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WELCOME

Welcome to the 7th Annual Forest Inventory and Analysis Symposium. As the name implies, this is the seventh in our annual Forest Inventory and Analysis symposia series. In the early years, symposium participation consisted mostly of members of our own regional FIA programs; we made presentations mostly to ourselves; and we focused mostly on the statistical and remote sensing details of implementing an annual inventory system. In recent years, we have expanded our focus to include uses of FIA data to satisfy our internal program reporting requirements and innovative approaches to distributing and making our data available to users. In addition, recent symposia have featured presentations by researchers and users from outside the FIA program on an ever expanding array of new and interesting applications. This year, we are particularly privileged to welcome international colleagues from at least 10 other countries. We are enthusiastic about the opportunity to learn how national forest inventories are designed and implemented elsewhere and how forest inventory data are distributed and used. Our desire is that this symposia series will promote greater interaction and collaboration at both the national and international levels.

Symposium Organizing Committee
Ronald E. McRoberts
Gregory A. Reams
Paul C. Van Deusen
William H. McWilliams

Program Schedule

MONDAY, 03 OCTOBER

0630..0745 BREAKFAST: Eastland Ballroom

OPENING, WELCOME, AND KEYNOTE PRESENTATIONS
Room: Eastland Ballroom
0800..0815 Welcome
Ronald E. McRoberts, Program Committee, USDA Forest Service
0815..0835 Overview of the Forest Inventory and Analysis Program
Gregory A. Reams, FIA National Program Leader, USDA Forest Service
0835..0900 Staff Director's View
Richard W. Guldin, Director, Science Policy, Planning, Inventory and Information, USDA Forest Service
0900..0930 Keynote Address: Society of American Foresters – An advocacy for forest inventory
John Moser, Purdue University, USA
0930..1000 Keynote Address: Forest inventory data in the State of the Nation's Ecosystems report series: Past, present and future
Kent Cavender-Bares, The H. John Heinz III Center for Science, Economics and the Environment, USA

1000..1030 BREAK: Eastland Ballroom

CONTRIBUTED SESSION 1: Remote Sensing Support for Forest Inventories
Room: Eastland Ballroom
Moderator: Mike Hoppus
1030..1055 Advances in remote sensing: moving from imagery to answers
John S. Ahlrichs, RapidEye, Brandenberg an der Havel, Germany
1055..1120 The utility of high resolution imagery for ancillary information to forest inventories
Tracey S. Frescino, Gretchen G. Moisen, Larry T. DeBlander, USDA Forest Service
1120..1145 Phase I area estimates in the South and quality control measures
Douglas O. Shipley, Jamie Cochran, USDA Forest Service
1145..1210 Mapping forest attributes in the Interior Western states using FIA data, MODIS imagery, and other spatial information
Jock A. Blackard, Gretchen G. Moisen, USDA Forest Service

Program Schedule

MONDAY, 03 OCTOBER

CONTRIBUTED SESSION 2: Carbon/Net Primary Productivity

Room: Sarah Orne Jewett
Moderator: Chris Woodall

1030..1055 Use of FIA Phase 3 soils data for estimating carbon in forest floor: experiences and data availability
David C. Chojnacky, USDA Forest Service

1055..1120 Filling the gap: estimating tree carbon in agricultural landscapes
C. H. Perry, C.W. Woodall, G.C. Liknes, M.M. Schoeneberger, USDA Forest Service

1120..1145 Methods for computing forest net primary productivity (NPP) at the plot level from forest inventory data
Jennifer C. Jenkins, University of Vermont; Jeffrey A. Hicke, Colorado State University; Mark J. Ducey, University of New Hampshire

1145..1210 Net primary productivity (NPP) estimated from forest inventories: variability among environmental and forest conditions
Jeffrey A. Hicke, Colorado State University; Jennifer C. Jenkins, University of Vermont; Mark J. Ducey, University of New Hampshire

CONTRIBUTED SESSION 3: Forest Inventory Estimation Issues

Room: Longfellow
Moderator: Will McWilliams

1030..1055 Single panel inventory statistics – do they convey trends?
Raymond M. Sheffield, USDA Forest Service

1055..1120 Estimation strategies for the Nevada photo-based inventory pilot
Paul L. Patterson, Gretchen G. Moisen, USDA Forest Service

1120..1145 Cost efficiency of modeling inventory attributes under constrained estimation error
Tara Barrett, USDA Forest Service

1145..1210 The poor man's GIS: plot expansion factors
Paul C. Van Deusen, National Council for Air and Stream Improvement, USA

1210..1315 LUNCH: Eastland Ballroom

Program Schedule

MONDAY, 03 OCTOBER

INVITED SESSION 1: FIA Remote Sensing Band Invited Paper Session
Room: Eastland Ballroom
Moderator: Mark Nelson

1315..1345 Integrating forest inventory and remotely sensed data to support national and international reporting: Canadian approaches and experiences
Mike Wulder, Canadian Forest Service, Canada

1345..1415 Thematic and positional accuracy assessment of digital remotely sensed data
Russell G. Congalton, University of New Hampshire, USA

1415..1445 Current and emerging operational use of remote sensing in Swedish forestry
Håkan Olsson, Mats Nilsson, Swedish University of Agricultural Sciences, Sweden

1445..1515 Forest change detection: Challenges and potential solutions for combining FIA and satellite data
Warren Cohen, USDA Forest Service

1515..1545 BREAK: Eastland Ballroom

CONTRIBUTED SESSION 4: Estimating and Mapping Forest Fuels
Room: Longfellow
Moderator: Frank Roesch
1545..1610

1545..1610 A mid-scale approach to mapping forest fuel and fire hazard at the wildland urban interface by imputation and modeling of inventory plot data
Jeremy S. Fried, Janet Ohmann, USDA Forest Service; Volker Radeloff, University of Wisconsin

1610..1635 Use of LiDAR for forest inventory and management
Birgit Peterson, USDA Forest Service; Ralph Dubayah, Peter Hyde Michelle, Michelle Hofton, University of Maryland; J. Bryan Blair, NASA; JoAnn Fites-Kauffman, USDA Forest Service

1635-1700 Can we predict fuel loadings? Relationships between the size, density, and biomass estimates of standing live and dead down trees in forests of the Lake States
Christopher W. Woodall, USDA Forest Service; Linda M. Nagel, Michigan Technological University

1700-1725

Program Schedule

MONDAY, 03 OCTOBER

CONTRIBUTED SESSION 5: Estimating Forest Biomass
Room: Eastland Ballroom
Moderator: Mark Hansen

1545..1610 Experimental investigation into the retrieval of tree height with PolInSAR
Keith Morrison, University of Cranfield, UK

1610..1635 Using five soil properties to model forest biomass and growth
C.H. Perry, M.C. Amacher, USDA Forest Service

1635..1700 Estimating forest biomass at stand level using high resolution satellite data
Y. Hirata, Forestry and Forest Products Institute; K.Sato, Japan Wildlife Research Center; S. Kuramoto, Forestry and Forest Products Institute, Japan

1700..1725 Allometric equations for predicting Puerto Rican dry forest volume and biomass
Thomas Brandeis, USDA Forest Service; Matthew Delaney, Delaney Forestry Services; Larry Royer, Bernard Parresol, USDA Forest Service

CONTRIBUTED SESSION 6: Taper/Profile Models
Room: Sarah Orne Jewett
Moderator: Jim Westfall

1545..1610 Improving coarse wood debris measurements: a taper-based technique
Christopher W. Woodall, James Westfall, USDA Forest Service

1610..1635 A stem profile model for cross-border comparisons of wood valuation of Red Pine in Ontario and Michigan
W.T. Zakrzewski, Ontario Forest Research Institute, Canada; D.W. MacFarlane, Michigan State University, USA; M. Penner, Forest Analysis, Ltd., Canada

1635..1700 Compatible taper algorithms for California hardwoods
James W. Flewelling, USA

1700-1725

1800..2000 RECEPTION (hors d'oevres): Eastland Ballroom

Program Schedule

TUESDAY, 04 OCTOBER

0630..0745 BREAKFAST: Eastland Ballroom

INVITED SESSION 2: National Forest Inventories
Room: Eastland Ballroom
Moderator Ron McRoberts
0800..0830 A new flexible forest inventory
Claude Vidal, Directeur de l'Inventaire national, France
0830..0900 Austrian National Forest Inventory – Caught in the past and heading towards the future
Klemens Schadauer, Federal Research and Training Center for Forests, Natural Hazards, and Landscale, Austria
0900..0930 Italian National Forest Inventory: methods, state of the project, and future developments
C.Gagliano, F. De Natale, P. Gasparini, and G. Tabacchi, Forest and Range Management Institute, Italy
0930..1000 Finnish National Forest Inventory: Methods and data analysis
Erkki Tomppo, Finnish Forest Research Institute, Finland

1000..1030 BREAK: Eastland Ballroom

CONTRIBUTED SESSION 7: Forest Inventory History and Policy
Room: Sarah Orne Jewett
Moderator: Greg Reams
1030..1055 History of the United States' forest survey: 1870-2004
Jim LaBau, Forest Resources Consultants; H. Gyde Lund, Forest Information Services, USA
1055..1120 Addressing forest management policy and sustainability issues using comprehensive FIA datasets for Maine, USA
William H. McWilliams, USDA Forest Service; Kenneth M. Laustsen, Maine Forest Service
1120..1145 Lund's great land classification test or how to separate the cows from the trees
H. Gyde Lund, Forest Information Services, USA
1145..1210

Program Schedule

TUESDAY, 04 OCTOBER

CONTRIBUTED SESSION 8: Statistical Issues
Room: Longfellow
Moderator: Paul Van Deusen

1030..1055 Development and comparison of parameter prediction and recovery approaches for basal area weighted Weibull diameter distribution
Jukka Nyblom, University of Joensuu; Lauri Mehtätalo, Finnish Forest Research Institute, Finland

1055..1120 A Bayesian approach to quantifying uncertainty in multi-source forest area estimates
Andrew O. Finley, Sudipto Banerjee, University of Minnesota, USA

1120..1145 Validation of geospatial models using equivalence tests
B. Tyler Wilson, Mark H. Hansen, USDA Forest Service

1145..1210 Grid-based sampling designs and area estimation
Joseph M. McCollum, USDA Forest Service

CONTRIBUTED SESSION 9: Characterizing trends in forest disturbance and recovery: Integrating FIA and historical Landsat datasets
Room: Eastland Ballroom
Moderator: Gretchen Moisen

1030..1045 North American forest disturbance and regrowth since 1972 from FIA and Landsat data
Samuel N. Goward, University of Maryland; Jeffrey G. Masek, NASA; Warren Cohen, Gretchen Moisen, USDA Forest Service

1045..1100 LEDAPS: A continental, decadal assessment of forest disturbance from Landsat data
Jeffrey G. Masek, Forest Hall, Robert Wolfe, NASA; Warren Cohen, USDA Forest Service; Chenquan Huang, University of Maryland

1100..1115 Documenting forest disturbance and regrowth history using Landsat data: methodology development through a prototype study
Chenquan Huang, Samuel N. Goward, University of Maryland; Jeffrey G. Masek, NASA; Shannon Frank, Nancy Thomas, University of Maryland

1115..1130 Potential uses of FIA/NACP forest cover change maps
Sean Healy, Gretchen Moisen, Warren Cohen, USDA Forest Service

1130..1145 Integration of FIA and Landsat for empirical characterization of post-disturbance recovery variability
Scott Powell, USDA Forest Service; Todd Schroeder, Oregon State University; Warren Cohen, USDA Forest Service

1145..1200 Characterizing change in above ground biomass and forest cover in western Oregon using historical FIA data and Landsat data
Todd Schroeder, Oregon State University; Warren Cohen, USDA Forest Service; Zhiqiang Yang, Oregon State University; Andrew Gray, USDA Forest Service

Program Schedule

TUESDAY, 04 OCTOBER

1210..1315 LUNCH: Eastland Ballroom

INVITED SESSION 3: FIA Analysis Band Invited Paper Session
Room: Eastland Ballroom
Moderator: Sally Campbell

1315..1345 Forest inventory: Role in accountability for sustainable forest management
Lloyd C. Irland, The Irland Group and Yale School of Forestry and Environmental Studies, USA

1345..1415 Development of a national forest inventory for carbon accounting purposes in New Zealand's planted Kyoto forests
John Moore, Ian Payton, Larry Burrows, Chris Goulding, Peter Beets, Paul Lane, Peter Stephens, New Zealand Forest Research Institute and Landcare Research Institute, Ltd., New Zealand

1415..1445 Rapid forest change in the Interior West presents analysis opportunities and challenges
John D. Shaw, USDA Forest Service

1445..1515 Using FIA data for understanding plant-climate relationships
Nicholas L. Crookston, Gerald E. Rehfeldt, Marcus Warwell, USDA Forest Service

CONTRIBUTED SESSION 10: Spatial Interpolation Contest
Room: Eastland Ballroom
Moderator: Ty Wilson

1545..1610 Bayesian spatial regression of continuous forest attributes
Andrew O. Finley, Sudipto Banerjee, University of Minnesota

1610..1635 Using Landsat imagery to create stand age classes for use in small area estimation
David Gartner, USDA Forest Service

1635..1700 Predicting total tree basal area using Landsat and digital elevation model-based predictors
Andrew Lister, Ray Czaplewski, USDA Forest Service

1700..1725 Gradient Nearest Neighbor imputation for local-scale basal area mapping
Kenneth B. Pierce, Matthew J. Gregory, Janet L. Ohmann, USDA Forest Service

Program Schedule

TUESDAY, 04 OCTOBER

CONTRIBUTED SESSION 11: Invasive Insects

Room: Longfellow

Moderator: Ray Sheffield

1545..1610 A comparison of tree crown condition in areas with and without Gypsy moth activity
KaDonna C. Randolph, USDA Forest Service

1610..1635 Modeling potential hosts for the Emerald Ash Borer in the complex landscape of southern Lower Michigan
David W. MacFarlane, Benjamin D. Rubin, Steven K. Friedman, Michigan State University

1635..1700 Methods of predicting the potential distribution of the Emerald Ash Borer using FIA data
Susan J. Crocker, W. Keith Moser, Mark D. Nelson, Mark H. Hansen, USDA Forest Service

1700..1725 The ground truth: weighting misclassification error into sampling error when using classified satellite imagery for large scale forest inventory and mapping
David W. MacFarlane, Benjamin Rubin, Michigan State University

CONTRIBUTED SESSION 12: Forest Attribute Modeling

Room: Sarah Orne Jewett

Moderator: Chip Scott

1545..1610 Imputing diameter growth rates using geographically weighted regression
Mark J. Ducey, University of New Hampshire; Jeffrey A. Hicke, Colorado State University; Jennifer C. Jenkins, University of Vermont

1610..1635 A flexible height model for tree species in Maine, USA
James A. Westfall, USDA Forest Service; Kenneth M. Laustsen, Maine Forest Service

1635..1700 Ecoregion-based tree height-diameter models for major Appalachian hardwoods in West Virginia
John R. Brooks, West Virginia State University; Harry V. Wiant, Jr., Pennsylvania State University

1700-1725

Program Schedule

WEDNESDAY, 05 OCTOBER

0630..0745 BREAKFAST: Eastland Ballroom

INVITED SESSION 4: FIA Statistics Band Invited Paper Session
Room: Eastland Ballroom
Moderator: Frank Roesch
0800..0830 New methods for sampling sparse populations
Anna Ringvall, Swedish University of Agricultural Sciences, Sweden
0830..0900 Another look at point-to-tree distance sampling
Christoph Kleinn, Universität Göttingen, Germany
0900..0930 Area-independent sampling for total basal area
J.W. Flewelling, Consulting biometrician, USA
0930..1000 Searching for American Chestnut – The estimation of rare species attributes in a national forest inventory
Francis A. Roesch, USDA Forest Service

1000..1030 BREAK: Eastland Ballrom

CONTRIBUTED SESSION 13: k-Nearest Neighbors
Room: Longfellow
Moderator: Andy Finley
1030..1055 Finnish National Forest Inventory: Methods and data analysis
Erkki Tomppo, Finnish Forest Research Institute, Finland
1055..1120 Training data needs for Landsat ETM+ forest/nonforest classifications used to produce FIA Phase I forest area estimates
Christine E. Blinn, Randolph H. Wynne, Virginia Polytechnic Institute and University; John A. Scrivani, Virgina Department of Forestry; Gregory A. Reams, USDA Forest Service
1120..1145 A k-NN approach to tree biomass prediction in forest inventories
Lutz Fehrmann, Christoph Kleinn, Georg-August-Universität, Göttingen, Germany
1145..1210 Variance estimation for k-Nearest Neighbors methods
Ronald E. McRoberts, USDA Forest Service; Erkki Tomppo, Finnish Forest Research Institute, Andrew O. Finley, University of Minnesota; Juha Heikkinen, Finnish Forest Research Institute

Program Schedule

WEDNESDAY, 05 OCTOBER

CONTRIBUTED SESSION 14: Applications Using Forest Inventory Data

Room: Eastland Ballroom

Moderator: Hobie Perry

1030..1055 Estimating the Balsam bough resource of Minnesota
Mark H. Hansen, Ronald E. McRoberts, USDA Forest Service; Keith Jacobsen, Chung-muh Chen, David Heinzen, Steve Flackey, George Deegan, Minnesota Department of Natural Resources

1055..1120 Use of FIA plot data in the LANDFIRE project
Chris Toney, Matthew Rollins, USDA Forest Service; Karen Short, Systems for Environmental Management; Tracey Frescino, Ronald Tymcio, Birgit Peterson USDA Forest Service

1120..1145 Bioindication of air pollution in the greater Central Valley of California, USA, with epiphytic macrolichen communities
Sarah Jovan, Oregon State University; Bruce McCune, USDA Forest Service

1145..1210 If it has thorns, it grows here: Implementing the FIA vegetation structure and diversity indicator in the Caribbean
Sonja N. Oswalt, USDA Forest Service; Britta P. Dimick, University of Tennessee; Thomas J. Brandeis, USDA Forest Service

CONTRIBUTED SESSION 15: Information Science

Room: Sarah Orne Jewett

Moderator: Bill Bechtold

1030..1055 Online, map-based estimation of forest attributes
Patrick D. Miles, Ronald E. McRoberts, USDA Forest Service

1055..1120 Automating FIA annual reports using the Virtual Analyst program
W. Keith Moser, Mark H. Hansen, Patrick D. Miles, Barbara Johnson, Ronald E. McRoberts, USDA Forest Service

1120..1135 Challenges of working with FIADB17 data: the SOLE experience
Michael P. Spinney, Paul C. Van Deusen, National Council for Air and Stream Improvement, USA

1135..1210 Forest Inventory and Analysis information delivery architecture
B. Tyler Wilson, USDA Forest Service; Wim S. Ibes, Pillar Applications Group, Inc.

1210..1315 LUNCH: Eastland Ballroom

1400..1800 SOCIAL EVENT: Harbor Cruise and Lobster Bake

Program Schedule

THURSDAY, 06 OCTOBER

0630-0745 BREAKFAST: Eastland Ballroom

INVITED SESSION 5: Statistical Topics
Room: Eastland Ballroom
Moderator: Ron McRoberts

0800..0830 Error uncertainty in inventory/monitoring/modeling systems
George Z. Gertner, University of Illinois, USA

0830..0900 Estimating the number of tree species in a population from a forest inventory: issues and challenges
Steen Magnussen, Fanglian He, Jean-Pierre Pascal, Canadian Forest Service, Canada

0900..0930 Application of the mixed estimator to annual inventory data
Paul C. Van Deusen, National Council for Air and Stream Improvement, USA

0930..1000 Design-based versus model-based sampling and estimation
Ronald E. McRoberts, USDA Forest Service

1000.1030 BREAK: Eastland Ballroom

CONTRIBUTED SESSION 16: Species Occurrence and Abundance
Room: Sarah Orne Jewett
Moderator: Greg Reams

1030..1055 Comparing approaches to species richness estimation for large-area forest inventory data
Tzeng Yih Lam, Christoph Kleinn, Georg-August-Universität, Göttingen, Germany

1055..1120 Predicting tree species presence and basal area in Utah: a comparison of stochastic gradient boosting, generalized additive models, and tree-based methods
Gretchen G. Moisen, Elizabeth A. Freeman, Jock A. Blackard, Tracey S. Frescino, USDA Forest Service; Niklaus E. Zimmerman, Swiss Federal Research Institute, Switzerland; Thomas C. Edwards, Jr., Utah State University

1120..1145 Modeling forest bird species' likelihood of occurrences with FIA and LANDFIRE vegetation models and generated pseudo-absence points
Phoebe Zarnetske, Thomas C. Edwards, Jr., Utah State University; Gretchen G. Moisen, USDA Forest Service

1145..1210 Comparing simple, common approaches to estimating tree species richness
Ronald E. McRoberts, USDA Forest Service

Program Schedule

THURSDAY, 06 OCTOBER

CONTRIBUTED SESSION 17: Estimating and Mapping Forest Cover

Room: Eastland Ballroom

Moderator: Mark Hansen

1030..1055 Testing the partial contributions of remotely sensed and topo-climatic predictors for tree species habitat modeling in Utah
N.E. Zimmerman, Swiss Federal Research Institute; Gretchen G. Moisen, USDA Forest Service; T.C. Edwards, Jr., Utah State University; T.S. Frescino, J.A. Blackard, USDA Forest Service

1055..1120 Estimating proportion of forest cover in the southern Great Plains using a two-stage stratified cluster sample and high resolution imagery
Kevin Megown, Mark Finco, Ken Brewer, Dennis Jacobs, USDA Forest Service

1120..1145 Mapping timberland and other forest land from land cover maps, geospatial analysis, and forest inventory data
Mark D. Nelson, USDA Forest Service

1145..1210 Spatial modeling of high-frequency forest attributes
John Coulston, Frank Koch, North Carolina State University; William D. Smith, USDA Forest Service

CONTRIBUTED SESSION 18: Inventory-based Assessments

Room: Longfellow

Moderator; Will McWilliams

1030..1055 Softwood timber supply outlook and influences
Richard A. Harper, Raymond M. Sheffield, USDA Forest Service

1055..1120 Deriving simple and adjusted financial rates of return on Mississippi timberlands by combining Forest Inventory and Analysis and Timber Mart-South data
Andrew J. Hartsell, USDA Forest Service

1120..1145 Alternative categorization techniques (stocking charts, stand diameter class, and FIBER habitat)
Kenneth M. Laustsen, Maine Forest Service; Todd Caldwell, L.E. Caldwell Co.; William H. McWilliams, USDA Forest Service

1145..1210 Evaluation of the impact of incorporating weather data into an on-going study of oak decline in Missouri
W. Keith Moser, Greg C. Liknes, Mark H. Hansen, USDA Forest Service

1210..1315 LUNCH: Eastland Ballroom

Program Schedule

THURSDAY, 06 OCTOBER

CONTRIBUTED SESSION 19: Land Use and Land Change

Room: Eastland Ballroom

Moderator: Mark Nelson

1315..1340 Forest land use dynamics in the Northeastern United States
Brett J. Butler, Tonya W. Lister, William H. McWilliams, Susan L. King, USDA Forest Service

1340..1405 Identifying areas of relative change in forest fragmentation in New Hampshire between 1990 and 2000
Tonya W. Lister, Andrew J. Lister, Rachel Riemann, and William H. McWilliams, USDA Forest Service

1405..1430 Forests on the Edge – I: Overview and methodology
Mark Hatfield, Susan M. Stein, Mark D. Nelson, Greg C. Liknes, Ronald E. McRoberts, Xiaoping Zhou, John Mills, Mike Eley, USDA Forest Service; Mike Dechter, American Farmland Trust

1430..1455 Forests on the Edge – II: Results and implications
Susan M. Stein, Ronald E. McRoberts, Xiaoping Zhou, Mark Hatfield, Greg C. Liknes, John Mills, Mile Eley, USDA Forest Service; Mike Dechter, American Farmland Trust

CONTRIBUTED SESSION 20: Plot Measurement Issues

Room: Longfellow

Moderator: Paul Van Deusen

1315..1340 Location uncertainty and the tri-areal design
Francis A. Roesch, USDA Forest Service

1340..1405 Characterizing forest edge-interior fragmentation using 0.6-ha ground-based samples with applications to forest resource assessments
Victor A. Rudis, USDA Forest Service

1405..1430 An investigation of condition mapping and plot proportion calculation issues
Demetrios Gatziolis, USDA Forest Service

1430..1455 The status of accurately locating FIA plots using GPS
M.L. Hoppus, Andy Lister, USDA Forest Service

1455..1520 Repeatable tree canopy densities with a modified convex densitometer
Kenneth W. Stolte, USDA Forest Service

Program Schedule

Poster Abstracts

Harvesting, timber product output, and mill distribution: A southern perspective

Tony G. Johnson, Sonja N. Oswalt, James Bentley, Mike Howell, Carolyn Steppleton
USDA Forest Service
Knoxville, Tennessee USA

Abstract: The thirteen states of the Southern U.S. contain only 1.7 percent of the global timber base, yet the South produces 18 percent of the world's timber products. Furthermore, forest industry and timber products contribute more than $100 billion annually to the Southern economy. Consequently, harvest and TPO trends are a significant component of the USDA Forest Service Forest Inventory and Analysis program (FIA) in the Southern United States.

Three levels of resource data are required to provide reliable information on resource use and product output in the South. Timber removal data from FIA inventory plots are combined with timber product output data from forest industry surveys and utilization data from felled-tree harvesting studies to produce estimates of total harvest from the South's timberland. Data collected by the Resource Use section of FIA estimate that removals from the 13 states inventoried by the Southern Research Station total 11.8 billion cubic feet annually. Timber products comprise 74 percent of the total removals—enough volume to fill nearly 3,500 logging trucks per day in each of the 13 states. Trends in output are discussed, along with current harvest and utilization data, mill statistics, and mill distribution throughout the south.

The National Biomass and Carbon Dataset 2000 (NBCD 2000): A high spatial resolution baseline to reduce uncertainty in carbon accounting and flux modeling

Josef Kellndorfer, Wayne Walker
The Woods Hole Research Center
Woods Hole, Massachusetts USA
e-mail: jkellndorfer@whrc.org

Michael Hoppus, Jim Westfall, Elisabeth LaPoint
USDA Forest Service
Newtown Square, Pennsylvania USA

Abstract: A major goal of the North American Carbon Program (NACP) is to develop a quantitative scientific basis for regional to continental scale carbon accounting to reduce uncertainties about the carbon cycle component of the climate system. Given the highly complementary nature and quasi-synchronous data acquisition of the 2000 Shuttle Radar Topography Mission (SRTM) and the Landsat-based 2001 National Land Cover Database (NLCD 2001), an exceptional opportunity exists for exploiting data synergies afforded by the fusion of these high-resolution data sources. Whereas the thematic layers of the NLCD are suitable for characterizing horizontal structure (i.e., cover type, canopy density, etc.), SRTM provides information relating to the vertical structure, i.e., primarily vegetation height. Research from pilot study sites in Georgia, Michigan, and California has shown that SRTM height information, analyzed in conjunction with bald Earth elevation data from the National Elevation Dataset (NED), is highly correlated with vegetation canopy height. In the NBCD2000 initiative, data are analyzed in 60 ecologically diverse regions, identical to the NLCD 2001 "mapping zones", which cover the entire conterminous United States. Within each mapping zone data from the space shuttle are combined with topographic survey data from the NED to form a radar-measured vegetation height map. Subsequently, this map is converted to estimates of actual vegetation height, biomass, and carbon stock using survey data from the U.S. Forest Service Forest Inventory and Analysis (FIA) program and derived biomass data, as well as ancillary data sets from the NLCD2001 project.

Poster Abstracts

A "Keep it simple" approach to simulating basal area generating surfaces for the National Insect and Disease Risk Map

Frank J. Krist Jr.,
USDA Forest Service, Fort Collins, Colorado USA
fkrist@fs.fed.us

Abstract: Basal Area (BA) surfaces representing nearly 80 individual tree species are playing a critical role in the construction of the 2005 – 06 National Insect and Disease Risk Map compiled by the USDA Forest Service, State and Private Forestry Area, Forest Health Protection Unit. These layers provide information on individual host distributions, stocking density, forest composition, and provide volume estimates. This information forms the building blocks of most of the risk models that make up the National Insect and Disease Risk map. In order to accommodate the schedule and needs of the National Insect and Disease Risk Map a highly automated, repeatable, and not computationally-intensive process was required for generating BA surfaces that depict natural variation. This paper briefly discusses the most successful results of a series of tests FHTET performed on the Bartlett Experimental Forest plot network to identify a suitable approach for surfacing BA. Techniques tested included spline, IDW, gradient-plus-inverse distance squared (GIDS), ANUDEM (discretised thin plate spline technique) or TOPOGRID, and kriging. The experiment yielding the best results was a "modified" surfacing technique that included the following steps: 1) Surface BA using the Arc/Info TOPOGRID command, 2) Multiply the resultant surface by a NLCD percent canopy closure layer, and 3) Offset the negative bias in the resultant BA values by multiplying by a constant of 1.16 for total BA. Despite the simplicity of the approach and the speed at which it can be run the results are surprisingl

Tree species and size structure of interior and edge of large-scale old-growth remnants, and neighboring shelterbelts of lowland warm-temperate forests in Shikoku region, southwestern Japan

Shigeo Kuramoto[1], Shigenori Oshioka[2], Takahisa Hirayama[2],
Kaori Sato[3], and, Yasumasa Hirata[1].
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[2]Nishi-nihon Institute of Science and Technology, Co.Ltd.
[3]Japan Wildlife Research Center (JWRC)
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Abstract: Warm-temperate old-glowth forests in southwestern Japan, especially in lowland area were highly converted into coniferous plantations, farmland and other land-use. Natural forests remnants are important to forest restoration and maintain biodiversity, since they potentially contribute vegetation recovery in adjacent clear-cut or thinned area of plantation forests as seed sources and hold many species of trees, other plants and animals. In current, large-sized old-growth remnant forests are rare, most natural forests remnants are shelterbelts among coniferous plantations or clear-cut area.

We characterized the structure of a large-sized old-growth remnant with comparison of edge and interior and adjacent shelterbelts in lowland warm-temperate forests in Shikoku region, southwestern Japan. The data was obtained from tree censuses of all living trees >5 cm diameter at breast height in eight interior transects and five onsets of edge plots (fifteen plots), settled in a 25ha of old-growth forest and in ten plots in different shelterbelts with various size (1.9-15.0ha). Using two-way indicator species analysis of total 33 plot data, we identified and characterized four structural groups in terms of relative density and relative basal area. Four structural groups were interior type of large-sized old-growth, edge type of large-sized old-growth, middle-sized shelterbelts, and small-sized shelterbelts, respectively. Canonical correspondence analysis also showed differentiation of above four structural types along edge-interior gradient and remnant size gradient.

Poster Abstracts

Eliminating the effect of overlapping crowns from aerial inventory estimates

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Abstract. When a forest stand is inventoried from aerial photographs or with the use of laser scanners, suppressed trees, which are covered by the crown of a larger tree, are not observed. This means that the probability of a tree being observed from the air depends on its height and is equal to the proportion of the forest area not covered by taller trees. This study derives a mathematical formula for the probability of a tree being observed from the air under the following assumptions: (i) trees are randomly located within the stand and crown diameters within a stand are uncorrelated, (ii) tree height increases as a function of crown diameter, (iii) the tree crown forms a circle around the tree tip, and (iv) a tree is invisible (i.e., cannot be observed from the air) if the tree tip locates within the crown of a taller tree. After presenting this formula, different approaches are proposed for the correction of the censoring effect upon the observed distribution of crown areas. All of these proposed methods provide estimates for the distribution of crown areas and the total number of stems in the stand. The proposed approaches offer rather accurate estimates of the number of stems (RMSE of 5.7−11.3%; bias of -3.3−6.0% was not statistically significant) and realistic estimates of the distribution of crown areas in simulated data sets, in which all stated assumptions were valid.

Modeling contemporary climate profiles for biotic communities and tree species in western United States and predicting the effect of global warming on future climate profile locations

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Abstract. The Random Forests multiple regression tree was used to develop bioclimatic models of 26 biotic communities in western USA and several of their constituent species. The models were based on present-absent data of species from approximately 118,000 locations, largely from FIA and on a gridded sample of 140,000 locations on which biotic communities were superimposed. A spline climate model was used to generate climate data. The fit for the bioclimatic models was superb. Out of bag errors averaged nearly 20 % for the plant communities, but when adjusted for ecotones and asynchronization between their shape files and the DEM's, errors were reduced to less than 2 %. For the bioclimatic models of species, errors of omission and commission jointly averaged less than 10 %.

The results showed that the climatic profiles of either communities or species could be predicted from climate variables. The variables of most importance for segregating the communities tended to be those that generally separated maritime from continental climates: ratio of summer to total precipitation and the summer-winter temperature differential. Those of importance for the profiles of species varied greatly but invariably involved simple interactions between temperature and precipitation (e. g., the mean temperature in the coldest month by annual precipitation for *Picea engelmannii*, but the annual moisture index for *Pseudotsuga menziesii* and *Pinus ponderosa*). Projected distributions of climatic profiles according to the averages of two GCM's suggested, therefore, that the montane forests should increase in area by about 12 % largely at the expense of the alpine-tundra vegetation which should decrease by nearly 7 %. The Great Basin woodlands should also decrease to the extent that grasslands generally increase. However, the analyses showed that nearly 47 % of the future region should be extramural to the contemporary climate profiles of the plant communities. This would mean that a different composition of species would tend to make up these communities in the future. Analyses of the profiles of species suggested that those for *P. menziesii* and *P. ponderosa* should remain roughly the same in area while those for others (e. g., *P. engelmannii*, *Juniperus osteosperma*, *Pinus edulis*, and *Querxus gambelii* should decrease greatly. However, the contemporary profiles of all species should migrate upwards in altitude such that only a small proportion (61 % for *P.menziesii* but 0.0 % for *Pinus leiophylla* should remain within the species profile throughout the century.

Poster Abstracts

Effects of forest management practice on forest bird community and vegetation structure in warm-temperate zone of Shimanto River Basin, Japan

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Abstract: Disturbance of forest by human affects many forest organisms not only in case of deforestation but also in case that natural forest had replaced into forest plantation or coppice stand. Though it is not well known how forest animal communities respond to those forest conversions. In warm-temperate zone of Japan, most of natural forest had been replaced to conifer plantation and young secondary forest. In the result, old-growth natural forest is extremely fragmented to small remnants because of forest utilization. In Shimanto River Basin, which locates southwestern part of Shikoku Island, Japan, most of natural forest had been replaced to copse and conifer plantation. In order to elucidate the impacts on forest bird community and the relation with vegetation by forest utilization, we compared the species composition of forest bird community and vegetation structure in 20 research plots in this area. The research plots were set in 8 old-growth natural forests, 5 secondary forests and 7 confer plantations. The number of bird species of old-growth natural forests was not significantly higher than those of secondary forest or of confer plantation. But species composition of old-growth forests was distinguished from those of secondary forests and of conifer plantations by multidimensional scaling (MDS). More tree trunk users and tree cave users, which need dead trees or large trees with caves, were recorded in old-growth natural forest. It was suggested that forest utilization had limited the habitat area of those species.

Our changing forest evironment - Examples from UNEP atlas - One planet, many people

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Abstract. This poster shows changes in forest cover from satellite images in various parts of the world. Lands are converted from natural forests to plantations or from forests to croplands. In addtion to changes in forest land, the Atlas clearly shows human influences on our Earth including changes in land use, biological diversity, and climate. Through the use of some 271 satellite images (nearly 80 comparative images), 215 ground photos and 66 maps, One Planet presents visual proof of global environmental changes – both the good and the bad -resulting from natural processes and human-induced activities including those of the atmosphere, coastal areas, waters,croplands, grasslands, urban areas, and tundra and Polar regions. The Atlas demonstrates how our growing number of people and their consumption patterns are shrinking our natural resource base. The challenge is how do we satisfy human needs without compromising the health of ecosystems. One Planet, Many People is an additional wake-up call to this need. The United Nations Environment Programme (UNEP), in cooperation with the National Aeronautical and Space Agency (NASA), United States Geological Survey (USGS) and University of Maryland, developed One Planet Many People in celebration of World Environment Day on June 3, 2005. In addition, the development of the Atlas involved the input of 75 contributors from 33 organizations in 20 countries.

Poster Abstracts

Development of a Forest Health Monitoring—Appalachian Trail System

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Abstract. Concerns about the health and sustainability of forest ecosystems are a result of the technological advances of the 21st century that have some negative side effects such as the unwanted degradation or destruction of forest communities. The Appalachian Trail (AT) is a 2170 foot long foot-trail extending from Maine to Georgia, creating an ecological north-south transect through the most of the prevalent Eastern forest types. The AT often separate slopes with different forest types or environmental conditions on each sides—thus the AT is often in these *ecotonal* areas that often are the first areas to show signs of changing conditions and creates an ecological transect Monitoring the condition of forests along the AT will provide two primary benefits: 1. an estimate of condition of forests and trails that will help land owners, managers, and policy makers develop strategies to maintain or improve the condition of the AT and associated forests; and 2. an ecological monitoring system in one of the first places in the Eastern United States to show effects from landscape-scale stressors like air pollution or climate change. The forest health monitoring system for the Appalachian Trail (AT-FHM) consists of a probabilistic sample of the entire trail and adjacent forests within 144 feet of the trail on either side. The primary sampling unit is the FIA and FHM fixed-area plot with *indicators* of forest condition (biological diversity, structural diversity, understory vegetation, soil condition, lichen communities, wildlife habitat, fuel loading and fire risk, exotic invasive species, ozone and acid deposition air pollution, carbon sequestration, climate change, and tree growth, regeneration, mortality, and damage) that will provide much of the information for the National Park Service-Vital Signs program and for management of the AT by the Appalachian Trail Park Office (ATPO), the Appalachian Trail Conservancy, and other partners. Citizen-Scientists will assist in the implementation and monitoring of the AT-FHM system. In 2005 we established several demonstration plots in both the north and south sections of the trail, and we plan to implement the first panel of a 5-year rotating panel design in 2006—each panel consists of about 40 plots (20 north and south).

Poster Abstracts

Repeatable measures of canopy density on FHM and FIA plots

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Abstract. Tree canopy density is important for estimating photosynthetic efficiency, wildlife habitat, understory vegetation and lichen community composition, soil erosion risk, water temperatures in aquatic habitats, integrating diverse crown measurements, and other uses. Canopy density measurements will also the improve interpretation of FIA and FHM indicators: Crown Condition, Vegetation Diversity and Structure, Lichen Communities, and Soil Condition. Methods to quantify tree canopy density, typically as percent open or closed, can be complicated, expensive, or time-consuming. Concave and convex spherical densiometers, first developed in the mid-1950s, have been used as a simple, inexpensive, and relatively rapid way to estimate percent tree canopy density, and can be used under of variety of field conditions. However repeatability among observers is often poor, and use is limited in long-term monitoring studies. A modification of a convex densiometer, when used with specific data collection protocols on current FIA/FHM 4-cluster fixed-area plots, produced a highly repeatable method for 16 Indonesian Ministry of Forestry crew leaders, both within the crew leader group and compared to *expert* trainers with more experience. Percent tree canopy of 16 crew leaders averaged 22.9 (6.3 sd) percent compared to an average of 23.0 (5.3 sd) percent for 4 trainers on one subplot. On another subplot, 10 crew leaders averaged 18.1 (7.3 sd), compared to 16.4 (6.2 sd) percent for 3 trainers. If two of the crew leaders, who recorded consistently higher values, were excluded from analysis then standard deviations would have been lower on each subplot (4.3 and 2.4 sd, respectively). On another subplot with an obvious denser tree canopy, 4 trainers averaged 58.8 percent canopy density, with a 5.0 percent standard deviation. Urban foresters were trained to use the Canopy Density method in Syracuse, NY in 2004 with similar high comparability among observers. The addition of a 3rd cell on the data sheet to record 'hits' on buildings and structures enables users to compare tree canopy densities with building cover densities and open sky on urban forest plots.

Building a condition change matrix

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Abstract: Measuring forestland change is a major component of the FIA program. Users of the data want to know how much forestland was cleared to nonforest, how much forestland reverted from nonforest, and what nonforest land uses are associated with conversions and diversions. Further, the ability to quantify change within the forest is also desirable. For example, the amount of upland hardwood forestland that has recently been converted to pine plantations is an issue to a variety of constituents in some southern states. While the mapped plot provides a unique opportunity to evaluate area change on the forest landscape, a standard method to quantify condition level change has not been implemented. This poster presents a method of creating a condition change matrix using a Pro-C program to merge current and previous cycle boundary information from Oracle tables. The resultant division of the subplot into sub-sections is used to calculate actual areas, which can then be used to determine percentage change from one condition to another within the subplot.

What is the relative density of forests in the United States?

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Abstract. A relative stand density assessment technique, using the mean specific gravity of all trees in a stand in order to predict its maximum Stand Density Index (SDI) and subsequently its relative stand density (current SDI divided by maximum SDI), was used to estimate the relative density of forests across the United States using a national-scale forest inventory. Live tree biomass (dry metric tons) varies widely across the US with largest amounts in the Pacific Northwest region followed by central hardwood areas of the eastern US. In contrast, the relative density of forests appears to be less pronounced in the Pacific Northwest with high relative density areas dispersed across the US.

Poster Abstracts

Keynote Presentation Abstracts

Forest inventory data in The State of the Nation's Ecosystems report series: Past, present and future.

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Abstract. In 2002, the Heinz Center released the first in an ongoing series of reports on the condition and use of US ecosystems, titled *The State of the Nation's Ecosystems*. This report was prepared by experts from business, environmental organizations, academic institutions, and federal, state and local government. The effort has been supported by federal (including Forest Service), foundation, and corporate funds. Just over 100 indicators are used to describe six different ecosystem types, with 15 indicators in the forest chapter. Of these, 11 had full or partial data available to report on the entire country. At least 7 indicators included data from the FIA program, making FIA one of the larger sources of data for the report, and forests the ecosystem with the most data reported. In addition, FIA will likely be a key data source in the future for some of those indicators currently lacking data. The next major edition in the series is due out in 2007, and many new data are anticipated from FIA.

Biographical Sketch: Kent Cavender-Bares is a Senior Research Associate at The H. John Heinz III Center for Science, Economics and the Environment. As a staff scientist for the Environmental Reporting program for the past five years, Kent has worked on many aspects of The State of the Nation's Ecosystems project, including indicator design, working with data providers, and report writing. Before joining the Center in 2000, he received his Ph.D. from the Massachusetts Institute of Technology, for which he studied the ecology of marine phytoplankton. He holds degrees from Stanford and Cornell and has had work experiences ranging from agricultural waste management to manufacturing engineering.

Keynote Presentation Abstracts

Society of American Foresters – An advocacy for forest inventory

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Abstract: The Society of American Foresters represents all segments of the forestry profession in the United States, including public and private practitioners, researchers, administrators, educators, and students. Its mission is to advance the science, education, technology, and practice of forestry. SAF's science and education program and its policy program have been long term advocates for forest inventory with a specific focus on the U. S. Forest Service's FIA program. Aspects of their advocacy are presented and discussed.

Biographical sketch: Following undergraduate education at West Virginia University, John served as a field operations supervisor with Nelson Tree Service of Dayton, Ohio. After subsequent military service and graduate school at Penn State, he was a timber management forester on the Monongahela National Forest; a research forester with the Northeast Forest Experiment Station and the State Extension Forester for West Virginia. In 1964, he began doctoral study at Purdue University where he subsequently advanced from graduate instructor to Assistant Department Head. Dr. Moser is a strong advocate for and a national leader in the Society of American Foresters. He has assumed increasing responsibilities from chapter to national levels. His duties have included: Chair, Indiana SAF; Chair, Inventory Working Group; 2-terms as Measurements Subject Area Representative on the Forest Science and Technology Board and 2-terms as Chair of the Board; Associate Editor of Forest Science; and served as Council Representative for District IX that includes ten states from Ohio to Oklahoma. In addition, he has organized several SAF workshops and conferences, was the program chair for the 1993 Indianapolis National Convention and served on numerous national and local committees. In 1993 he was SAF Vice President and became President on January 1, 1994; in 1995, he served as the Immediate Past President. In 1996 he served as the National Program Chair for the Seventh American Forest Congress. He was elected a SAF Fellow in 1987 and in 1997; he received The John A. Beale Memorial Award for exemplary service to SAF.

Invited Presentation Abstracts

Forest change detection: Challenges and potential solutions for combining FIA and satellite data

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Abstract: FIA is the best source of current and historic plot-based forest inventory data for the US. The inventory system has undergone a series of changes over several decades, from a region-specific, unstandardized set of measurements to a consistent set of protocols and measurements now being used nationally. Although FIA is moving toward more integrated use of digital remote sensing in its measurement protocols, there still is no national standard for doing so. Moreover, because the protocols have never explicitly incorporated digital, satellite remote sensing, the plot design is not optimal for use with these types of data. A host of issues are important to consider, such as grain of field measurement vs. grain of satellite data, heterogeneity of plot condition, accuracy of ground coordinates, format and scale of airphotos used for Phase 1 stratification relative to their other uses for support of satellite data interpretation, and whether additional field observations at the plot level are needed to support image interpretation, etc. For detecting changes in measured forest attributes, there are additional problems and considerations. Because only a fraction of plots have been remeasured in the field, our ability to infer change using the plot data is at least partially compromised. In many areas there at most only two dates of measurement for any given plot, limiting the temporal window over which changes can be assessed. For some proportion of remeasured plots there are missing data for subsequent measurements, which can weaken the use of the plot data for change assessment independent of the satellite data. Where plot location is of questionable geographic precision, linking even remeasured plot data to satellite data can be a significant challenge. Unknown is the spatial extent over which change analysis is valid. It is not likely that the field-based design will be changed to more explicitly incorporate satellite remote sensing. Yet, there is increasing pressure for FIA to do so. Some progress is being made for current inventories. However, for change detection very little is being done, and it is inevitable that this too will need to be addressed. Thus, the question of how to best integrate remote sensing and FIA plot measurements for change detection using the existing protocols will become an important focus for FIA.

Invited Presentation Abstracts

Thematic and positional accuracy assessment of digital remotely sensed data

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Abstract: Accuracy assessment or validation has become a standard component of any land cover or vegetation map derived from remotely sensed data. Knowing the accuracy of the map is vital to any decision-making performed using that map. The process of assessing the map accuracy is time consuming and expensive. It is very important that the procedure be well thought out and carefully planned to be as efficient as possible. This paper presents a brief review of the current methods used in thematic map accuracy assessment. A discussion of positional error is included as it is impossible to assess thematic accuracy without carefully considering positional accuracy. Techniques for mitigating positional accuracy to insure that the thematic accuracy is unaffected by position are discussed. Some results of a recent study evaluating the impact of positional accuracy on thematic accuracy are presented. Finally, new ideas and issues related to the current state of accuracy assessment are summarized.

Using FIA data for understanding plant-climate relationships

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Abstract: We are using FIA data from the eleven western conterminous states to gain an understanding of (1) climate factors corresponding with the contemporary distribution of tree species, and (2) the role of climate in driving the Forest Vegetation Simulator (FVS). On the former front, we are using Leo Breiman's Random Forest regression tree algorithm to relate climate variables to the presence-absence of species thereby defining a species contemporary climate profile. Predicted bioclimatic maps are presented for Douglas-fir (*Pseudotsuga menziesii*) and Engelmann spruce (*Picea engelmannii*). Classification errors for the models were about 10%, a value categorized as excellent. Predictions of global warming from two global circulation models were then used to show how the spatial distribution of the climate profiles will change during this century. On the second front, the basal area increment equation used in FVS was modified to include climate drivers and was calibrated for Douglas-fir using the FIA data from the same area. The focus of this work is to start the process of modifying FVS so that it can be used to predict changes in forest dynamics that take climate-change predictions into account. Evidence from the genetics literature is presented that shows that adding climate drivers to the base statistical model is not sufficient for this purpose. Further modification of this model is proposed that adds necessary genetic responses.

Invited Presentation Abstracts

Area-independent sampling for total basal area

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Abstract: An unbiased direct estimator of total basal area for a stand is presented; stand area need not be known. Sampling can use horizontal point samples or fixed area plots, distributed on a regular grid or randomly selected. The sample space extends beyond the stand boundar. The estimator for basal area makes no distinction between plots whose centers are interior to the stand boundary and those whose centers are outside. Only trees within the stand boundary are tallied. For horizontal point sampling, the estimator is the product of the sample tree dcount, the basal area factor, and the area per grid point, with the latter being derived from grid spacing. This method avoids the complexities associated with most other estimators designed to minimize or eliminate edge bias. The proposed method may require more sample points to achieve the same level of precision as competing estimators. The method could have application in FIA sampling for stand type.

Italian National Forest Inventory: Methods, state of the project, and future developments

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Abstract: During 2002, the Forest and Range Management Research Institute (ISAFA-CRA) designed the sampling scheme and the main survey procedures for the 2nd NFI of Italy or "National Inventory of Forests and Carbon Sinks" (INFC). A triple sampling for stratification scheme was adopted: in the first phase a set of about 301.000 sample points were located on a 1 km^2 grid, with sample points randomly selected within each square of the grid. The point layer was then overlayed on white and black digital ortho-photos in order to classify the land cover according to a scheme with five main classes and some sub-classes relevant for the NFI. In the second phase, a sub-sample of the first phase points, approximately 30.000 belonging to the forest and other wooded land cover classes, was randomly selected and used to collect data on qualitative attributes (property, protection status, management issues, vegetation structure and condition, etc.). The measurements of trees and the collection of other quantitative data on soil, dead wood, etc. are carried out during the third phase, by which a sub-sample of the second phase points, approximately 10.000 for the whole nation, are surveyed again. At present, the first phase is finished and the second phase data cover almost the whole country. This paper describes the sampling method and the survey procedures of the Italian NFI and gives some details on the state of the project. Moreover, an overview of the research activities aiming at integrating NFI data with information from other sources (remote sensing, collection of data on trees outside forest, surveys on vegetation composition) is given.

Invited Presentation Abstracts

Error uncertainty in inventory/monitoring/modelling systems

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Abstract: Error-free data and models do not exist in the real world. Error is a natural property of surveys and models. Research related to error budgets will be summarized. An error budget is a comprehensive catalog of the different error/uncertainty sources in inventory/monitoring/modeling systems. When there are errors, it is not intuitive how all these errors propagating through these systems will influence final estimates and their uncertainties. The uncertainties due to these errors can also be quite different for small and large areas. Error budgets can help in assessing how various errors propagate through inventory/monitoring system. They also provide a means for the systematic improvement of the inventory/monitoring/modeling systems. Practical uses of error-budgets include data correction, model evaluation, quality control, and decision-making with uncertainty, error management, etc. Examples of error budgets will be given for different inventory/monitoring/modeling systems.

Forest inventory: Role in accountability for sustainable forest management

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Abstract: National programs of Forest Inventory, such as the USDA Forest Service FIA program, supply essential elements for accountability in programs of Sustainable Forest Management. The prominent role played by this data in the recent National Report (2004) indicates this. In implementing the Montreal C&I, the variables measured using FIA data have the best results for availability, coverage, and usefulness. In contrast, whole lists of the hoped for indicators of ecological condition and health are entirely absent. A few examples will illustrate the importance of this resource information for management and policy, in both US and international settings.

Numbers never speak entirely for themselves, as early attempts to implement C&I schemes have shown us. This tells me that the skill of Resource Analysis will be ever more important as analysts apply Forest Inventory data on resource condition and trend to C&I efforts. Early efforts have, it seems to me, failed to recognize that over-aggregated results are generally meaningless. Within sampling error limits, there is much more that FIA data can contribute to meaningful assessment. I think that geographic completeness and currency of data are less critical than precision. Important limitations also need to be recognized.

By design, FIA data are most valuable for broad regions. Too often, we confine these regions to state lines, arbitrary type groups, and other artificial boundaries. New data processing and geocoding achievements are liberating us from these limitations, but too often we haven't pushed outside outmoded boxes yet. Even as we need to push beyond these old limits, we are facing improved capabilities for integrating powerful remote sensing and GIS capabilities into what we do. Also, there are dangers in the tendency of low-intensity samples to turn into solid "facts" when entered into a GIS and, massaged by many assumptions, turned into a map. Finally, pressures will rise to measure more things to fill in the huge gaps in our ability to match C&I wishlists against actual data. This will need to be resisted, on grounds of cost and feasibility and because the FIA inventory design may not be a sound sample scheme for many important ecological variables. The degree to which the existing datasets can answer ecological and nontimber questions is under-appreciated.

A revolution in access to the basic datasets is opening the FIA information base to new users, and thereby increasing the risks of error and misunderstanding. It will be critical to educate new users about data traits and limitations, and to actively engage the user community in both developing innovative applications, while avoiding misapplication of the information. These points are applicable worldwide.

Invited Presentation Abstracts

Another look at point-to-tree distance sampling

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Abstract: Point to tree distance sampling, where the *k* nearest trees to a sample point are included as sample trees, is a very efficient response design option in practical terms because the same number of *k* trees is in each sample plot. While these techniques are widely used in ecology, forest inventory applications are rare because of the concern of bias. A general unbiased estimator has not been presented yet. The size of this bias is known to have to do with the spatial arrangement of the trees, i.e. the degree of clustering. If we use the distance to the *k*-th tree as radius for a circular sample plot, then we systematically use the smallest possible sample plot size for the *k* sample trees, which explains the positive systematic error when using the corresponding expansion factors. In this paper, I elaborate on the history of point to tree distance sampling, compare useful approximation approaches as discussed in the literature, suggest a new approximation method and discuss the required elements of an eventually unbiased estimator.

Estimating the number of tree species in a population from a forest inventory: Issues and challenges

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Abstract : Criterion one in the Montreal Process of Criteria and Indicators of sustainable development is the conservation of biological diversity. The number of tree species (richness) in our forests (*S*) is an important component of this diversity. Obtaining unbiased and precise estimate *S* for a region, a state or a country will be a challenge. The number of tree species observed in a sample of size (S_{obs}) is a downward biased estimate of *S* with bias a function of sample size and the structure of the tree population. A large number of estimators for 'predicting' S-S_{obs} has been developed. In this study we examine and discuss the performance of six sample-based estimators of *S* with data from two species rich tropical forest stands across a range of conventional sample designs.

Invited Presentation Abstracts

Design-based versus model-based sampling and estimation

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Abstract. Forest inventory sampling and estimation has traditionally been design-based, meaning that sampling designs have usually been simple random, stratified random, systematic or some combination. Further, the properties of the estimators associated with these sampling designs are based on the designs themselves. Model-based sampling, which forest inventories have traditionally not used, is based on properties of models. Model-based samples are often selected to optimize or enhance properties of the model or model predictions. In a spatial context, model-based estimation may entail use of a model to predict the value of an attribute for each mapping unit in an area of interest. The model parameters may be estimated using data obtained from either a design-based or a model-based sample. The presentation highlights with a simple example the difference between design-based and model-based sampling, but focuses primarily on the differences between design-based and model-based estimation using data obtained from a design-based sample. In particular, the role of spatial correlation and the superpopulation concept in model-based estimation, comparisons between design-based and model-based estimates, and the potential for increased precision with model-based estimates are discussed. Design-based estimates of proportion forest area are compared to logistic regression model-based estimates where the model is calibrated using forest inventory data and the spectral values of satellite imagery. The results indicate model-based estimates are not statistically significantly different that the design-based estimates, but the former are typically an order of magnitude more precise.

Development of a National Forest Inventory for carbon accounting purposes in New Zealand's planted Kyoto forests

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Abstract: This paper discusses the development of a monitoring system, being funded by the NZ Climate Change Office, to estimate carbon sequestration in New Zealand's planted Kyoto forests, i.e., those forests that have been planted since 1 January 1990 on land which previously did not contain forest. This system, which is part of the NZCAS (New Zealand Carbon Accounting System), must meet the Intergovernmental Panel on Climate Change (IPCC) good practice guidance and as such it must be seen to be unbiased, transparent and be verifiable. At the same time it is intended to meet a wider set of objectives related to international forest reporting requirements and forest health. The core of the system is a network of permanent sample plots, each established objectively where the intersections of a 4 km by 4 km grid coincide with an area of Kyoto forest. It is estimated that the total area of afforestation since 1990 is approximately 600,000 ha yielding some 400 sample points. At each sample point a cluster of four, 0.04 ha circular plots would be installed in a design similar to that employed in the FIA. Sufficient data are collected at each point to enable the carbon density in each of the required reporting pools to be calculated or modelled. At a subset of points, integrated with an existing system implemented on an 8km square grid over New Zealand's indigenous forest and shrubland, detailed assessments of soil carbon and plant biodiversity are made. The inventory will have a three year measurement cycle, with one-third of the points remeasured each year.

Invited Presentation Abstracts

Current and emerging operational use of remote sensing in Swedish forestry

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Abstract: Inventories for forest management planning are in Sweden the responsibility of the forest owners. These inventories are carried out by a combination of air photo interpretation and field work. Images from digital surveying cameras and softcopy photogrammetric work stations are just being introduced. Promising results have also been reached with laser scanning. Object level photography is frequently carried out with digital Hasselblad cameras, carried by sports aircraft, but for this purpose small UAV's is an emerging technology. The activities of the forest owners are supervised by the Forest Administration, which acquire a yearly set of SPOT HRG or similar satellite imagery for all of Sweden. These images are used for digital change detection, and comparison with a GIS data base with cutting permits. The digital analysis is made by the local forest administration staff. Statistics of the national forest resources is obtained from the sample plot based National Forest Inventory, which is carried out by the Swedish University of Agricultural Sciences (SLU). SLU has also developed a production line for combining the NFI field plots with satellite imagery. The NFI plots are first used as an aid for slope correction, and within-scene haze reduction, and then also as ground truth for the remote sensing data. A kNN data base for almost all of Sweden has been produced. It is used by authorities and researchers, since it provides the best geographically explicit overview of the national forest resources. The kNN data base is also used for post stratification of NFI statistics.

New methods for the sampling sparse populations

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Abstract: Sparse and scattered objects or species are generally difficult to sample with sufficiently good precision unless large areas are covered during the survey. To improve the efficiency of such surveys, guided transect sampling has been suggested. The method use prior information with a high spatial resolution, e.g., from aerial photographs, in the layout of survey strips. Instead of being laid out straight as in general, the survey strips will wind between potentially more interesting areas. The idea is to imitate a skilled surveyor that purposively seek for the species of interest, yet it is a probability sampling method. Initial studies have shown that the method has a potential to improve the efficiency of surveys of sparse populations. To utilize auxiliary information not available prior to the survey, guided transect sampling can be combined with 3P sampling (Probability Proportional to Prediction) for subsampling of substrates, e.g., pieces of coarse woody debris, for species inventories. Then, the surveyor's judgments of the substrates' suitability for the species of interest are used as the base for selection. The presentation will give an overview of the methods together with some results from theoretical evaluations and practical examples.

Invited Presentation Abstracts

Searching for American Chestnut – the estimation of rare species attributes in a national forest inventory

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Abstract: American Chestnut, once a dominant tree species in Northeastern United States forests, has become extremely rare in those same forests. So rare, in fact, that upon completion of 80% of the plot measurements of the USDA Forest Service's most recent (as of this writing) inventory in Pennsylvania, only 33 American Chestnut trees, greater than or equal to 1.0" diameter at breast height, out of 72,416 sampled trees, were found. This paper investigates auxiliary sampling strategies to allow Forest Inventory and Analysis units to provide better estimates of this rare but interesting species. The strategies involve increasing the initial plot size, using adaptive cluster sampling methods, and a combination of the two. The adaptive cluster sampling methods are an extension of those developed for rare clustered events in Roesch (*Forest Science* 1993, 39(4):655-669) and Roesch (*Journal of Forestry* 1994, 92(12):31-34). Roesch (1993) showed adaptive cluster sampling to be a viable sampling method when one is interested in rare forest characteristics that occur in clusters.

Invited Presentation Abstracts

Austrian National Forest Inventory –Caught in the past and heading towards the future

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Abstract: The Austrian National Forest Inventory (AFI) is carried out by the Federal Research and Training Centre for Forests, Natural Hazards and Landscape, which, up to 2005 was a subordinated institution of the Ministry for Agriculture, Forests, Environment and Water Management. In the meantime its legal status was changed and BFW has become a body of public law which is similar to a limited liability company. AFI is a binding mandate and embodied in the Austrian forest law including the right to undertake measurements in every forest in Austria. But there is no legislation concerning the periodicity of the assessments. Therefore, each assessment cycle is the outcome of negotiations with the ministry.

The Austrian Forest Inventory provides comprehensive and basic data for forest management on country and (sub)provincial level. It is used as a tool for forest policy decision-making and forest administration, as a data base for scientific forest studies and a source of information for wood-industry. The smallest spatial units, for which results are provided, are identical with the smallest forest administrative units, from 10.000 ha to 250.000 ha in size. At least for the small ones the statistical features of the results are rather weak. Every assessment year covers the whole country but yearly results based on yearly assessments are not used for reporting. Simple linear interpolation of the period results is used in cases where yearly figures are needed. AFI started in 1961 on a temporary plot design with a systematic grid and a 10 years` period. For the first 30 years it was conducted as Continuous Forest Inventory. In 1981 a permanent plot system (300 m^2) was installed and the assessment period was reduced to 5 years. From this time onwards the assessment percentage is 0.008% of the total land area. With the 6^{th} cycle (2000/2002) the assessment period was reduced once again to 3 years and all permanent plots were reassessed for the 4^{th} time. There were only slight changes in the plot design since the beginning of the inventory. Excluding the first inventory cycle no prestratification has been used. A cluster or tract system provides spatial cost efficient sampling. Trees are mainly sampled with mirror relascope technique.

During the last 45 years AFI changed from a survey of forest area, stock and increment to a complex monitoring system covering many aspects of the forest ecosystem. Up to now the assessments have been restricted to the forest but in future AFI could be widened to become a landscape monitoring system. The use of remote sensing techniques within AFI was restricted to find the plots with aerial photographs in the field. At the moment a project is conducted using satellite imagery from LANDSAT with k-nn methodology over all of Austria aiming at estimates with higher accuracy for small regions (ca. 10.000 ha). One key element of this attempt is the solar radiation correction due to the orographic situation of Austria.

Invited Presentation Abstracts

Rapid forest change in the Interior West presents analysis opportunities and challenges

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Abstract: Several years of drought have led to profound compositional and structural changes in forests of the Interior West. A complex of drought, insects, and disease caused high rates of mortality in several species and forest types on a regional scale. The magnitude of these changes is probably not unprecedented, even in historic time, but previous events of comparable magnitude were not well documented. The existence of recent periodic inventories, coupled with the implementation of annual inventories prior to or during the period of elevated mortality offers a unique opportunity to analyze forest changes on a grand scale. This "natural experiment" also provides opportunities to test the effectiveness of Forest Inventory and Analysis (FIA) methodologies with respect to monitoring forest health and long-term change. It also presents some analysis challenges. For example, successive panels of annual inventory data may be treated as quasi-periodic data or as time series data, with each approach producing markedly different estimates of the "current" state of the forest. In addition, analysts must evaluate the relative contributions of data obtained on Phase 2 and Phase 3 (i.e., Forest Health Monitoring) plots. In the case of the latter, some variables (e.g., P3 crown data), may offer some insight into less-that-catastrophic changes. Data collected before, during, and after the drought allow FIA analysts to move out of the theoretical realm and into a position to answer some long-standing, fundamental questions.

Invited Presentation Abstracts

Finnish National Forest Inventory: Methods and data analysis

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Abstract: The National Forest Inventory (NFI) of Finland has produced large-area forest resource information since the beginning of the 1920s. Beginning with NFI10 in 2004, the design was changed and the rotation was shortened to five years. Measurements are done in the entire country each year through measuring annually one fifth of the plots. About one fifth of the all plots are permanent. Using field data only, it is possible to compute reliable estimates for large areas only, the minimum size of the area typically about some hundreds of thousands of hectares. In practical forestry, estimates are also often required for smaller units, e.g., for municipalities in Finland, with a typical area of some tens of thousands of hectares. This is possible only if ancillary data are used, in addition to the sparse field data. Since 1990, the Finnish multi-source NFI (MS-NFI) has used satellite images and digital map data, in addition to field data, to produce estimates for small areas and wall-to-wall maps. It has been modified continuously and new features have been added. Error estimation methods are being developed in a co-operation with the Forest Inventory and Analysis program of the USDA Forest Service.

Information from Finnish NFIs has traditionally been used in large area forest management planning, e.g., in planning regional and national level cutting, silviculture and forest improvement regimes, making decisions concerning forest industry investments, and as a basis for forest income taxation. NFI also provides forest resource information for national and international forest statistics and processes like FAO's FRA process and UNFCCC LULUCF reporting.

The history, content, goals, and definitions of forest inventories vary among European countries. International processes, decisions and forest resource assessments need comparable data. In order to be able to respond to the needs of harmonised information at the European level, representatives of European National Forest Inventories have established an informal network called ENFIN – European National Forest Inventory Network. Its work is realised in COST Action E43, “Harmonisation of National Forest Inventories in Europe: Techniques for Common Reporting” which is funded by European Commission. The design, scope and methods of the Finnish National Forest Inventory are discussed, as well as COST Action E43 objectives and methods.

Invited Presentation Abstracts

Application of the mixed estimator to annual inventory data

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Abstract: Annual inventory data may reveal emerging trends more efficiently than periodic data. However, this requires estimation techniques that are parsimonious and do not impose a priori trend. A mixed estimation approach that is well suited for this application is explained and demonstrated. The method allows for a wide range of trends and can accommodate time series as short as 3 years. This talk will include real-time applications of the mixed estimation method to the FIADB.

A new flexible forest inventory in France

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Abstract: Since1958, the French National Forest Inventory (NFI) method has provided accurate results by local administrative units (called "département"). It has collected data on 1/12 of the départements every year. Above département level, results are obtained by consolidation without updating of results relating to different reviewing years. This method is not very well adapted to ever changing requests, which focus on the administrative region more than the département as the reference unit for National and European statistics, need more frequent updating especially after an exceptional event, refer to precisely located results for any spatial domain, involve variables weakly correlated with the growing stock, the main stratification criterion of the former method.

The spatial systematic sampling answers these requirements fairly well. Since different restitution levels are needed, it is necessary to build a multi-phase and multi-level spatial systematic sampling with different measurements for each sub-sample. The main principle is to use the concept of "complete sub-sample". A complete sub-sample is a systematic subset of the basic sample having at each level n twice the number of points of level n+1. It thus has points of each level in the same proportions as the basic sample. This ensures independence of specification and planning. It is then possible to use different methods on a complete sub-sample to answer various questions (cluster for sparse situations, transect for lines of trees …).

The same adaptability may be obtained in the time frame. In order to adapt the system to human resources and to balance the burden of surveyor work, a time systematic sampling repeats annually the same multi-phase and multi-level spatial systematic pattern. In this splitting, the annual time step is chosen because it rules the vegetation cycle as well as the budgetary exercise. So the global system adding different year points is built to always be a systematic sampling grid for each sub-level and variable. However, splitting into small territorial subdivision and using different year results raise the problem of data updating. Only small study domains will need such a consolidation of asynchronous data.

In this respect, the global sample must be split into an odd number of annual sub-samples, because the different levels are defined according to the powers of 2. An important derived constraint is the necessity to respect the annual planning each measurement campaign having to coincide with a vegetation season. Missing the annual campaign would complicate studies based on an inventory balance or on stand growth simulation, in fact most wood resource studies.

Invited Presentation Abstracts

Integrating forest inventory and remotely sensed data to support national and international reporting: Canadian approaches and experiences

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Abstract: With forested areas approaching half of the total landmass of Canada, the issue of resource sustainability is of utmost importance both environmentally and economically. Forests support the largest industry in the country by directly generating over 373 000 jobs and contributing over $CDN 37 billion to the balance of trade. In addition, Canada's forests support a multibillion dollar recreation and tourism industry. The ability to manage forest resources in a sustainable manner is essential for the future success of the forest, recreation, and tourism sectors in Canada. As a consequence, Canada requires a forest measuring and monitoring system that is capable of response to key policy drivers related to climate change and to report on sustainable development of Canada's forests both nationally And internationally. To meet these needs a plot based National Forest Inventory has been implemented that enables the monitoring of Canada's forests. Remotely sensed data is utilized for mapping of forests in areas not typically captured with photography (e.g., northern forest extents) and also provides a means for auditing and the detection of biases in the areas that are characterized with photography. The National Forest Carbon Accounting Framework benefits from the availability of standardized national information and products. The integration of these programs is focused upon the development of transparent monitoring and reporting of the structural and functional conditions of Canada's forests.

Invited Presentation Abstracts

Contributed Presentation Abstracts

Advances in Remote Sensing: Moving from imagery to answers

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Abstract: The last six years have brought major changes in the remote sensing industry including new sensor platforms, updated processing tools an the development of new services. The loss of Landsat 7and impending loss of Landsat 5 eliminates a popular source of imagery while new demands for more frequent, wide area monitoring of forest health and inventory is forcing agencies and organizations to re assess needs and capabilities. This presentation will explore the new sensors that are or becoming available and highlight features that could assist in inventory and health assessments. It will also propose new opportunities for using multi-temporal, same season imagery to enhance the land cover classification process, facilitating improved sample stratification and extension of point sample statistics to the forest level. The last point will consider the opportunity to use wide area, annual collections of multi-temporal imagery to facilitate more frequent inventory updates and automate portions of the forest health monitoring and inventory analysis processes.

Cost efficiency of modeling inventory attributes under constrained estimation error

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Abstract: Some attributes such as canopy cover, individual tree height, or diameter growth are frequently modeled rather than measured in forest inventories. Research in this area has focused on the accuracy of modeling without explicitly examining the efficiency gains from reduced measurement time. This research presents a generic method for using integer programming optimization to examine efficiency gains of attribute modeling subject to constraints on estimation error and field crew travel time. The method is applied to a demonstration problem of selecting height modeling strategies for 80 million acres of forest inventoried during the field season of 2002.

Contributed Presentation Abstracts

Mapping forest attributes in the Interior Western States using FIA data, MODIS imagery, and other spatial information

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Abstract: Spatial representation of numerous forest attributes across the Interior West Region have recently been produced, using a similar hierarchical modeling procedure to that of the FIA National Forest Biomass Map product. These forest attributes included: forest/nonforest mask, basal area, basal area by ponderosa pine species, biomass, crown cover, forest type/group, growth, quadratic mean diameter, stand age, stand density index, trees per acre, volume, and weighted stand height. Investigations were conducted to 1) analyze different candidate models to determine a suitable regional forest/nonforest mask, 2) compare the performance of various forest attribute models, 3) create a new modeling layer in predicting basal area for a specific species, and 4) explore the utility of forest mapping products in common land management decision-making processes. Results from these analyses are presented in the form of accuracy assessments performed on independent test sets, as well as comparisons of map- and plot- based distribution functions.

Training data needs for Landsat ETM+ forest/nonforest classifications used to produce FIA phase I forest area estimates

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Abstract: Simulations were carried out to explore training data requirements for nearest neighbor classifications of Landsat ETM+ imagery. Variations were explored in classification accuracies, forest area estimates, and precisions of forest area estimates with training samples created with three sampling methods and eight sample sizes. Two methods for estimating the proportion and precision of forest area were compared. A method for editing the available training data set to remove points where the spectral response of the land cover in the satellite image differed from the informational class assigned during land use interpretation resulted in significant improvements in classification accuracies. Additionally, a robust assessment was made of appropriate band combinations for forest area estimation. Finally, training data sample characteristics were explored in an attempt to predict a priori the utility of a given sample in terms of its ability to result in accurate classifications.

Contributed Presentation Abstracts

Allometric equations for predicting Puerto Rican dry forest volume and biomass

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Abstract. The accuracy of stem volume and aboveground biomass estimates in the subtropical dry forests of Commonwealth of Puerto Rico will be improved by the development regression equations derived from locally-collected data. Total stem volume outside bark is used by the United Nations' Food and Agriculture Organization's Forest Resource Assessment when reporting on forests worldwide, while merchantable stem volume (stem volume to a 10 cm upper stem diameter) inside bark is used by the USDA Forest Service's Forest Inventory and Analysis program for their reporting. Both organizations report aboveground live tree biomass and carbon. We outline the intensive tree measurement, destructive sampling, laboratory analysis of collected samples, and statistical procedures that were used to develop predictive equations that will estimate aboveground biomass, merchantable stem volume, and total volume from data collected during forest inventory. These equations produce reasonable biomass and volume estimates for the forests in our study area and could potentially be used to estimate biomass on other Caribbean islands with subtropical dry forest of similar species composition and stand structure.

Ecoregion-based tree height-diameter models for major Appalachian hardwoods in West Virginia.

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Abstract: A Chapman-Richards growth model was used to model total height-diameter relationships for five major species in West Virginia. Based on the 2000 FIA data for West Virginia, a total of 1,379 black cherry (*Prunus serotina* Ehrh.), 2,083 red oak (*Quercus rubra* L), 5,725 red maple (*Acer rubrum* L.), 3,826 sugar maple (*Acre saccharum* Marsh.) and 3,714 yellow-poplar (*Liriodendron tulipifera* L) were used to fit species specific total height models. Significant differences were found between species total height-diameter relationships among some of the five ecoregions within the state. Recognition of height-diameter differences between ecoregions would suggest that tree taper, volume and weight differences could also exist.

Contributed Presentation Abstracts

Forest land use dynamics in the Northeastern United States

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Abstract: The first and largest issue facing forests in the northeastern United States, as in many other parts of the world, is loss of forest land and, in particular, forest land being converted to developed land uses. In the Northeast, approximately 100,000 acres of forest land are being converted to developed uses every year. But these losses are not apparent from traditional forest land use metrics (e.g., total area of forest land at multiple points in time) that mask the underlying land use dynamics (e.g., land use change matrices). Until recently, area of forest land lost to developed land uses has been less than or nearly equal to the area gained from other land uses, particularly reversions of abandoned agricultural fields, but this trend is ceasing in parts of the Northeast. There is a long and continuing trend of transitions back and forth between forest and agriculture land uses, but forest-developed land use dynamics are largely unidirectional – very little developed land is expected to revert back to forest in the foreseeable future. Data collected by the USDA Forest Service's Forest Inventory and Analysis program can be used to model land use dynamics. Based on land rent theory, we develop a statistical model describing the loss of forest land to developed land uses as of function of population pressures, landscape context, and other socioeconomic variables. This research has implications for the Renewable Resource Planning Act Assessment and other policy assessments that are aimed at understanding broad-scale forest issues.

Use of FIA Phase 3 soils data for estimating carbon in forest floor: experiences and data availability

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Abstract: Much of the carbon in forests is contained in the soil and forest floor. The U. S. Department of Agriculture (USDA), Forest Service, Forest Inventory and Analysis (FIA) program monitors soil and forest floor in its phase-3 (P3) soils protocol. FIA separates the forest floor into two successive layers including: (1) litter (leaves and other *recognizable* plant material) and (2) duff (original plant forms *not recognizable* that are below litter but just above mineral soil). This paper reports on a study of carbon in soil, duff and litter for continential U.S. forests using data from the FIA soils protocol. FIA samples soil carbon in the top 20 cm of soil cores and samples duff and litter in 30.5-cm circular plots, followed by lab measurement for organic carbon content. Although FIA has been collecting these data since 2001, not all are available at this time. I examined available data to test their utility for developing regression models to estimate soil and forest floor carbon for all FIA phase-2 (P2) plots. The regression equations were developed from FIA variables and auxiliary climate data. Results estimate the amount of carbon in the soil and forest floor, and variation of these amounts among different forest conditions throughout the continental U.S. Discussion highlights some features of FIA data measurement and data availability that could be modified to improve the reliability and usefulness of such models nationwide.

Contributed Presentation Abstracts

Spatial modeling of high-frequency forest attributes

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Abstract: National and regional maps of forest attributes, such as basal area, are commonly created based on Forest Inventory and Analysis data. These maps are then used in regional planning and ecological risk assessments. However, many forest attributes exhibit a high-frequency spatial pattern where much of the total variance occurs at local scales. In this case, linear interpolation methods may be inadequate because they tend to act as low-pass filters. One common result of using linear models to predict high-frequency patterns is that predicted values tend to approach the global mean, thus over-predicting small values and under-predicting large values. The objectives of this presentation are to examine the behavior of linear models when creating maps of high-frequency forest attributes and discuss alternatives to these methods. Using Forest Inventory and Analysis data from Maine, we will examine the behavior of spatial regression models, inverse distance models, and kriging when the response variable displays a high-frequency pattern. We will also discuss the use of high-frequency kriging and localized spectral analysis as alternatives to conventional interpolation techniques.

Methods of predicting the potential distribution of the Emerald Ash borer using FIA data

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Abstract: The emerald ash borer, (*Agrilus planipennis* Fairmaire, Coleoptera: Buprestidae), a native of Asia, was initially discovered in the United States in May/June of 2002. It is believed to have entered the US in packing material transported to Detroit, Michigan, as many as five years prior to initial detection. Since 2002, the emerald ash borer (EAB) has rapidly expanded its North American range. It has decimated ash populations in southeastern Michigan and can now be found in Windsor, Ontario, throughout Michigan's Northern Lower Peninsula, Indiana, Ohio and has been transported via nursery stock to Maryland and Virginia. To map future spread of the EAB, the distribution and abundance of all species of ash in Michigan were analyzed using Forest Inventory and Analysis (FIA) data. Digital orthophotoquads and National Wetlands Inventory data were used to estimate the extent of ash forest type in riparian areas. The aim of which is to enhance ash abundance estimates and to identify corridors which would facilitate spread of the EAB.

Contributed Presentation Abstracts

Imputing diameter growth rates using geographically-weighted regression

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Abstract. To fully exploit the potential of FIA data for the spatial analysis of regional patterns in productivity, it is tempting to "fill in" tree diameters that are unavailable due to changes in plot design, or plots that have not been remeasured. Using a classical growth and yield approach to estimate diameter growth rates in this context requires assuming stationarity in the underlying relationships between growth and tree and stand characteristics. However, that assumption may be violated for widely-distributed species occurring in diverse ecological conditions. Geographically-weighted regression is one possible technique for meeting this challenge. We describe methodological challenges and suggested solutions, including (a) appropriate weighting when geographic coordinates are imperfectly known; (b) evaluation of bias-variance tradeoffs; and (c) assessment of the difference between maps produced using geographically-weighted and unweighted regressions.

A k-NN Approach to tree biomass prediction in forest inventories

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Abstract: Biomass (and carbon) is a tree and forest attribute which is of high interest for the UNFCCC and the Kyoto protocol a very actual topic. It is at the same time one of the difficult to estimate variables. Numerous models have been built from destructive sampling studies. Most biomass models are allometric models built by regression analysis and they allow to predict tree (or stand) biomass as a function of easy to observe variables. However, the validity of these models is often limited to the specific conditions of that particular study; this refers mainly to species – most biomass functions are species specific -, but also to, region, site, etc. In all too many cases they are not even readily available. While it is acknowledged that there are species specific characteristics, we hypothesize that biomass is more a function of individual tree architecture. If a comprehensive data base could be built up with many tree biomass data, one could – for a particular individual tree, for which the biomass is to be determined – look up the most similar tree from that data base. In this paper, we present intermediate results of a study where biomass is predicted by means of the *k*NN technique. For some European tree species we built an example data base and compare the non parametric, instance based *k*NN approach with conventional parametric biomass models. Key to the successful application of this technique is the data base itself. There are many data sets worldwide (usually gathered to build a biomass regression). Together with the Forestry Department of FAO we are in the process to build a spatially specific data base which would be accessible for the entire forestry community. The *k*NN-technique appears to be a promising approach for the complex task of tree and forest biomass and carbon prediction and may develop toward an interesting component for forest inventory data analysis.

Contributed Presentation Abstracts

A Bayesian approach to quantifying uncertainty in multi-source forest area estimates.

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Abstract: This paper presents a Bayesian approach to estimating forest area and associated standard error of prediction for any given area of interest. To model the forest/non-forest dependent variable, we implement a binomial-logit model that accommodates spatial correlation among observations. The model is applied to FIA plot data with the dependent variable set as forest/non-forest and independent variables derived from the Landsat ETM+ sensor and a digital elevation model. We discuss computational considerations for using the Metropolis-Hastings algorithm to sample from the parameters' posterior distribution, and subsequent mapping of forest probability predictions. Further, we highlight advantages and disadvantages of following a Bayesian analysis when dealing with spatial data.

Bayesian spatial regression of continuous forest attributes

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Abstract: This paper presents a Bayesian approach to estimating forest basal area and associated standard error of prediction for any given area of interest. To model the continuous dependent variable, we implement a hierarchical Bayesian model that accommodates spatial correlation among observations. The model is applied to data collected at the Bartlett Experimental Forest, NH. The dependent variable is set as basal area and independent variables are derived from the Landsat sensor and a other pixel level attributes. We discuss computational considerations for using the Metropolis-Hastings algorithm to sample from the parameters' posterior distribution, and subsequent mapping of forest probability predictions.

Contributed Presentation Abstracts

Compatible taper algorithms for California hardwoods

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Abstract: For thirteen species of hardwoods native to California, volume equations to three merchantability standards had been developed earlier. The volume equations are based are wood from the primary bole, forks and branches - but do not differentiate between the sources of the wood. The FIA now wants the ability to make predictions to any small-end diameter limit, with input variables of DBH and total height. Accordingly taper equations are devised which are compatible with the major trends in the pre-existing volume equations. An algorithm is developed to predict various numbers of solid wood pieces representing the primary bole and branches, each piece having a predicted inside bark and outside bark profile. The algorithm is calibrated so as to force approximate agreement with the volume equations over a range of DBH's and total heights. Limited use is made of published equations describing the profile of the primary bole for white oak and bigleaf maple growing outside of California. No actual data on branch size distribution was used. This was a somewhat unique project in that there was original detailed taper and volume data for individual trees were no longer available. But even if the full original data had been available, the problem of predicting taper for various branches would have been difficult within a system that limits inputs to DBH and total height.

The utility of high resolution imagery for ancillary information to forest inventories

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Abstract: With the continuous advancement of remote sensing technology, high resolution imagery, such as Quickbird and photography from the National Agriculture Imagery Program (NAIP), is becoming more readily available for use in forestry applications. Quickbird imagery is currently the highest resolution imagery commercially available. It consists of 2.44 m (8 ft) resolution multi-spectral bands ranging from blue to near infrared and a panchromatic band acquired simultaneously at 0.61 m (2 ft) resolution. In the near future, NAIP will provide annually updated, orthorectified, natural color, aerial photography at 1 meter resolution across the continental U.S. Our objective is to explore the utility of high resolution Quickbird and NAIP imagery for providing ancillary products to improve forest inventory estimates in the Interior West.

Contributed Presentation Abstracts

A mid-scale approach to mapping forest fuel and fire hazard at the wildland urban interface by imputation and modeling of inventory plot data

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Abstract: Forest inventory plot data for California's Sierra Nevada region were imputed by applying the method of gradient nearest neighbor (GNN) imputation to LANDSAT imagery, and a multitude of ancillary geographic information layers (e.g., elevation and its derivatives, land owner class, climate) to generate spatially comprehensive maps of fuel and fire potential attributes and characterize crown fire hazard. A map of the wildland-urban interface (WUI), generated from publicly available census and land cover data, was combined with the fire hazard map to produce a treatment prioritization map that identifies areas of WUI in close proximity to areas of high crown fire hazard. Using this map, we were able to quantify the proportion of high hazard forest land likely to pose a direct threat to human communities in the event of a fire. Accuracy of the GNN map was assessed at multiple scales. Accuracy of the housing density component of the WUI map accuracy was assessed via a county tax assessor database. We expect that the fire hazard treatment prioritization map will prove useful for identifying forested areas where fuel treatment is likely to have the greatest utility for moderating fire behavior where people live, and for systematically and objectively comparing the scope of the fuel treatment challenge on forested lands among broad regions.

Using Landsat imagery to create stand age classes for use in small area estimation

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Abstract: The current Forest Inventory and Analysis plot density is designed for large area estimation. This density is not thick enough to support small area estimation without additional data. The additional data used most for small area estimation is either satellite imagery or aerial photography. Because satellite imagery is available on a much denser grid that FIA plots, satellite imagery data can be a great aid in small area estimation. One of the main stand variables discernable by satellite imagery is leaf area. However, stand leaf area tends to approach its maximum relatively early in the stand's development. Stand basal area and stand volume and biomass tend to approach their maximums after leaf area has reached its maximum. Therefore, satellite imagery from just the time in question has limited usefulness for estimating basal area or biomass. Further information on stand age is will help estimate basal area and biomass changes after the leaf area maximum has been reached. Since Landsat TM data is available as early as 1970, Landsat data from previous years can be used to create age classes. A test of the hypothesis that using Landsat imagery to create age classes will improve the estimates of basal area and biomass will be conducted using the data from the Bartlett Experimental Forest.

Contributed Presentation Abstracts

An investigation of condition mapping and plot proportion calculation issues

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Abstract: The annual FIA field data collection protocol mandates the mapping of condition types. Condition boundaries identified visually in the field are often found, when examined in the office, to violate the protocol rules due to errors sustained during boundary delineation. Condition topology errors usually remain undetected by the NIMS data compilation modules and propagate into inaccurate calculation of condition proportions. Errors in proportion are often found even in the absence of any condition topology inconsistencies. A series of ArcInfo AML scripts have been written that process plot condition data, identify topology errors, compute condition proportions, and generate a condition map for each plot. The scripts operate on both the subplot and macroplot designs. Condition data processed through the AMLs for more than 12,000 PNW-FIA plots visited between year 2001 and 2004 revealed that inconsistent topology, undetected during compilation, was present in 5.4% and 3.4% of the plots susceptible to topology errors at the macroplot and subplot design respectively. NIMS-calculated proportions for plots with no condition topology errors and at least one condition boundary present were found to be incorrect for 7.0% and 2.9% of the plots at macroplot and subplot design, with proportion errors consistently underestimating forested conditions in favor of non-forested ones. The statistically significant bias was attributed to the inability of the NIMS modules to properly account for small, usually forested, sliver polygons at the periphery of plots. The investigation has enabled the identification of circumstances that facilitate condition delineation errors and helped training the field crews on how to avoid such errors.

North American forest disturbance and regrowth since 1972 from FIA and Landsat data

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Abstract: A team of researchers from the University of Maryland, NASA Goddard Space Flight Center and the U.S. Forest Service submitted a successful bid to the multi-agency North American Carbon Program (NACP). This activity combines the long term observation records of the NASA Landsat Program (1972 to present) with the US Forest Service Forest Inventory and Analysis (FIA) measurements. The satellite remotely sensed observations supply a relatively consistent, systematic assessment of land conditions which easily permit detection of many disturbances as well an estimate of regrowth patterns. FIA measurements will be employed to confirm and evaluate the observed patterns. A national estimate of these patterns will be derived from a sampled selection of 20 Landsat scene locations (~ 32500 km^2 each). These disturbance and regrowth patterns will be used with in the NACP to better understand the role of US (and Canadian) forest in North America carbon dynamics, specifically the proposed carbon sink in the continent.

Contributed Presentation Abstracts

Estimating the Balsam bough resource of Minnesota

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Abstract: The harvesting of over 4,000 tons of balsam fir (*Abies balsamea*) boughs and the production of wreaths and garland is a $20 million plus annual industry in Minnesota. Little is know about the long term availability and the impact that this harvesting has on the resource. Basic information concerning the extent, location and condition of the resource is needed by resource managers. Models that relate the harvestable balsam bough weight in individual standing trees based on standard FIA field measurements are presented. These models are used to estimate and map the available balsam bough resource in Minnesota based on data collected in the 1999-2003 annual forest inventory. Yield tables that predict average available tons per acre given total basal area of all live trees and balsam basal area are developed. Regional modifications to the national FIA program that were added in the North Central Region in 2004 which will enable continuous monitoring of bough harvesting on FIA plots are discussed.

Contributed Presentation Abstracts

Softwood timber supply outlook and influences

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Abstract: As far back as the 1500s, there has been concern regarding timber famine. By the late 1800s, the "cut and get out" mentality ravaged the forestlands in the eastern United States, and conservation concerns began to mold public policy and the practice of forestry. Significant growth in lumber and paper production after World War II offered many opportunities in the economic development of our nation, but not without concern for the depletion of the timberland resources. Fortunately, strong domestic forest product markets and legislation offering incentives for landowners to practice sustainable conservation forestry has kept timber supply in line with market demands. However, recent shifts in global economic dynamics and third world development are having significant impacts on the primary and secondary wood products industry in the United States.

The timber resource constitutes 75 percent of the cost in softwood lumber production. Sawmill owners and managers have a vested interest in wood supply and how it may influence future stumpage prices and competitive mill production. Information is presented that:

- looks at the influences, shifts, and trends of the softwood forest products industry during the 20th century in the United States, with a focus on the South (13 states),
- compares and contrasts softwood timber (sawtimber) supply and removal in the United States. and the South,
- addresses the influence of plantation forestry, forestland ownerships, National Forest harvest policy, and industry consolidation and capacity, and
- projects future wood supply in relation to national policy, population density, and landowner incentives to practice sustainable conservation forestry.

The information presented further demonstrates that the Southern United States (13 states – AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA):

1. is the single largest producer of industrial roundwood,
2. produces approximately 25% of the world's pulp, and 18% of solid wood products,
3. produces 58% of the total U.S harvest,
4. dedicates approximately 60% of total U.S. forest industry capital spending, and
5. is projected to continue to maintain a reliable wood supply from family, corporate, and industry timberlands, which constitutes almost 90% of the available timberland base in the South.

Contributed Presentation Abstracts

Deriving simple and adjusted financial rates of return on Mississippi timberlands by combining Forest Inventory and Analysis and Timber Mart-South data

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Abstract: The objective of this study is to compare the feasibility of investing in Mississippi timberlands as opposed to alternative investments. The real annual rates of return from mature, undisturbed timberlands in Mississippi were computed over a 17-year period (1977-1994). This is performed by utilizing Southern Research Station – Forest Inventory and Analysis (SRS-FIA) timber volume data and Timber Mart-South (TMS) data on timber prices. FIA Trees were assigned a TMS dollar value based on species, size and condition. The dollar value of each plot was derived summing the per acre value of all trees on the plot. Simple and adjusted financial maturity concepts are investigated and compared. Simple financial maturity considers the value of the timber only, while adjusted financial maturity considers the implicit costs of holding timber. Average annual rates of change in monetary value and volume change were computed and compared for four forest types and three distinct time periods: 1977-1987, 1987-1994, and 1977-1994. These rates of return are compared to alternative investments such as stocks, bonds, certificates of deposit and treasury bills. The 1977 to 1987 average annual rate of return of all forest types was 6.82% for the simple model and 3.50% using the adjusted financial maturity models. The 1987 to 1994 average annual rates were calculated to be 18.58% and 11.32%, while rates of return for the entire study period were 13.82% and 8.06% for the simple and adjusted rates of return, respectively. These rates of return indicate that investments in Mississippi timberlands can compete with alternative investments. This study illustrates the effectiveness of using FIA data in performing state and regional level macro-economic analysis.

Forests on the Edge - Part I: Overview and methodology

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Abstract: The Forests on the Edge project, sponsored by the USDA Forest Service, uses geographic information systems (GIS) to analyze data and construct maps depicting pressures and opportunities on private forests in the watersheds of the conterminous United States. The analyses focus on ranking watersheds with respect to the contributions of private forests to water quality and timber resources and with respect to threats to their private forest component from conversion to urban and exurban uses; fire; insect pests and diseases; and air pollution. The approach to ranking the watersheds is based on using GIS functions to combine spatial layers depicting a variety of ecological, topographical, and human attributes. Some layers are ready for use as they are acquired, while others require construction from raw data sources such as FIA plot data and weather data. Part I of this 2-part presentation focuses on the underlying data sources, construction of spatial layers, and techniques for combining the spatial layers to produce relevant and useful information.

Contributed Presentation Abstracts

Potential uses of the FIA / NACP forest cover change maps

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Abstract: FIA currently has the programmatic and physical resources to produce exhaustive and unbiased estimates of forest conditions nationwide. However, the sample plot system upon which these estimates are based has varied over time in most areas and does not accommodate direct measurement of forest change. Consequently, trends in forest structure must be studied in aggregate in a spatially generalized manner. The maps of forest cover change under production through the FIA/NACP (North American Carbon Project) partnership will provide a spatially explicit context for estimates of change. This context can dramatically increase the potential uses of forest change information. For example, a regional map of stand-replacing harvests and fires was recently used in the 10-year review of the Northwest Forest Plan to update habitat maps, measure changes in the distribution of old-growth forests, and characterize human impact at the watershed scale. This presentation will detail the process by which FIA data is being used in concert with Landsat imagery to produce forest change maps in five focal scenes throughout the country. The potential uses of this data will also be discussed using examples relevant to each of the five FIA regions. While more consistent sampling protocols will augment FIA's ability to characterize changes in the future, the FIA/NACP maps represent an unparalleled opportunity to study changes in the nation's forests over the last three decades in a way that is both spatially explicit and is consistent among regions and over time.

Net primary productivity (NPP) estimated from forest inventories: Variability among environmental and forest conditions

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Abstract. Net primary productivity (NPP) varies substantially among forests and across environmental gradients. Quantifying this variability is important for understanding and modeling plant productivity, particularly in the context of global change. Widespread, extensive forest inventories that span a range of climate and forest conditions are useful for establishing NPP responses. The Forest Inventory and Analysis (FIA) database is an excellent source for study as a result of its repeated measurements of many trees across the United States. Here we estimated forest NPP at the plot level using FIA inventories in the northeastern United States. We present results that described the variability of plot-level NPP by stratifying across climate, elevation, species, and forest variables such as stand age.

Estimating forest biomass at stand level using high-resolution satellite data

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Abstract: Observations from space with high-resolution satellite have shifted from forest stands, clusters of trees or mixture of some land-cover types to individual trees. Crown area and stand density are extracted directly from high-resolution satellite data, particularly panchromatic data. Other factors such as tree height, diameter at breast height (DBH), volume or biomass of forest stand are estimated with the factors derived from direst observation. We estimated above ground biomass of plantations and natural forest at stand level using high-resolution satellite data. The study plots were located in national forests managed by the Shimanto District Forest Office in the Shimanto River basin, Shikoku Island, Japan. DBH of whole trees was measured and species were recorded. Tree heights were measured for some of trees and that for the rest were estimated from the DBH-height relationship, which was derived from the field survey. Stand density was calculated in each plot based on the number of standing trees for the area of each plot. Panchromatic data of QuickBird satellite with 1-meter ground resolution were acquired on 20 July 2002. A local maximum filter was adopted for satellite data to extract stand density and watershed method was used to estimate crown area of individual trees in plantations. DBH was estimated from the crown area and DBH-height relationship was adopted referring spices of stand and topographic features from DEM. Forest biomass above the ground was estimated with spices, DBH and tree height derived from high-resolution satellite data and GIS data.

Contributed Presentation Abstracts

The status of accurately locating FIA plots using GPS

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Abstract: Historically, the GPS coordinates were intended to assist the field crews in relocating the plots, as well as to document their general location. During the past 5 years, the increase in GIS capabilities and in customer requests that utilize the spatial relationships between FIA plot data and other GIS layers has increased the value of and requirements on measurements of plot locations. In order to meet current FIA business requirements, it is essential that the GPS locations be accurate. NE-FIA started using the PLGR GPS units in the late 1990's. This was a reasonable choice of equipment due to the fact that it was a moderately priced unit that allows accurate navigation and reasonably accurate locations under a canopy without the requirement of differential correction. NE-FIA tested the PLGR on a set of 12 surveyed points (2 non-forested and 10 forested), and determined the average deviation of GPS points from the known point to be 8 meters with a standard deviation of 2 meters. On a set of Maine plots measured in 1999 and again in 2004 using the PLGRs, distance offsets were determined between the measurements in time1 and those in time2. 85% of the paired GPS positions were within 12.5 meters of each other. Six per cent of the paired plots were separated by more than 20 meters. These indications of location accuracy are reasonable, however, it still leaves about one third of the plots with questionable locations that are a concern for those doing GIS analysis and modeling. In a few cases, gross errors were encountered in some regions due to GPS unit malfunction or user error. Furthermore, significant problems with re-projections of plot locations from different datums were identified by additional tests with two different GPS brands on a survey course. Solutions to these problems and a description of the improvements provided by NE-FIA's new 12 channel GPS unit are discussed.

Documenting forest disturbance and regrowth history using Landsat data: Methodology development through a prototype study

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Abstract: The 30+ years of Landsat imagery archive is a unique data source for characterizing historical forest dynamics of North America, a critical activity in support of the North American Carbon Program (NACP). Retrieving forest information using Landsat data over such a large area requires robust and efficient data mining methods. A prototype study is being conducted at three sites in the Mid-Atlantic region in order to develop methods for reconstructing spatially explicit forest disturbance and regrowth history using Landsat observations. In this study, we will also assess the quality of historical Landsat imagery and recommend appropriate preprocessing procedures to minimize artifacts in this data set. Methods developed through this study will be applied to 20 Landsat scene locations selected across the United States to characterize North American forest disturbance and regrowth patterns.

Contributed Presentation Abstracts

Methods for computing forest net primary productivity (NPP) at the plot level from forest inventory data

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Abstract. Forest inventory data are an invaluable source of information for large-scale assessment of forest productivity and carbon (C) sequestration. Available methodologies for computing forest C cycling rates from inventory data, however, are based on FIA estimates of growing stock volume, and are thus limited to county-level resolution. Previous efforts to compute forest productivity from inventory data at the plot level have focused on "potential" productivity, and have thus ignored the important effects of disturbance and harvest on productivity estimates (Jenkins et al. 2001). In this paper, we propose a method for computing estimates of "actual" forest net primary productivity (NPP) and aboveground wood biomass accumulation using plot-level forest inventory data. Results developed using this method are aggregated to the county level for comparison with C sequestration estimates developed using contrasting methodologies. Because they are computed at the plot level, these data can also be post-stratified to investigate controls on productivity such as the impact of management regime, soil chemistry, climate, or species composition.

Bioindication of air pollution in the greater Central Valley of California, USA, with epiphytic macrolichen communities

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Abstract. In the United States, instrument-based air quality monitoring is typically focused on urban areas even though the detrimental effects of pollution often extend into surrounding ecosystems. The Forest Inventory and Analysis Program (FIA) monitors epiphytic macrolichen communities to evaluate potential air quality impacts to forest health. The main purpose of this study was to construct a model, using FIA lichen data, for bioindication of air quality in forests of the greater Central Valley of California. We used non-metric multidimensional scaling (NMS) ordination to investigate how lichen communities at 98 plots relate to concentrations of common pollutants such as ozone, sulfur dioxide, nitrogen dioxide, and ammonia. One gradient in community composition clearly corresponded with ammonia, as evidenced by high correlations with deposition estimates (r = -0.63) as well as percent abundance (r = -0.78) of lichen indicator species characteristically associated with ammonia-rich environments. The model suggested relatively high ammonia deposition to forests near large cities in addition to stands from small, intensely agricultural towns. The response of lichen communities to ozone and nitrogen dioxide gradients was less clear and requires further study. However, the model is suitable for estimating relative, local ammonia deposition to forests throughout the Sacramento Valley, San Joaquin Valley, San Francisco Bay area, the central coast, and parts of the Sierra Nevada foothills. The FIA Program will also use the model for monitoring temporal trends once plots are re-surveyed, which is especially important for U.S. forests since ammonia is not typically monitored by state or federal agencies.

Contributed Presentation Abstracts

History of the United States' forest survey: 1870-2004

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Abstract: This presents the history and development of the national Forest Survey (Forest Inventory) program as it evolved within the U.S. Department of Agriculture, Forest Service over a period of more than 100 years. It draws upon the writings of several authors, who over the years, have published on various aspects of the Forest Survey program. There is a review of nine ground plot designs used in the Forest Survey and Forest Inventory and Analysis (FIA) programs since 1931. The report also highlights the major events contributing to the current FIA, beginning as far back as 1870.

Comparing approaches to species richness estimation from large-area forest inventory data

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Abstract. Many processes and organizations, such as Montréal Processes and ITTO, include biodiversity conservation as criteria for sustainable forest management. Total number of species is one of the indicators used for biodiversity conservation, yet its estimation is notoriously difficult. Often, estimation is made from small area census data—as in ecological sampling. Major objectives of this study are (1) to evaluate nonparametric species estimators—specifically jackknife estimator, and (2) to evaluate the potential use of large-area forest inventory data in estimating species richness.

Burnham and Overton (1978 & 1979) developed a total of five order plus interpolated jackknife estimators for estimating species richness; yet higher order—third to fifth plus interpolated—estimators are seldom used. Comparison is made with three other estimators.

The dataset used in this study comes from a regional forest inventory in northern Costa Rica. Investigation of sensitivity of species richness estimators to variation in dataset is done by artificially manipulating the original dataset. This is possible due to the nature of the dataset—species are identified using local names.

Preliminary results indicate insufficiency of all five jackknife estimators in estimating species richness but shows promising result of the interpolated jackknife estimator. The proposed error variance estimator is evaluated but shows results that contradict what the developers published.

Contributed Presentation Abstracts

Alternative categorization techniques (stocking charts, stand diameter class, and FIBER Habitat)

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Abstract: A reviewer of the final draft of the report "The Forests of Maine, 2003" cited serious inconsistent trends and dynamics in forest typing across the multiple inventory dates of 1982, 1995, and 2003. This concern was raised in spite of the complete reprocessing of tree data by the Northeastern Research Station using a single set of current algorithms and classification matrices. Since the FIA forest type assignment is predicated and linked to underlying categorizations of both stand size and stocking value assignments, a holistic alternative approach was necessary. A collaborative effort between the authors utilized a series of other techniques to provide a complete alternative grouping and naming structure to stocking, stand size, and forest type. This enabled the final report to present the requisite FIA core tables and an in-depth discussion of real trends using the alternative methodology. The current duplicity of these three categories has not yet become a policy issue of its own or raised other allegations about the integrity of the FIA data collection, processing, or analytical protocols.

Predicting total tree basal area using Landsat- and digital elevation model-based predictors

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Abstract: Maps of total tree basal area are of interest to land managers, planners,and scientists who seek to understanding the spatial distribution and quantities of trees across the landscape. Geographic Information Systems (GIS) and geospatial statistical methods can be used to construct models describing the relationship between measured forest attributes (such as tree basal area) and maps of predictor variables. These models can then be applied to the sets of predictor data to create maps of the forest attribute. In the current study, plot data from the USDA Forest Service's Bartlett Experimental Forest (BEF), located in New Hampshire, were used. Tree basal area was measured on 437 0.1-ha square inventory plots located uniformly 250 meters apart across the BEF. A nearest neighbor imputation approach was used to define relationships between a set of georeferenced predictor data (Landsat- and digital elevation model-based, 30-m imagery) with unknown levels of total tree basal area, and a set with known levels of basal area. This set of relationships was then used to impute basal area to each 30-m pixel on the map. Various transformations of the predictor data were applied, as were different distance metrics. Results will be discussed, as well as compared and contrasted with other techniques presented in the session.

Identifying areas of relative change in forest fragmentation in New Hampshire between 1990 and 2000

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Abstract: Forest fragmentation has the potential to impact many facets of natural ecosystems. For example, behavior patterns of birds, richness of plant species, local weather patterns, diversity of stream fauna, and water quality have all been either shown or hypothesized to be affected by habitat loss and fragmentation. Many methods have been employed to assess forest fragmentation, including manual delineation of forest fragments and calculation of descriptive metrics, as well as automated analysis of raster land cover maps. Few studies, however, have analyzed changes in forest fragmentation over time. In the current study, we employ automated fragmentation analysis on land cover maps created in 1990 and in 2000, and calculate relative differences within a set of overlapping square windows of various sizes covering the state of New Hampshire. The goal of the study is to identify areas of the state where the fragmentation metrics differ significantly between the two dates, relative to other areas of the state. These findings can be used by resource planners and land managers in the formulation of management plans.

Lund's great land classification test or how to separate the cows from the trees

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Abstract: An Oregon Demonstration Project (FS 1998) showed that there were significant differences in area estimates obtained using definitions of "forest" in use by the Forest Service (FS) and the Natural Resource Conservation Service (NRCS). Nation-wide, up to 50 million acres may be in question as to whether they are forest or rangelands (or both). This is an area about the size of Nebraska. How lands are classified affects how they are managed. An interagecny Rangeland and Forest Definitions Planning Group (RFDPG) supporting the Roundtable on Sustainable Forest recognized a need to standardize definitions of forest and rangeland. This paper reports on a study I did for the the RFDPG. It reviews the breadth of definitions in use by the various federal agencies, past efforts to standardize, and makes recommendations on what federal agencies need to consider in their quest to come up with a national definition of "forest" and "rangeland."

Modeling potential hosts for the Emerald Ash Borer in the complex landscape of southern Lower Michigan

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Abstract: The exotic insect pest the Emerald Ash Borer (EAB, *Agrilus planipennis*), first discovered in the Detroit-Metropolitan Area in 2002, has been killing estimated millions of ash trees (Fraxinus spp) in southern Lower Michigan and is spreading to other areas of MI and the U.S. Assessing the abundance and spatial distribution of ash trees is critical for effective strategic management of the pest, but, unfortunately, EAB has been introduced into a complex, urbanizing landscape where forest inventory is especially difficult, due to complex ownership patterns and the high degree of spatial heterogeneity in species composition and forest structure. Here, we discuss forest inventory methods developed to address sampling in a complex landscape and present results describing differences in ash species distribution and abundance across many different types of treed space. Particularly important was developing a sampling scheme that included inventory of trees in urban settings, such as street and yard trees, not typically included in large scale forest inventories, as many potential EAB hosts (and many ash trees already killed by EAB) are planted trees.

The ground truth: Weighting misclassification error into sampling error when using classified satellite imagery for large scale forest inventory and mapping

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Abstract: Classified remotely sensed images of the Earth (e.g., land use classes) make it possible to define spatial strata for large scale forest inventory and analysis. However, strata defined by remotely-sensed images are map-models that may contain large amounts of misclassification error. This error manifests itself when ground sampling determines that areas within a map-defined strata, do not, in fact, meet the definition of that strata. Major problems associated with this error are misallocation of sampling effort and difficulty creating thematic maps that are attributed by scaling up measurements from ground inventory to the larger landscape. We discuss approaches to deal with misclassification error that are being applied to the problem of modeling variability in Emerald Ash Borer host distribution in a complex urbanizing landscape. The main approach involves weighting the error matrix for the map-model into the mean estimate for ground-truthed strata for the attribute of interest. Misclassification error, when unaccounted for, contributes to occlusion of real differences between strata types and reduces the overall accuracy by which forest attributes are estimated and mapped across large landscapes.

Contributed Presentation Abstracts

Grid-based sampling designs and area estimation

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Abstract: The author explores some grid-based sampling designs, popularized by Stevens and Olsen, in turn based on the ideas of Horvitz and Thompson as well as those of Yates and Grundy. Among the sampling designs are the congruent-tesselation stratified (CTS) design, the multi-density, randomized-tesselation, stratified (MD-RTS), and the multi-density, nested randomized-tesselation, stratified (MD-NRTS). The CTS somewhat resembles FIA's own Phase 2 grid, while the MD-RTS resembles the ozone grid and the MD-NRTS resembles the Phase 3 grid. A method of area estimation and calculation of standard error is presented and compared with the current method.

Comparing simple, common approaches to estimating tree species richness

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Abstract. Montreal Process Criterion 1, Conservation of biological diversity, expresses species diversity in terms of number of forest dependent species. Species richness, defined as the total number of species present, is a common metric for analyzing species diversity. Because species diversity relates only to the presence or absence of species, regardless of distribution or abundance, estimation of species diversity is difficult apart from a complete census. However, complete tree censuses are not practical for the naturally regenerated, mixed species, uneven aged forests that occur in much of the world. As a result, estimation of tree species richness must depend on sample data. The difficulty is that traditional sampling may easily miss rare or highly clustered species. However, a variety of model-based techniques have been developed to estimate the total number of species from sample plot data. The techniques are generally based on the rate of observing previously unobserved species as the number of sample plots increases. Several of these techniques were evaluated and compared using data obtained from forest inventory plots. The most promising techniques were then applied to compare estimates of tree species richness for categories of forest fragmentation and housing density in forested areas of the north central USA.

Contributed Presentation Abstracts

Variance estimators for k-Nearest Neighbor methods

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Abstract: The k-Nearest Neighbors (k-NN) method has become extremely popular in both Europe and North America for mapping applications that use forest inventory data and satellite imagery. The k-NN method is both non-parametric and multivariate, making it particularly useful for simultaneously mapping suites of inventory variables, many of which do not Gaussian distributions. This paper reports an analytical approach to estimating the precision of k-NN predictions for individual pixels and precision of estimates consisting of aggregations of pixel predictions. The approach relies upon a model-based estimation framework in which estimates of superpopulation means, variances, and spatial correlations are estimated. The k-NN method is applied to predict the proportion forest and volume per unit area for a Landsat Thematic Mapper scene in northeastern Minnesota, USA. Estimates are obtained for circular areas of radii 5 km, 10 km, and 15 centered in three locations in the scene. Bias is evaluated by comparing pixel-based and plot-based estimates for each circle. Precision is evaluated by comparing the design-based standard error and the pixel-based standard error.

Contributed Presentation Abstracts

Addressing forest management, policy and sustainability issues using comprehensive FIA datasets for Maine, USA

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Abstract: In 1999, the Maine Forest Service (MFS) and USDA Forest Service's Forest Inventory and Analysis (FIA) program implemented a new annual system for inventory and monitoring the forests of Maine, USA. The forestry and environmental community of Maine are typically embroiled in major discussions and debates concerning issues of sustainability for a wide range of forest-related resources. Often contentious and fractious, these discussions are aided by analysis of the most current comprehensive FIA dataset. Examples of issues; their delineation, documentation, and resolution are discussed for the recent state-level inventory-- the first full set of annual inventory data over a decade since the extreme spruce-budworm outbreak of the 1980's. The effects of the budworm epidemic are clearly still affecting the composition, structure, and distribution of Maine's forested ecosystems. The area of forest land in Maine has remained stable since the middle of the last century. Although relatively small acreages of forest land are converted to other land uses in Maine, land that converts often removes highly valued forests, such as white pine. Maine's forests are beginning to show increases in inventory volume in some areas. The spatial distribution of sapling-size spruce and fir across the state reveals a general abundance of regeneration, foretelling waves of merchantable wood over the next 15 years. The full suite of FIA indicators is discussed in the context of developing meaningful management and policy issues and recommendations--the end result of comprehensive analysis, making a difference on the land.

Contributed Presentation Abstracts

LEDAPS: A continental, decadal assessment of forest disturbance from Landsat data

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Abstract: Fine-resolution satellite imagery from the Landsat program offers a way to monitor the history of disturbance at continental scales, but to date this record has not been analyzed systematically. A new project, the Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) is now mining the 33-year Landsat archive to create wall-to-wall, decadal maps of forest disturbance across North America in support of the North American Carbon Program (NACP). We use the NASA/EarthSatellite Corporation GeoCover data set to produce atmospherically-corrected surface reflectance images, and then perform change detection to identify the location and type of disturbance events. Two disturbance mapping algorithms are being investigated. A simple, semi-empirical approach developed by Healey et al (in review) (the "disturbance index") is being applied to capture abrupt, stand-clearing disturbance events and recovery. To capture subtler forms of disturbance (e.g. partial harvest, defoliation due to insects) a canopy reflectance model is being used to relate changes in surface reflectance directly to changes in canopy cover and stand height. Surface reflectance products for 1990 and 2000 were released for the entire continent in April 2005, an initial disturbance frequency map for the mid-Atlantic has been created. A continental assessment of stand-clearing disturbance frequency for the 1990's is anticipated by the end of the year.

Healey, SP, Cohen, WB, Zhiqiang, Y., and Krankina, O., 2005, Comparison of Tasseled Cap-Based Landsat Data Structures for use in Forest Disturbance Detection, submitted to *Remote Sensing of the Environment*.

Online, map-based estimation of forest attributes

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Abstract. A crucial objective for the Forest Inventory and Analysis program of the Forest Service, U.S. Department of Agriculture, is to maximize the utility and use of inventory plot information for scientists and land managers while simultaneously complying with a federal prohibition on release of actual plot locations and proprietary ownership information. The objective may be at least partially achieved by constructing maps of forest attributes, making them available via the Internet, and providing an interface by which users may submit arbitrary polygons and receive areal estimates for attributes of interest. To this end, 30-m x 30-m resolution maps were constructed using forest inventory plot data, Landsat Thematic Mapper satellite imagery, and the k-Nearest Neighbors (k-NN) technique. Map-based areal estimates are calculated by adding or averaging k-NN predictions for individual image pixels. For selected circular test areas in Indiana, USA, the map-based estimates are statistically comparable to estimates obtained for the same areas using inventory plot data only. Online, map-based estimation provides general access to information derived from inventory data without revealing actual plot locations or proprietary ownership information. Techniques are discussed for increasing the speed of online estimation without compromising accuracy.

Estimating proportion of forest cover in the southern Great Plains using a two-stage stratified cluster sample and high resolution imagery

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Abstract: Due to a variety of reasons, such as remoteness or extremely hazardous conditions, there are several parts of the United States where little or no FIA plot data is available. When the un-sampled plots are large in extent or numbers, the quality of the information from the inventory is potentially compromised. This report presents results of a forest land inventory of the southern Great Plains, including parts of western Texas and Oklahoma (USA), which was previously un-sampled by field crews. A masked, two-stage, stratified cluster sample was used to derive the forest cover estimate from freely available digital data. A three-part methodology was used, which (1) utilized ancillary data to mask non-target land cover categories (i.e. urban and water); (2) created strata using coarse resolution MODIS and ancillary geospatial data layers; and (3) randomly sampled each strata using high resolution DOQ imagery to interpret forest cover. A new sampling tool, developed at RSAC, was used to quickly and accurately capture information from the DOQ's. Preliminary analysis of the data estimates the forest cover in the study area at 21 percent with less than 3 percent standard error.

Predicting tree species presence and basal area in Utah: A comparison of stochastic gradient boosting, generalized additive models, and tree-based methods

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Abstract: Many efforts are underway to produce broad-scale forest attribute maps by modeling forest class and structure variables collected in forest inventories as functions of satellite-based and biophysical information. Typically, variants of classification and regression trees implemented in Rulequest's© See5 and Cubist (for binary and continuous responses, respectively) are the tools of choice in many of these efforts. These tools have a reputation for producing superior predictions in large remote sensing applications, but are not easily interpretable, do not have ties with survey estimation methods, and use proprietary unpublished algorithms. Consequently, three alternative modeling techniques were compared for mapping presence and basal area of thirteen species located in the mountain ranges of Utah, USA. The modeling techniques compared included the widely-used See5/Cubist, generalized additive models (GAMs), and stochastic gradient boosting (SGB). Model performance was evaluated using independent test data sets. Evaluation criteria for the binary presence variables included percent correctly classified (PCC), specificity, sensitivity, Kappa, and area under the curve (AUC). Choices of threshold cut-off were also investigated for the binary response. Evaluation criteria for the continuous basal area variables included correlation, relative error, absolute error, and residual plots. Optimal threshold cut-offs, using four different threshold criteria, varied by modeling technique and species. Also, the effect of different methods of optimizing thresholds on predicted species distributions was explored. For predicting species presence (setting thresholds to maximize Kappa), SGB had higher values for the majority of the species for PCC, specificity and Kappa, while GAMs had higher values for the majority of the species for sensitivity. In evaluating resultant AUC values, GAM and/or SGB models had significantly better results than the See5 models where significant differences could be detected between models. For nine out of thirteen species, basal area prediction results for all modeling techniques were poor, but SGB provided the most stable predictions in these instances. SGB and Cubist performed equally well for modeling basal area for three species with moderate prediction success, while all three modeling tools produced comparably good predictions for one species.

Experimental investigation into the retrieval of tree height with PolInSAR

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Abstract: Over the past few years novel observing techniques have been developed exploiting polarimetric and interferometric capabilities that are now available from airborne and satellite SAR systems, of which PolInSAR is the most prominent. It exploits the polarisation dependence of scattering mechanisms to estimate scattering phase centre heights, which can be extrapolated to tree height. However, no comprehensive assessment of the operational potential and limitations of PolInSAR is yet available. Particular open questions relate to the conditions under which PolInSAR produces accurate results, with respect to structural canopy types, technical sensor specifications, and imaging conditions. To address these deficiencies, a programme of experimental research is underway based around the Ground Based SAR (GB-SAR) system. GB-SAR is a mobile, fully polarimetric, L- through X-band SAR imaging system. Interferometry requires that good coherence be maintained throughout the imaging process. However, there is an obvious danger of significant temporal decorrelation from wind-blown motion of the canopy. Experimental results are presented which investigate the effect on tree height retrieval of imaging wind-blown canopies with respect to wind conditions, canopy structure, and choice of radar frequency and polarisation. These are compared against theoretical results from a coherent modelling code. In addition, results from a developing tomographic SAR technique are presented. This exploits multi-incidence-angle imaging to provide truly 3D realisation of the scattering pattern through a canopy, allowing examination of the effects of variations in vertical biomass of forest stands. The results will be presented as canopy fly-through movies.

Evaluation of the impact of incorporating weather data into an on-going study of oak decline in Missouri

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Abstract: The Forest Inventory and Analysis program focuses on understanding the forested ecosystems of the United States. Historical weather data can add to our understanding of forest ecological processes by documenting some of the environmental inputs that influence competition, growth and mortality. However, growth and mortality reflect the results of a series of influences, not exclusively weather. This begs the question: Can the effect of weather be separated from this series of influences and if so, how much would the incorporation of weather data really enhance our understanding? Incorporating weather data is not without cost, so this is not a trivial question. This paper will discuss the basis for considering weather as an important source of data and the methodology for incorporating it. We compare several methods of spatial interpolation (kriging, co-kriging, inverse distance weighting) with geospatial climate datasets derived from physically-based simulations, using all live growth and mortality and biomass growth and mortality as response variables. We estimate the value of including weather in our analysis and draw some conclusions about the appropriate methodology for merging these data with FIA plot information.

Contributed Presentation Abstracts

Automating FIA annual reports using the Virtual Analyst program

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Abstract: In the 11 states of the North Central Forest Inventory and Analysis Program, one of the most valuable functions is the reporting of selected area, volume and growth/removal/mortality data via a series of annual reports. Using a standard format, these annual reports provide an updated view of the extent, composition and change of a state's forests. These reports also provide important early indicator and error checking functions. The Virtual Analyst program at NCFIA is designed to serve these multiple needs. Incorporating our understanding of important trends and relationships, and important "red flags" to be aware of, this program seeks to automate the more repetitive functions of report producing while highlighting any anomalies that may require further investigation by an analyst. In this paper, we discuss the underlying program logic and the design of the prototype. We document the information pathway from data-generating vehicles (Excel and Oracle) to the desktop application product (Microsoft Word), connected by PL/SQL, Visual Basic and Java procedures. Finally, we discuss the opportunity to expand this report-writing function into a customized, user-defined data query and analysis function.

Mapping timberland and other forest land from land cover maps, geospatial analysis, and forest inventory data.

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Abstract. The USDA Forest Service's Forest Inventory and Analysis (FIA) program produces statistical estimates of extent (area); volume, growth, and removals; and health and condition of our Nation's forest resources. These estimates typically summarize forest attributes within political or administrative boundaries, i.e., national forests, counties, states, regions, and the Nation. Analysis and mapping of forest inventory attributes would be improved by a nationwide geospatial dataset that differentiates timberland from other forest land. Timberland is defined as unreserved (not withdrawn from timber utilization by statute or administrative regulation) forest land that is capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. A combination of land cover data, geospatial data, and forest inventory data are integrated in a geographic information system to produce a digital map of timberland and other forest land for the conterminous United States. The land cover data is from satellite image-derived land cover maps that portray forest land. A delineation of reserved land is derived from the Protected Areas Database. Forest productivity is modeled using a combination of existing maps of land cover, ecological units, soils, climate, and forest inventory data. Resulting geospatial datasets of forest land, reserved/unreserved land, and forest productivity are combined to differentiate timberland from other forest land. Map-based estimates of timberland and other forest land area are compared with FIA's published estimates to assess the utility of the resulting map. Approaches for operational mapping of timberland and forest land cover/use are discussed.

Development and comparison of parameter prediction and recovery approaches for basal area weighted Weibull diameter distribution

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Abstract: Forest planning calculations, diameter distribution is used, for example, in calculating the current volumes between specified diameter limits and in generating the group of sample trees for prediction of stand development using individual tree models. In the inventory of forest planning, measuring the diameter distribution of a sample plot from each stand is too time-consuming and the estimation of diameter distribution has traditionally been based on prediction of parameters values of an assumed distribution function (PPM). The stand variables used in prediction are basal area, basal area median diameter (DGM), stand age and site fertility class. More recently, also the number of stems has been used. Parameter recovery (PRM), where the parameter values compatible with the measured stand variables are recovered using measured stand variables, has been used only partially in Finland, i.e., as many parameters as possible have been recovered and the rest have been predicted. As the distribution is scaled with the measurement of basal area, the diameter distribution to be predicted is the distribution weighted by basal area. This study recovers the relationship between the basal area weighted two-parameter Weibull distribution and the corresponding unweighted distribution using the size biased distribution theory. The results are used in prediction and recovery of the parameters of the basal-area weighted Weibull distribution.

If it has Thorns, it Grows Here: Implementing the FIA vegetation structure and diversity indicator in the Caribbean

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Abstract: The vegetation of the Caribbean island of St. John has been dramatically impacted by anthropogenic disturbance. Danish settlement in the early 1700's resulted in island-wide forest clearing for the cultivation of sugar cane, cotton, tobacco, and coffee (Acevedo-Rodriguez 1996, Woodbury and Weaver 1997). Following acquisition by the United States, approximately 65% of the island was donated to the National Park Service for the development of the Virgin Islands National Park. The result has been a unique opportunity for the protection and study of West Indian flora and fauna. In 2004, The USDA Forest Service Forest Inventory and Analysis program (FIA) initiated a special intensified study on the West Indian island of St. John to investigate the structure and diversity of forest vegetation, among other forest attributes. Twenty-six plots were established across the 5,180 ha island based on a systematic sample designed by the USDA Forest Service national FIA program. Of those, 20 plots were classified as forested by FIA standard definitions, and were sampled for vegetation characteristics. Specifically, our objectives were to 1) measure the composition, relative abundance, and vertical position of all vascular plants on forested plots 2) quantify populations of native and introduced vegetation occurring on forestland and 3) identify environmental variables important in structuring the distribution of vascular plants across the island. We present results, discussion, and spatially interpolated maps derived from the forested FIA plots. In addition, we discuss the performance of the FIA P3 Understory Vegetation Structure and Diversity Indicator in a diverse tropical region, with comparisons to studies implemented elsewhere in the United States.

Estimation strategies for the Nevada photo-based inventory pilot

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Abstract: With the recent launch of the annual forest inventory in Nevada, IW-FIA is investigating the potential to improve precision in estimates of forest parameters, reduce field data collection costs, address the potential of strategic-level inventory on lands not traditional sampled by FIA such as rangelands and riparian areas, and refine definitions of forestland. The Nevada Photo-based Inventory Project (NPIP) involves acquisition and processing of large-scale real time GPS controlled aerial photography (LSP) throughout the State of Nevada over two field seasons. In this paper, we describe the estimation strategies for integrating the LSP data with FIA field plots and ancillary, moderate resolution satellite imagery for estimating field and photo-derived forest attributes with known confidence after just two years of data collection. In addition, we outline the process by which photo-derived nonforest attributes can be estimated.

Contributed Presentation Abstracts

Using five soil properties to model forest biomass and growth

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Abstract: The Soils Indicator of the USDA Forest Service Forest Inventory and Analysis (FIA) program has used a consistent data collection protocol since 2001. The three extant years of data are now of sufficient density to permit useful comparisons of soil properties and Phase 2 attributes. In this paper we compare five soil properties (soil pH, effective cation exchange capacity - ECEC, Ca:Al and N:P ratios, and bulk density) with traditional forest attributes (e.g., biomass and growth). Our hypothesis is that biomass and growth generally increases with ECEC and Ca:Al ratios. Conversely, N:P ratios and bulk density should be indirectly correlated to forest biomass and annual growth. Soil pH is unique since the optimal value is in the middle of the measured range. Additionally, we expect unique relationships between forest biomass and growth and our select soil properties across different tree species and ecoregions.

Filling the gap: Estimating tree carbon in agricultural landscapes

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Abstract: The current draft USDA Forest Service Forest Inventory and Analysis (FIA) Strategic Plan suggests the addition of an "other treed land inventory" (excluding urban forests). This is necessary because an unknown number of trees exist outside traditional forested landscapes, particularly landscapes defined as "forest" by FIA, and these non-forest trees provide a wide variety of valuable ecosystem services. Here we estimate non-forest-tree carbon sequestration in Iowa and Missouri in the absence of an all-tree inventory by combining MODIS Vegetative Continuous Fields (VCF) with FIA Phase 2 data. The Phase 2 data (e.g., forest type group and volume) on inventory plots are used to model the MODIS VCF response. This model is then used to predict forest volume and carbon storage on non-inventoried plots. Ultimately, our hypothesis is that MODIS VCF can be used as a surrogate for field inventory data for the estimation of carbon sequestration. If this is true, then MODIS VCF will serve as a useful tool for estimating non-inventoried carbon. If we must reject our hypothesis, then the expansion of the FIA program to an all-tree inventory is all the more essential.

Contributed Presentation Abstracts

Use of Lidar for forest inventory and management

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Abstract: Lidar remote sensing is rapidly evolving into a standard tool for monitoring forest resources and condition. Over the past two decades various lidar systems have been used in numerous studies to retrieve forest structure characteristics such as height, canopy cover and biomass for a variety of vegetation types. More recent studies have demonstrated that lidar data can be used to evaluate structure-dependent landsurface conditions such as successional stage or potential fire hazard. The goals of this paper are twofold. First, we review the current status of lidar in forestry and explore how lidar may be used to augment existing protocols for forest inventory. Second, we demonstrate how lidar data may help fill specific data needs of forest managers. A significant impediment to forest managers has been the difficulty in obtaining large-area forest structure and fuel characteristics at useful resolutions and accuracies. This paper demonstrates how lidar data were used to predict canopy bulk density (CBD) and canopy base height (CBH) for an area in the Sierra National Forest. The lidar data were used to generate maps of canopy fuels for input into a fire behavior model (FARSITE). The results indicate that lidar metrics are significant predictors of both CBD ($r^2 = 0.71$) and CBH ($r^2 = 0.59$). In summary, lidar is no longer an experimental technique and has become accepted as a source of accurate and dependable data that are suitable for forest inventory and assessment.

Gradient Nearest Neighbor imputation for local-scale basal area mapping

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Abstract: Vegetation mapping takes many forms depending on the available data and the intended use. Methods combining plot and remote sensing data have the potential to leverage expensive-to-collect field observations with image and ancillary spatial coverages. Methods differ however in their ability to incorporate ancillary data, recapture natural variation and covariance structures from multiple field-measured attributes and map uncertainty. We applied Gradient Nearest Neighbor (GNN) imputation to observational data from the Bartlett Experimental Forest and generated maps of total basal area for comparison with maps produced by other researchers employing alternative mapping methods. GNN is applied at the pixel level and imputes a measured value from a plot as opposed to a new value. The method is fundamentally a multivariate tool which begins with a statistical model relating response variables to spatial variables measured at the same locations. New locations are assigned data from a single, most similar plot from the training data, with plot selection based on the distance in multivariate gradient space to the target location. GNN's strengths lie in its ability to the full range of variation contained within the plot dataset and the covariance between multiple attributes for any given map location. The ranking of plots based on similarity to a target location is a useful model byproduct in that it facilitates mapping natural variability as captured in the training data, and the sufficiency of the sampling effort for each location. GNN can be used as a primary mapping method or as a diagnostic accompaniment to more traditional predictive methods.

Integration of FIA and Landsat for empirical characterization of post-disturbance recovery variability

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Abstract: A principal goal of the North American Carbon Program (NACP) is to improve understanding of disturbance processes as they relate to the carbon cycle. To that end, we have undertaken a study to characterize the inherent variability associated with the recovery of forest ecosystems following disturbance. In order to accomplish this objective, we are developing methods to integrate current and historical Forest Inventory and Analysis (FIA) plot-level data, with photo-interpreted plot-level data, and dense temporal sequences of Landsat data. We expect that significant empirical relationships between these data sets will ultimately aid in the prediction and characterization of forest cover and biomass change trajectories in recently disturbed forest stands. Our proposed approach is to develop continuous regression-based models of percent forest cover and biomass. Then, assuming accurate radiometric normalization of dense temporal sequences of Landsat data, we intend to apply these models through both space and time in order to summarize change trajectories. Historical aerial photographs and FIA plot data will then be used for validation purposes. To illustrate our approach for the purposes of this symposium, we have begun to compile the necessary data and develop empirical relationships for a test focus site in the Northeastern U.S. If the relationships and approach are valid, we seek to apply the methodology across a larger number of samples sites across the U.S. and Canada in support of the NACP.

Contributed Presentation Abstracts

A comparison of tree crown condition in areas with and without gypsy moth activity

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Abstract: Measurement of a suite of ecological indicators on its network of Forest Inventory and Analysis (FIA) Phase 3 plots is one of the ways by which the USDA Forest Service monitors forest health in the United States. Included among the ecological indicators are measures of individual tree crown condition. Crown condition has long been recognized as a general gauge of forest health because healthy crowns are usually distributed in a predictable manner along the stem and examinations for deviations from this pattern may indicate a tree undergoing stress. Despite its general acceptance and long-time use as an indicator of forest health, past studies have had varying degrees of success in relating crown condition to other measures of forest health. One way to gauge the usefulness of the crown condition indicators is to determine if trees in areas with and without a known stress agent, particularly one that acts directly upon the foliage, exhibit different crown conditions. If the impact of an unambiguous stressor acting directly upon the foliage cannot be observed, then the ability to use crown condition to detect the occurrence of more subtle, perhaps unknown stressors, is called into question. A study was implemented, therefore, to compare crown conditions of trees in areas of gypsy moth (*Lymantria dispar* Linnaeus) defoliation to the crown conditions of trees outside areas of defoliation. Results of this study will be presented and discussion will highlight the usefulness of the FIA crown condition indicators in the task of monitoring forest health.

Location uncertainty and the tri-areal design

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Abstract: The USDA Forest Service Forest Inventory and Analysis (FIA) uses a field plot design incorporating multiple sample selection mechanisms. Not all FIA units currently use the entire suite of available sample selection mechanisms. These sampling selection mechanisms could be described in a number of ways with respect to the optional mechanism known as the annular plot. The annular plot is an auxiliary sampling mechanism intended for sampling rare attributes of interest. One explanation is that the subplot, which samples all trees greater than or equal to 5" dbh is surrounded by an annular plot, concentric with the subplot. FIA allows this selection mechanism for rare, but regionally important, events. To date this selection mechanism has only been used to increase the sample of larger trees, those above a predefined diameter at breast height (DBH), known as a breakpoint diameter. Alternatively, the selection mechanisms could be viewed as disjoint concentric circles. The subplot in this latter view would sample all trees that are greater than or equal to five inches and less than the breakpoint diameter. The larger circle can be referred to as a "macroplot", and it serves as the sole sampling mechanism for trees greater than or equal to the breakpoint diameter. For simplicity, we'll call the former description the annular plot view and the latter, the macroplot view. This paper focuses on the importance of clarity between these two descriptions and the estimation bias that can result from a misunderstanding of the distinctions between them, especially with respect to change estimates.

Characterizing forest edge-interior fragmentation using 0.6-ha ground-based samples with applications to forest resource assessments

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Abstract: Contrasts between the forest edge (forest land bordered by nonforest land) and the interior (forest land without nonforest boundaries) have a long history in landscape ecology and wildlife management, but are not widely referenced in forest resource reports, risk models of various damage agents, or to assess forest resource trends. Common myths are that forests and their resource values are uniform regardless of the presence and type of nonforest edge and that these edges have similar effects on associated species and the likelihood of damage agents. Presented is a method to classify forest samples with a nonforest edge from the systematic, 0.6-ha mapped-plot sampling scheme of USDA Forest Service, Forest Inventory and Analysis (FIA) surveys. Results from the 2003 east Texas FIA survey show that about 28 percent of forest-sampled locations contain a nonforest edge, with over 80 percent of that having a plurality of pasture, right-of-way, or cropland uses. Grazing and debris associated with human activities are significantly more frequent in forest edges, but evidence of fire is more frequent in the forest interior. Many of the region's invasive plant species are more frequent and infestations more severe in forest edge than interior plots. A preliminary examination shows few differences in timber resources, but trends anticipated from other studies suggest larger tree diameter growth and greater tree mortality at forest edges. Apart from providing evidence that minimizing forest edges mitigates impacts from selected damage agents, this study puts forward the notion that the forest edge characteristics are important to the analysis, mapping, modeling, and comprehensive valuation of forest resources.

Characterizing change in above ground biomass and forest cover in western Oregon using historical FIA and Landsat data

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Abstract: There is growing evidence suggesting variability in how forest cover regenerates after disturbance in the Pacific Northwest, even among sites with similar abiotic conditions and management prescriptions. This variability has mostly been studied by ground surveys and interpretation of high-resolution aerial photographs, which can be subjective, time consuming and expensive. As a result, the number of stands analyzed is often fewer than required to statistically validate relationships between abiotic and biotic factors contributing to forest cover re-establishment. Presented here are empirical methods for characterizing above ground biomass and percent forest cover using relationships among ground survey data (FIA), photo-interpretation data (e.g. percent forest cover), and moderate resolution optical satellite data (Landsat). Models are formulated independently for two periodic FIA inventories (mid-80's and mid-90's) in western Oregon to assess the consistency of spectral-variable relationships over time. Issues addressed include model development, pixel extraction, image selection, biomass estimation and variable transformation. After assessing the consistency of relationships, there will be a brief comparison of approaches used for modeling plot-level changes in above ground biomass and percent forest cover between the two periodic FIA inventories. The research focuses on bridging the gap between techniques used to locally define rates of forest recovery at the stand level and those required for national scale characterization of forest disturbance and recovery patterns, such as those being developed by the North American Carbon Program (NACP).

Contributed Presentation Abstracts

Single panel inventory statistics—do they convey trends?

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Abstract: One of the advantages of annual inventories is the more expeditious identification of resource change. But can the addition of a single year of inventory data accurately depict change? Are multiple panels or years needed? Inventory statistics for single panels of data are compared with moving average values for several southern USA states to provide insight into answers for these questions.

Phase I area estimates in the South and quality control measures

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Abstract: Phase I estimates for Forest Inventory & Analysis are used to determine forest area. Historically in the South these procedures included interpretation of hard-copy aerial photography using the dot-count method. Technological advances such as GIS (Geographic Information Systems) allow for more sophisticated sampling tools to efficiently utilize both the ortho-rectified digital imagery and other ancillary data. The new Phase 1 grid is a systematic sampling frame that was developed to acquire area estimates in each state. These changes in technology and changes in land use definitions from modifications to the National Sample Design have added to the need for training and certification. To ensure data quality, ground truth visits, software training, and project timelines are brought together during staff training. The goal of the training is to enable U.S. Forest Service staff to work independently while producing high-quality results that are repeatable. Depending on changes in staff, technology, and aerial image acquisition, training materials are adapted to ensure continuation of consistent area measurement.

Challenges of working with FIADB17 data: The SOLE experience.

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Abstract: The Southern Online Estimator is an Internet-based FIA data analysis tool. SOLE is based on data downloaded from the publicly available FIA DB and summarized by plot condition. The tasks of downloading, processing, and summarizing FIADB data are made more difficult by limited documentation, data errors, and timeliness problems. The FIADB is an important FIA product that should be made as error free as possible.

Contributed Presentation Abstracts

Forests on the Edge - Part II: Results and implications

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Abstract: The Forests on the Edge project, sponsored by the USDA Forest Service, uses geographic information systems (GIS) to analyze data and construct maps depicting pressures and opportunities on the private forests in watersheds of the conterminous United States. Part II of this 2-part presentation focuses on the results of the analyses with emphasis on identifying the watersheds with high concentrations of private forest that contribute most to water quality and timber resources and that are at greatest risk due to factors such as conversion to urban and exurban uses; fire; insect pests and diseases; and air pollution. Resource availability and management implications derived from these analyses are discussed, particularly in the context of Montreal Process Criterion 2, Maintenance of the productive capacity of forest ecosystems.

Repeatable tree canopy densities with a modified convex densiometer

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Abstract: Tree canopy density is important for tree growth efficiency, wildlife habitat, understory vegetation and lichen community composition, soil erosion risk, water temperatures in aquatic habitats, integrating diverse crown measurements, and many other uses. Methods to quantify tree canopy density, typically as percent open or closed, can be complicated, expensive, or time-consuming. Concave and convex spherical densiometers, first developed in the mid-1950s, have been used as a simple, inexpensive, and relatively rapid way to estimate percent tree canopy density, and can be used under of variety of field conditions. However repeatability among observers is often poor, and use is limited in long-term monitoring studies. A modification of a convex densiometer, when used with specific data collection protocols on current FIA/FHM 4-cluster fixed area plots, produced a highly repeatable method for 16 Indonesian Ministry of Forestry crew leaders, both within the crew leader group and compared to *expert* trainers with more experience. Percent tree canopy of 16 crew leaders averaged 22.9 (6.3 sd) percent compared to an average of 23.0 (5.3 sd) percent for 4 trainers on one subplot. On another subplot, 10 crew leaders averaged 18.1 (7.3 sd), compared to 16.4 (6.2 sd) percent for 3 trainers. If two of the crew leaders, who recorded consistently higher values, were excluded from analysis then standard deviations would have been lower on each subplot (4.3 and 2.4 sd, respectively). On another subplot with an obvious denser tree canopy, 4 trainers averaged 58.8 percent canopy density, with a 5.0 percent standard deviation. This method was also used last year in an urban forest study in Syracuse, NY with similar training results. The addition of a cell for 'hits' recorded on buildings enables users to compare tree canopy densities with building cover densities on urban forest plots.

Contributed Presentation Abstracts

Finnish National Forest Inventory: Methods and data analysis

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Abstract: To get forest resource information for smaller areas than what is possible using field data only without increasing the costs of the inventory significantly, was a driving force to start the development of the multi-source forest inventory (MS-NFI) in the connection of the Finnish national forest inventory (NFI). One basic requirement, set to the method, was that it should be able to provide applicable information for forestry decision making, e.g., volume estimates, possibly broken down into sub-classes, e.g., by tree species, timber assortments and stand-age classes. In an optimal case, the method had to provide all the same estimates for the small areas as the field data based method provides for national and sub-national level. A non-parametric k-NN estimation method fulfils at least part of these requirements, is simply to apply in its basic form, and the final estimation is near to that based on field data only. The input data of the Finnish multi-source inventory are NFI field data, satellite images and digital map data of different types, e.g., basic map data, soil data, as well as digital elevation model. The first operative results were computed in 1990. The method has been modified continuously and new features added. The k-NN method has several advantages but also some limitations, e.g., the field plot data should cover the variation of the field variables in the target area. The application of the k-NN estimation method also presumes the selection of 'estimation parameters'. Particularly, the predictions of volumes by tree species may be biased if the area of interest is large and covers several different vegetation zones with different tree species compositions. The biases can be reduced if the set of potential nearest neighbors are somehow restricted or the selection of the neighbors directed. One challenging task related to k-NN method is the development of an analytic error estimation method for a target area of an arbitrary size. A recent work with the Forest Inventory and Analysis program of the USDA Forest Service has shown very much promise in this task. Progress and problems related to the development and application of k-NN method are discussed as well as the use of the results demonstrated.

Use of FIA plot data in the LANDFIRE project

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Abstract: LANDFIRE is a five-year interagency project that will generate consistent maps and data describing vegetation, fire, and fuel characteristics across the United States. Modeling and mapping in LANDFIRE depend extensively upon a large database of georeferenced field measurements describing vegetation, site characteristics, and fuel. The LANDFIRE reference database (LFRDB) incorporates new and existing data from numerous sources. This paper describes the contribution of FIA data to the LFRDB. Several attributes of FIA data important for mapping in LANDFIRE are not widely available from other existing data sets. We describe the plot selection, quality assurance procedures, and geoprocessing applied to FIA data for use in LANDFIRE. We also describe the use of FIA plot data as inputs to several modeling and mapping processes. The collaborative relationship between LANDFIRE and FIA is discussed in terms of benefits for both programs.

Contributed Presentation Abstracts

The poor man's GIS: Plot expansion factors

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Abstract: Plot expansion factors have long been part of the FIA database. They are used in all aspects of the estimation process, and even serve as a low-budget GIS system. Users often interpret the expansion-factor as the number of acres represented by a plot. This leads to the impression that some plots represent more acres than others, even though all plots were initially chosen with equal probability. Expansion factors are viewed as weights for estimation purposes and are also used to provide forest area estimates. The annual inventory introduces a new expansion factor conundrum, since expansion factors may need to be adjusted according to the number of panels in the analysis. On-line estimation tools must accommodate real-time expansion factor adjustment when users filter on measurement year or survey cycle. These issues are discussed and some solutions are proposed.

A flexible height model for tree species in Maine, USA

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Abstract: A model for predicting merchantable and total tree height for 18 species groups in Maine is presented. For merchantable heights, the user is permitted to specify the desired top-diameter limit. Only tree-level predictor variables are used, so stand-level attributes such as age and site quality are not required. A mixed-effects modeling approach accounts for the correlated within-tree measurements. Data-collection protocols encompass situations in which merchantability to a specified top diameter is not attained due to tree characteristics. The advantage of using the height prediction model over taper-derived estimates of merchantable height is shown for situations where merchantability is not solely defined by a top-diameter limit.

Contributed Presentation Abstracts

Validation of geospatial models using equivalence tests

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Abstract: Numerous modeling efforts, both within and outside of the Forest Service, are underway to develop maps of forest attributes (e.g. area, volume, and growth) utilizing satellite imagery and other geospatial datasets. More rigorous statistical tools must be developed in order to evaluate these models and their resultant maps. This paper proposes a method for validating geospatial models and maps of forest attributes by using FIA plot data with equivalence tests. Unlike traditional significance testing for model validation, equivalence testing posits as the null hypothesis that the test statistics for the population of observations and predictions are different. With sufficient evidence the null hypothesis can be rejected and the model can be validated. This differs from traditional tests where a failure to reject the null hypothesis does not suggest that the model has been validated. The proposed methodology is applied to several geospatial models of forest area for illustration.

Forest Inventory and Analysis information delivery architecture

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Abstract: FIA is developing a new generation of data and information access and analysis tools that are based on XML, designed around Web services, and written in Java using established open standards and toolkits. This effort is in response to the opportunity provided by Web services technologies to create an enterprise software development environment of loosely connected applications and services. When based on communication standards rather than specific implementation technologies, these applications and services are capable of a great degree of interoperability and reuse. The E-Government initiative is aligned with this paradigm and calls for an information architecture that is service-oriented, highly interoperable, and standards-based. This document presents the organizational context, an overview of the technical aspects, and a demonstration of the Forest Inventory and Analysis Information Delivery Architecture.

Contributed Presentation Abstracts

Improving coarse woody debris measurements: A taper-based technique

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Abstract: Coarse woody debris (CWD) are dead and down trees of a certain minimum size that are an important forest ecosystem component (i.e., wildlife habitat, carbon stocks, and fuels). Accurately measuring the dimensions of CWD is important for ensuring the quality of CWD estimates and hence accurately assessing forest ecosystem attributes. In order to improve the quality of CWD diameter and length measurements, the taper of inventoried CWD pieces was summarized across species, decay, and size classes. CWD taper summarizations in turn were used to develop field applicable taper thresholds to reduce measurement errors. Taper analysis results indicated that a model to predict large-end diameter based on small-end diameter and length may be broadly applied to CWD pieces, regardless of decay, size and species. The CWD taper technique may not accurately estimate the taper of any individual CWD piece; however, it may appropriately set a threshold for detection of egregious CWD dimension measurement errors. Overall, incorporation of CWD taper attributes allows "on the fly" assessment of possible measurement errors in the field.

Can we predict fuel loadings? Relationships between the size, density, and biomass estimates of standing live and dead down trees in forests of the Lake States

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Abstract: The size/density relationships of any given forest stand may follow predictable trajectories during the course of stand development. The attributes of down woody materials (fine and coarse woody debris) have never been quantified in terms of stage of stand development nor in the context of a stand's live tree size/density attributes. Refining understanding of the relationship between a stand's standing live and down dead trees in terms of size, density, and biomass attributes may aid efforts to predict fuel loadings based on standing tree attributes. Therefore, the objective of this study is to compare down dead and standing live tree attributes (size, density, and biomass) for inventory plots and establish any possible relationships. Study results indicate no relationship between down woody material biomass and trees per ha, stand basal area, or a stand's mean diameter. However, there appears to be defined limit to maximum observed down woody biomass in relation to stand density attributes (basal area and trees per ha). It is suggested from this study that down woody accumulation dynamics resulting from sudden stand-level disturbances (i.e., blowdowns) and slow stand development mortality obscure and confound attempts to broadly summarize relationships between a stand's standing live and down dead attributes in forests of the Lake States.

A stem profile model for cross-border comparisons of wood valuation of Red Pine in Ontario and Michigan

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Abstract: In recent years, considerable attention has been paid to the challenge of comparing wood valuation systems across different markets (e.g., stumpage prices), highlighted in the ongoing softwood lumber dispute between the United States and Canada. One major thrust is toward standardizing measurement systems across markets such that volume estimation is more consistent (e.g., cubic foot scaling rather than board foot scaling). A potential downside of the push toward cubic foot measures is that board foot measures capture more specific information regarding the potential use of standing trees or logs and thus provide a better basis for differentiating tree or log prices. Since stem profile models provide a robust and systematic way for linking the raw commodity (wood) to wood products, they should be useful for understanding differences in wood pricing systems and assessing potential growing timber stock value between different markets. Michigan DNR has implemented a taper model into the algorithms processing forest inventories. As part of the Great Lakes Stem Profile Modelling Project (GLSPMP), aimed at improving the local timber volume estimation and to enable cross-border comparisons of timber volumes, we present results of calibrating a taper model for red pine (*Pinus resinosa* Ait.) growing in Michigan, USA and Ontario, Canada. We developed a joint stem profile model predicting log volume for red pine in Michigan and Ontario with less than 10% error, demonstrating the feasibility of providing regionally valid stem profile models for major commercial tree species. Simultaneous estimation (3SLS) was used to calibrate a system of equations predicting outside bark diameter, bark thickness, height location of diameters along stems and inside bark volume of logs of variable lengths. The inclusion of data from a spacing and thinning trial allowed the investigation of the effect these silvicultural treatments have on stem taper and volume. The system of equations allows variable location of *DBH* (e.g., 1.3 m in Canada, 1.37 m in the US, 1.2 m in Japan) and compatible diameter, height, and volume estimates. We believe developing statistically and legally defensible estimates of timber product volumes across political borders, as exemplified by regional stem profile models presented here, will improve communication between the trade partners, such as the US and Canada, by reducing uncertainty created by a lack of comparable estimates.

Modeling forest bird species' likelihood of occurrence with FIA and Landfire vegetation models and generated pseudo-absence points

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Abstract: Modeling management indicator species' habitat and estimating their likelihood of occurrence across an extensive landscape can assist managers and ecologists in assessing a species' status on a broad scale. Both presence and absence points are necessary to create a statistically valid habitat classification model. Unfortunately, available occurrence data for landscape-scale modeling is often lacking and usually only in the form of observed presences. Combining generated pseudo-absence points and extant presence points can improve species habitat modeling. We are assessing several habitat classification models in Utah forests at two different resolutions (30 and 250-meter), each for Northern Goshawk (*Accipiter gentilis*) and for American Three-toed Woodpecker (*Picoides dorsalis*) based on the species' extant presence and generated pseudo-absence points. Habitat parameters at the 250-meter scale include Forest Inventory and Analysis (FIA) spatial vegetation models while the 30-meter scale includes USDA Landfire vegetation models. Additional parameters at both scales include: digital elevation models, prey richness layers, and U.S. Forest Service fire, beetle-kill, and timber surveys. Sets of species' pseudo-absence points were generated within habitat variable envelopes, encompassing nest site habitats for *A. gentilis* and both nest and foraging habitats for *P. dorsalis*. Internal and external cross-validation provide an assessment of the models' predictive capability. Use of pseudo-absence points to accompany extant presence points in regression analysis of habitat models can be a powerful tool in habitat modeling and species conservation.

Testing the partial contributions of remotely sensed and topo-climatic predictors for tree species habitat modelling in Utah

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Abstract: We linked two spatially explicit predictor sets of remotely sensed and topo-climatic variables with FIA plot-level data to model the distribution of of 19 tree species in Utah. We used variance partitioning techniques applied to generalized linear models to explore the combined and partial predictive powers of the two predictor sets. Non-parametric tests were used to explore the relationships between the partial model contributions of both predictor sets and life history traits. More than 60% of the variation in the models was explained by the two partial predictor sets alone, with topo-climatic variables outperforming the remotely sensed predictors. However, the partial models derived from only remotely sensed predictors still provided high model accuracies, indicating a significant correlation between climate and remote sensing variables. Overall model accuracy was high, ranging from 73% to 97%, but small sample sizes had a strong effect on cross-validated accuracies for rare species. Models of early-successional and broadleaf species benefited significantly more from adding remotely sensed predictors than did late seral and needleleaf species. Species with low prevalence benefited more from use of remotely sensed predictors than did more common species.