through genetic improvement, the potential dollar value of loblolly pine was increased by as much as 162% over local checks. Therefore, improving the genetic sawtimber potential along with silivicultural treatments is essential in increasing the potential dollar value of plantations. Planting genetically superior individuals such as clonal loblolly pine is a potential possibility to increasing the potential dollar value of plantation forests due to accelerated growth rates and improved timber quality. However, regenerating with clonal loblolly pine is a very expensive investment for many landowners. One way to reduce the initial investment in regeneration costs while also increasing the potential future dollar value could be by interplanting loblolly pine clonal varieties, which have superior growth characteristics and genetics, with other less genetically superior loblolly pine seedlings. By combining these different levels of improved genetics, the clonal varieties can be retained throughout the rotation of the plantation so they will grow to be the more valuable sawtimber trees, while the other genetic stock can be removed during thinnings. The objective of this study is to compare the composition of stands planted as pure clonal blocks to stands interplanted with a mixture of clonal and open-pollinated planting stock. Both individual-stem and stand-level traits will be compared in this study. This study uses a set of growth and yield block plots to research differences in the two planting regimes.

Bayes forest: combining measurements and models to understand biological diversity.

Wednesday, Oct 7 3:30 PM – Bienville Complex

Ilya Potapov[1*], Pasi Raumonen[1], Markku Åkerblom[1], Mikko Kaasalainen[1], Risto Sievänen[2]
[1]Tampere University of Technology, Department of Mathematics
[2]Finnish Forest Research Institute, Vantaa Research Unit

Recent developments in the analysis of Terrestrial Laser Scanning (TLS) data allow for a detailed 3D description of trees and forest stands at a fast rate. The measurement data combined with the biological knowledge on how trees grow can lead to a better understanding of the trees' structural and functional roles in the forest ecosystem. We propose a methodology utilizing both the experimental data and biological concepts in order to model the forest stand. In this approach, we combine the prior biological and empirical information in the Bayesian sense. Namely, at first, the TLS data, collected either from trees of the same species or those of different taxon groups, are utilized to reconstruct the corresponding trees. Next, these reconstructed trees are to be analyzed to form the statistical distributions of the entities needed to describe the spatial organization of a tree. Finally, the desired characteristics can be statistically obtained from the distributions and, combined with the biological knowledge on how these distributions are related to each other, provide the basis for modeling 3D forest stands for the given statistical data sets. As a result, the model trees differ from each other, though following the same experimental distributions. Thus, using the experimental TLS data we have reconstructed several trees of different coniferous species (Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*)), given their relative simplicity. Finally, using these models we have developed a set of biologically plausible rules for building statistical trees based on these results and built several tree samples. The results can be further used in various applications, like assessments of the forest canopy photosynthetic activity, biomass and oxygen production etc. This study gives an onset for the 4D space and time) modeling studies, based on the repeated TLS measurements and knowledge of the ecological dynamical systems.

Impacts of Ozone on Carbon sequestration by Swedish Forests: A modeling study

Monday, Oct 7 4:00 PM – Bienville Complex

N. Subramanian[1*], P. E. Karlsson[2], J. Bergh[1], U. Nilsson[1]
[1]Southern Swedish Forest Research Centre
[2]Swedish Environmental Research Institute

Carbon sequestration by terrestrial vegetation is important for the budget of greenhouse gas fluxes to and from the atmosphere, globally. The high rates of carbon sequestration to Swedish forests depend on the fact that the annual growth rate is higher than the annual harvest rate. Any factor that tends to reduce growth rates also potentially will reduce forest carbon sequestration rates such as Ozone. The aim of this study was to estimate to what extent the occurrence of elevated ozone concentrations near the ground can negatively affect the growth and carbon sequestration of Swedish forest ecosystems. This was achieved by the following procedure: 1) An assessment was made of which physiological processes influencing forest growth that could be particularly vulnerable to negative ozone impacts and ozone dose-response was established for each county of Sweden; 2) The net primary production (NPP) for the Swedish forests was modeled using 3-PG model for forest stand representative for six different geographical zones across Sweden, with or without the assumed negative ozone impacts derived for the dose – response relationships, and 3) The modeled NPP for the forests in the different zones, with and without ozone, was used to estimate the ozone impacts on the carbon sequestration for the forest living biomass carbon stocks. The results from the 3-PG model showed that the biomass production was reduced between 4-15% and 1-4% for conifers (Norway spruce and Scots pine) and silver birch respectively in ambient ozone as compared to the pre-industrial ozone. Biomass reductions were shown for all parts of Sweden, with the largest biomass reductions for the southern

parts. Biomass was reduced to similar magnitude in future climate scenarios as in current climate. The NPP was generally higher in the future A2- and B2 climate scenarios, as compared to current climate, for all tree species and in all geographical zones across Sweden. The results from this simulation can to some extent be regarded as independent confirmations of the ozone impacts of growth.

A non-absurd justification for extrapolation of regression models: constraining loblolly pine biomass predictions

Monday, Oct 7 4:30 PM – Bienville Complex

Don Bragg[1*]
[1]USDA Forest Service, Southern Research Station

Extrapolation, the process of estimating beyond observations, has always been approached cautiously by forest mensurationists. However, contrary to some purists who consider any extrapolation (especially if done well outside the range of data) problematic at best and "absurd" at worst, extrapolation can play an important role in the regression model selection process. To demonstrate this, I present an example of a loblolly pine (Pinus taeda) biomass model fit to data from southeastern Arkansas. This project was part of a study of ecosystem services (e.g., carbon sequestration) in loblolly pine-dominated, naturally regenerated forests. Because there are few local biomass models for small diameter natural-origin loblolly pine, we destructively sampled 66 such trees from 0.9 to 15.0 cm DBH, separated the specimens into various components, oven-dried the components, and then weighed them. We used ordinary least squares regression and conventional model evaluation to reduce over two dozen possible equation forms to a subset of strongly supported designs that were virtually indistinguishable from each other. However, knowing the propensity of many ecological modelers to extrapolate regression models well beyond the range of derivation, we projected each of the final models to loblolly pines of <1, 25, 50, and 100 cm DBH. The National Biomass Estimator and a different set of local weight-scaling equations were used to provide the standard upon which the extrapolations were judged. Of the 6 equations tested, only one demonstrated well-constrained behavior across the entire range of diameters. Interestingly, this model had one of the higher AICc values of the final subset. This example demonstrates considerable utility for extrapolation as a supplement to traditional goodness-of-fit tests, for which biological reasonableness should receive at least as much weight as statistical measures.

Seeing the forest from the wood: What can wood density attributes tell us about forest stand dynamics?

Tuesday, Oct 8 9:00 AM – Gravier Complex

Christopher Woodall[1], Matthew Russell[2*]
[1]USDA Forest Service, Northern Research Station, St. Paul
[2] University of Minnesota, Department of Forest Resources

An emerging research gap is the response of forests (e.g., biomass/carbon fluctuations) to global change across the diverse biomes of the earth. Wood density (i.e., specific gravity) has emerged as an indicator of tree function that can be estimated across large-scales to inform biomass/carbon assessments. Wood density can be used to define a spectrum of wood economics that relates to ecological function (e.g., wood density as indicator of modulus of elasticity that may constrain maximum crown sizes) and thus should help inform efforts to estimate biomass and forecast biomass change across large-scales. Using a remeasured forest inventory across the eastern US, changes in wood density and stand attributes (e.g., changes in biomass and regeneration) were ascertained. Initial results suggest that mean and standard error of a stand's wood density may refine understanding of stand dynamics and associated biomass/carbon attributes. A new paradigm is suggested where wood density attributes are a standard metric considered during the management of mixed species stands.

Parameters describing the topology of forest canopies

Tuesday, Oct 8 9:30 AM – Gravier Complex

Ernst-Detlef Schulze[1*]
[1]Max Planck Institute for Biogeochemistry

Forest canopies are quantitatively characterized by the composition, organization, and location of aboveground biomass and of interstitial spaces among these components. We used small footprint scanner with high pulse density for a quasi-continuous assessment of the three-dimensional structure of forest canopies and propose a set of simple and interpretable parameters to quantify outer and inner canopy characteristics.

The parameter north facing slopes, canopy gap fraction, crown islands, trunk-space height, and canopy texture entropy and contrast are not collinear and have an ecological significance. Habitats of bats and of canopy dwelling insects have been investigated. Although forest stands were under very different management schemes and species composition, there are unexpected similarities with respect to certain canopy structure parameters.

Variation in spruce budworm natural disturbance increases complexity in Acadian forest ecosystems

Wednesday, Oct 9 9:00 AM – Gravier Complex

David A. MacLean[1*]
[1]University of New Brunswick, Faculty of Forestry and Environmental Management

Spruce budworm (*Choristoneura fumiferana* (Clemens)) outbreaks are a major disturbance that influences stand dynamics in balsam fir (*Abies balsamea* (L.) Mill.) - spruce (*Picea* sp.) and mixed conifer-deciduous forests in northeastern North America. Several ecosystem processes result in substantial variation in spatio-temporal patterns of defoliation, differences in host tree growth reduction and mortality from that defoliation, and resulting stand dynamics. These include: 1) spruce budworm population processes that result in striking spatial differences in outbreak duration and severity; 2) differences in average defoliation among host species; 3) differences in survival rates among host species; 4) interaction of defoliation, growth reduction, and survival of host with deciduous tree species composition, thought to result from different parasitoid complexes; and 5) effects of pre-outbreak species composition on regeneration and succession. In general, tree species, age, and outbreak severity determine responses, while site and silvicultural effects are relatively weak. I will describe results of several studies of data collected before, during, and 30 years following the last major spruce budworm outbreak to examine and model the role of stand and regeneration characteristics in shaping future stand development. In mature unharvested fir stands, species composition 30 years following the outbreak was closely related to predisturbance species composition, and in immature fir stands, hardwood composition increased from 0% to 4%–27%. Species composition in harvested stands varied depending on whether intolerant hardwoods had been precommercially thinned, where thinned stands had 30% less hardwood 30 years postdisturbance than unthinned stands. Balsam fir-tolerant hardwood and spruce-tolerant hardwood stands were compared along a gradient of hardwood composition (12–82%), and a mortality regression tree model indicated that initial fir basal area, % tolerant hardwood basal area, maximum cumulative defoliation from 1983 to 1987, and spruce budworm outbreak zone (north, central, south New Brunswick) all significantly influenced fir–spruce mortality.

Spatiotemporal analysis of broken tree signatures on high-resolution satellite imagery

Monday, Oct 7 4:30 PM – Gravier Complex

Chris Cieszewski
University of Georgia

Abstracts without attendance

Comparing downed dead wood carbon stock estimates in the U.S. national forest inventory

Grant M. Domke[1 *], Christopher W. Woodall[1], Brian F. Walters[1], James E. Smith[2]
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The inventory and monitoring of coarse woody debris (CWD) carbon (C) stocks is an essential component of any comprehensive National Greenhouse Gas Inventory (NGHGI). Due to the expense and difficulty associated with conducting field inventories of CWD pools, CWD C stocks are often modeled as a function of more commonly measured stand attributes such as live tree C density. In order to assess potential benefits of adopting a field-based inventory of CWD C stocks in lieu of the current model-based approach, a national inventory of downed dead wood C across the U.S. was compared to estimates calculated from models associated with the U.S.'s NGHGI and used in the USDA Forest Service, Forest Inventory and Analysis program. The model-based population estimate of C stocks for CWD (i.e., pieces and slash piles) in the conterminous U.S. was 9 percent (145.1 Tg) greater than the field-based estimate. The relatively small absolute difference was driven by contrasting results for each CWD component. The model-based population estimate of C stocks from CWD pieces was 17 percent (230.3 Tg) greater than the field-based estimate, while the model-based estimate of C stocks from CWD slash piles was 27 percent (85.2 Tg) smaller than the field-based estimate. In general, models overestimated the C density per-unit-area from slash piles early in stand development and underestimated the C density from CWD pieces in young stands. This resulted in significant differences in CWD C stocks by region and ownership. The disparity in estimates across spatial scales illustrates the complexity in estimating CWD C in a NGHGI. Based on the results of this study, it is suggested that the U.S. adopt field-based estimates of CWD C stocks as a component of its NGHGI to both reduce the uncertainty within the inventory and improve the sensitivity to potential management and climate change events.

Preliminary estimates of boreal forest carbon stocks for Alaska with delineation of managed forest lands

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The US' National Greenhouse Gas Inventory (NGHGI) submissions under the United Nations Framework on Climate Change (UNFCCC) have not included much of the boreal forest ecosystem present in interior Alaska (AK). Much of the boreal forest lands within AK were delineated as unmanaged and hence not included in the NGHGI per US definition of managed land. However, with a revised definition of US managed lands, a refined delineation of managed forest lands in AK was combined with available information on forest ecosystem carbon stock density. Initial results suggest that numerous areas of coastal AK previously identified as managed may be unmanaged and vice versa for interior AK boreal forests. Application of preliminary carbon densities for common AK forest types suggest that sizeable carbon stocks are present in AK boreal systems that are not included in US inventory submissions under UNFCCC. Future work is needed to fully incorporate the refined managed land delineations into the US' NGHGI including monitoring mechanisms and survey development to track forest carbon in boreal systems common throughout much of AK.

A power analysis of above-ground woody carbon change using forest inventory data

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At a national scale, the carbon (C) balance of numerous forest ecosystem C pools can be monitored using a stock change approach based on national forest inventory data. Given the potential influence of disturbance events and/or climate change processes, the statistical detection of changes in forest C stocks is paramount to maintaining the net sequestration status of these stocks. To inform the monitoring of forest C balances across large areas, a power analysis of a forest inventory of live/dead standing trees and downed dead wood C stocks (and components thereof) was performed in states of the Great Lakes region, U.S. Using data from the Forest Inventory and Analysis (FIA) program of the U.S. Forest Service, it was found that a decrease in downed wood C stocks (-1.87 Mg/ha) was nearly offset by an increase in standing C stocks (1.77 Mg/ha) across the study region over a 5-year period. Carbon stock change estimates for downed dead wood and standing pools were statistically different from zero ($\alpha = 0.10$), while the net change in total woody C (-0.10 Mg/ha) was not statistically different from zero. To obtain a statistical power to detect change of 0.80 ($\alpha = 0.10$), standing live C stocks must change by at least 0.7 percent; standing dead C stocks would need to change by 3.8 percent; downed dead C stocks require a change of 6.9 percent. While the U.S.'s current forest inventory design and sample intensity may not be able to statistically detect slight changes (< 1 percent) in forest woody C stocks at sub-national scales, large disturbance events (>3 percent stock change) would almost surely be detected.

Estimating forest floor carbon content in the United States

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The USDA Forest Service, Forest Inventory and Analysis (FIA) program conducts an annual forest inventory which includes measurements of forest floor (FF) and soil carbon (C) content. Samples are collected on a systematic nation-wide array of approximately 7,800 plots where each one may represent up to 38,850 ha. Between 10 and 20 percent of these plots are measured on a recurring basis, and soil sampling includes measurements of both the FF and mineral soil (0-10 and 10-20 cm). In the US, the current method of reporting forest C stocks to international parties includes mathematical models of FF and mineral soil C. Forest type maps are combined with STATSGO soil survey data to generate soil C storage by forest types, but STATSGO possesses known shortcomings, particularly with respect to C estimation. STATSGO data are based largely on agricultural soils, so the data consistently underestimate C storage in FFs. These national-scale inventory data represent an opportunity to substantially improve our modeling and reporting capabilities because data are directly linked to forest cover and other geospatial information. Also, the FIA survey is unique in that sampling is not predicated on land use (e.g., hardwood versus softwoods, old-growth stand versus reverted agriculture) or soil type, so it is an equal probability sample of all forested soils. Given these qualities, FIA's field-observations should be used to evaluate these estimates if not replace them. Here we combined FF measurements with predictors of FF formation (e.g., climate, tree species and density, topography, and landscape position) to impute FF C storage across the US using gradient nearest neighbor techniques. The end result is an estimate of landscape-level FF C stocks from plot-level observations. Future work will include comparisons of these imputed results with simpler models currently used by the US greenhouse gas inventory.

Measurement and Assessment of Regeneration for Large Forest Landscapes of the Northern US

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Indicators of forest regeneration are needed to address long-term sustainability of forest ecosystems service. The Northern Research Station, Forest Inventory and Analysis (NRS-FIA) region spans the northern tier of the US from North Dakota to Maine and south to Missouri and Maryland. The science is challenged by the broad scope and scale of the region's ecosystems, e.g. diverse phenologies, forest types, and regeneration guidelines. NRS-FIA has introduced new measurement protocols for seedlings including all stems that have survived for a year along with height class and aerial browse impact. Targets and thresholds for regeneration are used to estimate probability of occurrence of forest regeneration. Spatial and temporal characteristics of the results are examined along with data limitations. An example for mixed-oak forests of the Mid-Atlantic region is provided. The framework provides a flexible approach that can be used to address concerns for sustaining forests following stand replacement events. Future work to apply the methodology to other large landscapes is discussed.

Quantifying Indicators for Sub-Arboreal Vegetation in Large Forest Landscapes Using Vegetation Profiles

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Sub-arboreal forest vegetation encompasses tree regeneration, herbs, grass, vines, shrubs, sub-dominant trees, and other native and exotic vascular plants. Existing science describing vegetation dynamics and management of this component lags behind that of the dominant tree canopy. At the landscape level, the research is complicated by diverse vegetation types and broad phenology within landscapes. The USDA, Forest Service, Forest Inventory and Analysis (FIA) program Vegetation Profile measurements provide empirical data that can be used to characterize and assess indicators of vegetative occupancy consistently across the United States. Results for the Northern Research Station (NRS) are used to exemplify analysis using percent cover to quantify indicators for regeneration interference, native-ness, and invasive-ness. Prospective use for wildlife habitat, forest biomass, fire risk, and aboveground carbon indicators are also discussed. The broad-scale indicators presented fill a void of empirical data and analyses needed to inform forest policymakers, forest managers, and eco-process modelers.

Spatial and Temporal Uncertainty Analysis for Lidar Driven Individual Tree Growth Model

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The US Forest Service Forest Vegetation Simulator (FVS) is a very widely used growth model developed for projecting individual trees and forest development through time. FVS is now being used to evaluate a variety of global change scenarios as it relates to forest health, carbon life cycle analysis, sustainability, wildlife habitat, wildland fires, etc. In this paper, an uncertainty budget is developed for FVS projections, where initial models inputs are spatially explicit single-tree stem maps developed with small-footprint airborne lidar. An uncertainty budget shows the overall precision of estimates/predictions made with a system, partitioned according to different types of uncertainty sources within and outside of the system. In a comprehensive fashion, sources of uncertainties due to measurements, classification, sampling, parameter estimates, are accounted for in the lidar derived stem maps and within the FVS system. Spatially identifying the sources of uncertainties in time, modeling their accumulation and propagation, and finally, quantifying them locally on a tree basis and globally on a forest level are presented. Uncertainties in future forest responses due to uncertainties in projected global climatic change predictions that will also drive this type of forest model will also be discussed. There are benefits to having an uncertainty budget for users of these types of models. The primary benefit is the acknowledgment that uncertainties exist; and it is reported. When using the model, the user will know that there is uncertainty and will use the model with full knowledge of the uncertainty and the risk of making the correct predictions (or incorrect predictions). The second most important benefit is that in a systematic fashion the decision-maker will understand the sources of uncertainties in the predictions.

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