Moving From Status to Trends

December 4–6, 2012  •  Baltimore, MD
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Agenda

Overview & Room Map Located Inside Back Cover (Revised Version)
Monday, December 3 — 6:00 to 7:00 PM

<table>
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Tuesday, December 4 — Session Overview

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<tr>
<td>8:00-8:15 AM</td>
<td>Welcome / Introductions / Logistics / Safety</td>
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<td>8:15-9:30 AM</td>
<td>Plenary Session – 20th Anniversary of the Blue Ribbon Panel</td>
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<tr>
<td></td>
<td>Jim Reaves - FIA: The Backbone of Forest Information</td>
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<td></td>
<td>Rich Guldin - The FIA Program Today: An Emerging Global Leader in Monitoring and Reporting on Changing Forest Conditions and Trends</td>
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<td>Al Lucier - Blue Ribbon Panel</td>
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<td></td>
<td>Greg Reams - Looking Forward to the Next 20 Years</td>
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<tr>
<td>9:30-10:00 AM</td>
<td>BREAK</td>
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<tr>
<td>10:00-12:00 PM</td>
<td>Concurrent Sessions</td>
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<tr>
<td>CONCURRENT SESSION 10:00-12:00 PM</td>
<td>Session 1: Forest Products Industry Status and Trends: National and Regional Perspectives</td>
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<tr>
<td>CONCURRENT SESSION 10:00-12:00 PM</td>
<td>Session 2: Social Dimensions of Forest Inventory</td>
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<tr>
<td>CONCURRENT SESSION 10:00-12:00 PM</td>
<td>Session 3: Methods for Measuring and Assessing Landscape Change</td>
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<tr>
<td>12:00-1:00 PM</td>
<td>LUNCH</td>
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<tr>
<td>CONCURRENT SESSION 1:00-3:00 PM</td>
<td>Session 4: The North American Forest Dynamics Project: Moving from Status to Trends through Landsat Time Series</td>
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<tr>
<td>CONCURRENT SESSION 1:00-3:00 PM</td>
<td>Session 5: Cool Tools</td>
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<tr>
<td>CONCURRENT SESSION 1:00-3:00 PM</td>
<td>Session 6: Connecting Forest Inventory with Climate Data</td>
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<td>3:00-3:30 PM</td>
<td>BREAK</td>
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<tr>
<td>CONCURRENT SESSION 3:30-5:30 PM</td>
<td>Session 7: Establishing Baselines and Projecting Trends</td>
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<td>CONCURRENT SESSION 3:30-5:30 PM</td>
<td>Session 8: Alternative Estimation Techniques for FIA Data</td>
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<td>CONCURRENT SESSION 3:30-5:30 PM</td>
<td>Session 9: Species Diversity, Species Distributions, and Vegetation Classification</td>
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## Tuesday, December 4 — 8:00 AM to 12:00 PM

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<td><strong>7:00-8 AM</strong></td>
<td><strong>7:00-8 AM</strong></td>
<td><strong>8:00 AM</strong></td>
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<td>Welcome / Introductions / Logistics / Safety</td>
<td>Plenary Session – 20th Anniversary of the Blue Ribbon Panel</td>
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<td><strong>8:15 AM</strong></td>
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<td><strong>8:15 AM</strong></td>
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<td>Plenary Session – 20th Anniversary of the Blue Ribbon Panel</td>
<td>Welcome / Introductions / Logistics / Safety</td>
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<td><strong>9:15 AM</strong></td>
<td><strong>8:35 AM</strong></td>
<td><strong>10:00 AM</strong></td>
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<tr>
<td>Looking Forward to the Next 20 Years</td>
<td>Al Lucier - National Council for Air and Stream Improvement</td>
<td>Using Multiple Research Methods to Understand Family Forest Owners</td>
<td>Comparison of Forest Area Data in the Chesapeake Bay Watershed</td>
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<td><strong>9:30-10 AM</strong></td>
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<td>Social Dimensions of Forest Inventory</td>
<td>Methods for Measuring and Assessing Landscape Change</td>
<td>Session 1</td>
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<tr>
<td>Presenter: Brad Smith</td>
<td>Presenter: Brett Butler</td>
<td>Presenter: Ken Brewer</td>
<td>Contributed / Moderator: Richard Harper</td>
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<td><strong>10:24 AM</strong></td>
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<td>Effects of the &quot;Great Recession&quot; on the Forest Products Sector in the Northern Region of the United States</td>
<td>Using Multiple Research Methods to Understand Family Forest Owners</td>
<td>Using Multiple Research Methods to Understand Family Forest Owners</td>
<td>Forest Products Industry Status and Trends: National and Regional Perspectives</td>
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<td>Presenter: Chris Woodall</td>
<td>Presenter: John Schelhas</td>
<td>Presenter: John Schelhas</td>
<td>Presenters: Brett Butler, Richard Harper</td>
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<td><strong>10:48 AM</strong></td>
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<td>Results and Issues Encountered While Investigating Southern Forest Industry and Market Responses to Changing Economic Conditions</td>
<td>Forest Values and the Impact of the Federal Estate Tax on Family Forests</td>
<td>Assessment of Land Use Change in the Contiguous United States for Global Assessment of Forest Loss Conducted by the Food and Agricultural Organization of the United Nations</td>
<td>Forest Products Industry Status and Trends: National and Regional Perspectives</td>
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<td>Presenter: Andrew Hartsell</td>
<td>Presenter: Brenton Dickinson</td>
<td>Presenter: Kevin Megown</td>
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<td>Impact of the Great Recession on the Forest Products Industry in the Western United States</td>
<td>Assessing and Mitigating Denied Access on FIA Plots</td>
<td>Image-Based Change Estimation for Land Cover and Land Use Monitoring</td>
<td>Forest Products Industry Status and Trends: National and Regional Perspectives</td>
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<td>Presenter: Todd Morgan</td>
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<td>Southern “Wall of Wood”: What Are Tree Size Dynamics Indicating?</td>
<td>Nontimber Forest Product Harvesting on Family Forests: Results from the National Woodland Owner Survey</td>
<td>Forecasting Sustainability: Growth to Removals Ratio Dynamics</td>
<td>Forest Products Industry Status and Trends: National and Regional Perspectives</td>
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<td>Presenter: Richard Harper</td>
<td>Presenter: Brett Butler</td>
<td>Presenter: Natasha James</td>
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### Moving From Status To Trends

**Tuesday, December 4 — 1:00 to 3:00 PM**

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<tr>
<td>1-3 PM</td>
<td><strong>Session 4</strong>&lt;br&gt;Contributed / Moderator: Gretchen Moisen&lt;br&gt;<strong>The North American Forest Dynamics Project: Moving from Status to Trends through Landsat Time Series</strong>&lt;br&gt;<strong>Cool Tools</strong>&lt;br&gt;<strong>Unlocking the Climate Riddle in Forested Ecosystems</strong></td>
<td>1-3 PM</td>
<td><strong>Session 5</strong>&lt;br&gt;<strong>Moderator: Rich Widmann&lt;br&gt;Cool Tools</strong>&lt;br&gt;<strong>Connecting Forest Inventory with Climate Data</strong>&lt;br&gt;<strong>Investigating Forest Inventory and Analysis-Collected Tree-Ring Data from Utah as a Proxy for Historical Climate</strong>&lt;br&gt;<strong>Adapt, Move or Die: FIA Data in Assessments of Forest Tree Genetic Degradation Risk from Climate Change and Other Threats</strong></td>
<td>1-3 PM</td>
<td><strong>Session 6</strong>&lt;br&gt;<strong>Moderator: Chris Woodall</strong>&lt;br&gt;<strong>Connecting Forest Inventory with Climate Data</strong>&lt;br&gt;<strong>Using FIESTA, an R-Based Tool for Analysts, To Look At Temporal Trends in Forest Estimates</strong>&lt;br&gt;<strong>Unlocking the Climate Riddle in Forested Ecosystems</strong>&lt;br&gt;<strong>Tree Species Migration in the Pacific Coastal United States</strong></td>
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<tr>
<td>1:00 PM</td>
<td>The North American Forest Dynamics Study: A Decade of Learning about U.S. Forest Disturbance&lt;br&gt;<strong>Presenter: Samuel Goward</strong>&lt;br&gt;<strong>New Features Added to EVALIdator: Radio Estimation and County Chloropleth Maps</strong>&lt;br&gt;<strong>Presenter: Pat Miles</strong></td>
<td>1:00 PM</td>
<td>New Features Added to EVALIdator: Radio Estimation and County Chloropleth Maps&lt;br&gt;<strong>Presenter: Pat Miles</strong>&lt;br&gt;The Development of a Legacy FIA Report Simulator&lt;br&gt;<strong>Presenter: Stephen Frisley</strong></td>
<td>1:00 PM</td>
<td>New Approaches to FIA Data for Understanding Distribution, Abundance, and Response to Climate Change&lt;br&gt;<strong>Presenter: Kai Zhu</strong>&lt;br&gt;Investigating Forest Inventory and Analysis-Collected Tree-Ring Data from Utah as a Proxy for Historical Climate&lt;br&gt;<strong>Presenter: Justin DeRose</strong></td>
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<tr>
<td>1:24 PM</td>
<td>First Wall-To-Wall Mapping of U.S. Forest Disturbances Using Dense Time Series Landsat Observations&lt;br&gt;<strong>Presenter: Chengquan Huang</strong>&lt;br&gt;The Development of a Legacy FIA Report Simulator&lt;br&gt;<strong>Presenter: Stephen Frisley</strong></td>
<td>1:24 PM</td>
<td>The Development of a Legacy FIA Report Simulator&lt;br&gt;<strong>Presenter: Stephen Frisley</strong>&lt;br&gt;Using FIESTA, an R-Based Tool for Analysts, To Look At Temporal Trends in Forest Estimates&lt;br&gt;<strong>Presenter: Tracey Frescino</strong></td>
<td>1:24 PM</td>
<td>Investigating Forest Inventory and Analysis-Collected Tree-Ring Data from Utah as a Proxy for Historical Climate&lt;br&gt;<strong>Presenter: Justin DeRose</strong>&lt;br&gt;Unlocking the Climate Riddle in Forested Ecosystems&lt;br&gt;<strong>Presenter: Greg Liknes</strong></td>
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<td>1:48 PM</td>
<td>Validation Strategy for NAFD Landsat Time Series Forest Change Maps&lt;br&gt;<strong>Presenter: Warren Cohen</strong>&lt;br&gt;Using FIESTA, an R-Based Tool for Analysts, To Look At Temporal Trends in Forest Estimates&lt;br&gt;<strong>Presenter: Tracey Frescino</strong></td>
<td>1:48 PM</td>
<td>Using FIESTA, an R-Based Tool for Analysts, To Look At Temporal Trends in Forest Estimates&lt;br&gt;<strong>Presenter: Tracey Frescino</strong>&lt;br&gt;Area Change Reporting Using the Desktop FIADB&lt;br&gt;<strong>Presenter: Pat Miles</strong></td>
<td>1:48 PM</td>
<td>Investigating Forest Inventory and Analysis-Collected Tree-Ring Data from Utah as a Proxy for Historical Climate&lt;br&gt;<strong>Presenter: Justin DeRose</strong>&lt;br&gt;Unlocking the Climate Riddle in Forested Ecosystems&lt;br&gt;<strong>Presenter: Greg Liknes</strong></td>
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<td>2:12 PM</td>
<td>Atributing Causal Agents to Nationwide Maps of Forest Disturbance&lt;br&gt;<strong>Presenter: Gretchen Moisen</strong>&lt;br&gt;Adapt, Move or Die: FIA Data in Assessments of Forest Tree Genetic Degradation Risk from Climate Change and Other Threats&lt;br&gt;<strong>Presenter: Kevin Potter</strong></td>
<td>2:12 PM</td>
<td>Area Change Reporting Using the Desktop FIADB&lt;br&gt;<strong>Presenter: Pat Miles</strong>&lt;br&gt;Nontimber Forest Products Output Information System&lt;br&gt;<strong>Presenter: James Chamberlain</strong></td>
<td>2:12 PM</td>
<td>Adapt, Move or Die: FIA Data in Assessments of Forest Tree Genetic Degradation Risk from Climate Change and Other Threats&lt;br&gt;<strong>Presenter: Kevin Potter</strong>&lt;br&gt;Tree Species Migration in the Pacific Coastal United States&lt;br&gt;<strong>Presenter: Andrew Gray</strong></td>
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<td>2:36 PM</td>
<td>Post-Disturbance Recovery Analyzed from Remote Sensing Time Series and FIA Data&lt;br&gt;<strong>Presenter: Jeffrey Masek</strong>&lt;br&gt;Nontimber Forest Products Output Information System&lt;br&gt;<strong>Presenter: James Chamberlain</strong></td>
<td>2:36 PM</td>
<td>Nontimber Forest Products Output Information System&lt;br&gt;<strong>Presenter: James Chamberlain</strong>&lt;br&gt;Tree Species Migration in the Pacific Coastal United States&lt;br&gt;<strong>Presenter: Andrew Gray</strong></td>
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<td>3:00 PM</td>
<td><strong>BREAK</strong>&lt;br&gt;<strong>BANKS</strong>&lt;br&gt;<strong>Shaving</strong>&lt;br&gt;<strong>Yard Rakes</strong>&lt;br&gt;<strong>Sustainability</strong>&lt;br&gt;<strong>Combined</strong></td>
<td>3:00 PM</td>
<td><strong>BREAK</strong>&lt;br&gt;<strong>BANKS</strong>&lt;br&gt;<strong>Shaving</strong>&lt;br&gt;<strong>Yard Rakes</strong>&lt;br&gt;<strong>Sustainability</strong>&lt;br&gt;<strong>Combined</strong></td>
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- Abstracts: pg. 31
- Abstracts: pg. 33
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<td><strong>Session 7</strong></td>
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<td>Moderator: Pat Miles</td>
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<td>Moderator: Randall Morin</td>
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<tr>
<td>Establishing Baselines and Projecting Trends</td>
<td>Alternative Estimation Techniques for FIA Data</td>
<td>Species Diversity, Species Distributions, and Vegetation Classification</td>
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<td>The Myth of a Business-As-Usual Baseline: A Review of Forest Inventory Projections</td>
<td>Hot Deck Matching of Annual Inventory Plots to Enhance Trends and Projections</td>
<td>Using Forest Inventory Data Along with Spatial Lag and Spatial Error Regression to Determine the Impact of Southern Pine Plantations on Species Diversity and Richness in the Central Gulf Coastal Plain</td>
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<td>Presenter: Stephen Prisley</td>
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<td>Presenter: Andrew Hartsell</td>
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<td>Emerald Ash Borer Modeling Methods for Future Forest Projections</td>
<td>An Efficient Estimator to Monitor Rapidly Changing Forest Conditions</td>
<td>Incorporating Evolutionary Relationships into Regional Assessments of Forest Biodiversity Across Forest Inventory and Analysis Plots</td>
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<td>Presenter: Keith Moser</td>
<td>Presenter: Raymond L Czaplewski</td>
<td>Presenter: Kevin Potter</td>
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<td>Implementation of the Reserved and Administratively Withdrawn Change Proposal by the Northern Research Station</td>
<td>The Fourth Dimension in FIA</td>
<td>Analysis of Urban and Natural Forest Composition Across the United States</td>
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<td>Presenter: Dale Gormanson</td>
<td>Presenter: Francis Roesch</td>
<td>Presenter: Mark Ambrose</td>
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<td>Presenter: Michael Farrell</td>
<td>Presenter: Greg Reams</td>
<td>Presenter: Jacob Gibson</td>
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<td>Project Trends in Forest Habitat Classes Under Climate and Land-Use Change Scenarios</td>
<td>Improving FIA Trend Analysis Through Model-Based Estimation Using Landsat Disturbance Maps and the Forest Vegetation Simulator</td>
<td>Effects of Projected Climate Change on Hybridization Zones of Pinion Pines and Junipers in Western North America</td>
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<td>Presenter: Brian Tavernia</td>
<td>Presenter: Sean Healey</td>
<td>Presenter: Thomas Edwards</td>
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<td>Site Productivity – Current Estimates, Change, and Possible Enhancements for the Northern Research Station</td>
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<td>Presenter: Scott Pugh</td>
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**Room:** Pisces

6:00-8:00 PM

Social / Mixer

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**Abstracts:** pg. 37

**Abstracts:** pg. 39
### Wednesday, December 5 — Session Overview

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<td>8:00-8:15 AM</td>
<td>Welcome / Announcements</td>
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<tr>
<td>8:15-9:30 AM</td>
<td>Plenary Session: National Forest Inventories</td>
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<td>David Morales - International National Forest Inventories</td>
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<td></td>
<td>Pavel Bermudez - The National Forest Inventory of Peru: Goals, Challenges, and Solutions</td>
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<td>Sharon Stanton - The Future of Forest Health Indicators</td>
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<td>Ian Yesilonis - Urban FIA</td>
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<td>9:30-10:00 AM</td>
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<td>9:30-10:00 AM</td>
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<tr>
<td>10:00-12:00 PM</td>
<td>Session 10: Forest Carbon: Accounting and Science</td>
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<td>Session 11: Issue Analysis</td>
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<td>Session 12: Large Landscape Assessments</td>
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<td>Lunch</td>
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<td>1:00-3:00 PM</td>
<td>Concurrent Sessions</td>
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<td>Session 13: USFS International Programs Activities Related to Forest Monitoring</td>
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<td>Session 14: Forest Inventory and Analysis Canopy Cover Activities</td>
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<td>Session 15: The Past, Present, and Future of Nonnative Plant Monitoring by the Forest Inventory and Analysis Program</td>
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<td>Session 16: USFS International Programs Activities Related to Forest Monitoring (Cont.)</td>
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<td>Session 17: Modeling Regenerative Capacity across the Eastern U.S.: Can FIA Inform Contemporary Models</td>
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<td>Session 18: Integrating NFI Data with Remote Sensing and GIS Applications</td>
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<tr>
<td>5:30 PM</td>
<td>ADJOURN</td>
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<tr>
<td>7:00-8:00 PM</td>
<td>FIDO/FIA Tools Training Session</td>
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**Wednesday, December 5 — 8:00 AM to 12:00 PM**

<table>
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<tr>
<th>Room:</th>
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<tbody>
<tr>
<td>7:30-8 AM</td>
<td>Registration</td>
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<tr>
<td>8:00 AM</td>
<td>Welcome / Announcements</td>
</tr>
<tr>
<td>8:15 AM</td>
<td>Plenary Session – National Forest Inventories</td>
</tr>
<tr>
<td>8:35 AM</td>
<td>The National Forest Inventory of Peru: Goals, Challenges, and Solutions</td>
</tr>
<tr>
<td>8:55 AM</td>
<td>Sharon Stanton - U.S. Forest Service, Pacific Northwest Research Station</td>
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<tr>
<td>9:15 AM</td>
<td>Ian Yesilonis - Baltimore Ecosystem Study, Northern Research Station</td>
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<thead>
<tr>
<th>Room:</th>
<th>Constellation D-F</th>
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<tbody>
<tr>
<td>10:00 AM</td>
<td>Technical Aspects of the Forest Carbon Inventory of the United States: Recent Past and Near Future</td>
</tr>
<tr>
<td>Presenter: Chris Woodall</td>
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</tr>
<tr>
<td>10:40 AM</td>
<td>The Climate Change Performance Scorecard and Carbon Estimates for National Forests</td>
</tr>
<tr>
<td>Presenter: John Coulston</td>
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<tr>
<td>11:00 AM</td>
<td>Assessing Estimation Techniques for Missing Plot Observations in the U.S. Forest Inventory</td>
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<tr>
<td>Presenter: Grant Domke</td>
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</tr>
<tr>
<td>11:20 AM</td>
<td>Gain-Loss Estimation of Components of Change in Forest Carbon: An Example from Oregon</td>
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<tr>
<td>Presenter: Andrew Gray</td>
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<tr>
<td>11:40 AM</td>
<td>Managing for Climate Benefits in Dry Mixed-Conifer Forests: Tracking the Carbon Implications of Fuel Treatments at Landscape Scale</td>
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<td>Presenter: Jeremy Fried</td>
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<tr>
<th>Room:</th>
<th>Constellation C</th>
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<tbody>
<tr>
<td>10:00 AM</td>
<td>Mapping Forest Soil Organic Matter on New Jersey's Coastal Plain</td>
</tr>
<tr>
<td>Presenter: Brian Clough</td>
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</tr>
<tr>
<td>10:40 AM</td>
<td>Estimating Tree Cavity Distributions from Historical FIA Data</td>
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<tr>
<td>Presenter: Mark Nelson</td>
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<tr>
<td>11:00 AM</td>
<td>Building Improved Models of Sugar Maple Mortality</td>
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<td>Presenter: Charles Perry</td>
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<tr>
<th>Room:</th>
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<tbody>
<tr>
<td>10:00 AM</td>
<td>Use of FIA Data for Large Scale Biomass and Carbon Assessment Projects</td>
</tr>
<tr>
<td>Presenter: James McGeer</td>
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<tr>
<td>10:40 AM</td>
<td>Remote Sensing Applications Center (RSAC): Supporting Vegetation Mapping, Inventory, and Monitoring</td>
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<tr>
<td>Presenter: Kevin Hallerson</td>
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<tr>
<td>11:00 AM</td>
<td>Approaches for Landscape-Scale Forest Carbon Assessment</td>
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<td>Presenter: Richard Birdsey</td>
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**CONCURRENT SESSIONS**

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<thead>
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<tr>
<td>10-12 PM</td>
<td>Session 10</td>
<td>10-12 PM</td>
<td>Session 11</td>
<td>10-12 PM</td>
<td>Session 12</td>
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<td>Contributed / Moderator: Chris Woodall</td>
<td>Issue Analysis</td>
<td>Moderator: Jim Stelmans</td>
<td>Large Landscape Assessments</td>
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<table>
<thead>
<tr>
<th>Time</th>
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<th>Session 12</th>
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<td>11:20 AM</td>
<td>Gain-Loss Estimation of Components of Change in Forest Carbon: An Example from Oregon</td>
<td>Utility of Tree Crown Condition Indicators to Predict Tree Survival Using Remeasured Forest Inventory and Analysis Data</td>
<td>Panel Discussion</td>
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<td>Presenter: Andrew Gray</td>
<td>Presenter: Randall Morin</td>
<td>Presenter: Jeff Turner</td>
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<tr>
<td>11:40 AM</td>
<td>Managing for Climate Benefits in Dry Mixed-Conifer Forests: Tracking the Carbon Implications of Fuel Treatments at Landscape Scale</td>
<td>Using the New Tree Growth, Removal and Mortality Estimation Table in FIA&amp;DB to Summarize Change in Estimates by Diameter Class</td>
<td>Panel Discussion</td>
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<tr>
<td>Presenter: Jeremy Fried</td>
<td>Presenter: Jeff Turner</td>
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### CONCURRENT SESSIONS

#### Room: Constellation D-F
**Session 13**
Contributed / Moderator: Andrew Lister
**USFS International Programs Activities Related to Forest Monitoring**

- **1:00 PM**
  - Five 20-minute sessions are planned, in which participants (which will include resource professionals from Peru, Colombia, Indonesia, the Philippines, Mexico and possibly others) will discuss specifics of their existing or proposed national forest inventories and answer questions. Sessions will correspond temporally with presentations in other rooms to facilitate transfer between sessions. The specific order of presentations and presenters’ names will be provided the day of the symposium after foreign visitors’ travel arrangements have been finalized.

- **1:00 PM**
  - A GIS-Based Tool for Estimating Tree Canopy Cover on Fixed-Radius Plots Using High-Resolution Aerial Imagery
    - Presenter: Sara Goeking

- **1:20 PM**
  - Building Capacity for Providing Canopy Cover and Canopy Height at FIA Plot Locations Using High-Resolution Imagery and Leaf-Off LiDAR
    - Presenter: Jarlath O’Neil-Dunne

- **1:40 PM**
  - Canopy Cover Estimates for Individual Tree Attributes
    - Presenter: James Westfall

- **2:00 PM**
  - Relating FIA Data to Habitat Classifications Via Tree-Based Models of Canopy Cover
    - Presenter: Mark Nelson

- **2:20 PM**
  - Densiometers and Canopy Density Measurements
    - Presenter: Keith Moser

- **2:40 PM**
  - Panel Discussion

#### Room: Constellation C
**Session 14**
Contributed / Moderator: Rachel Riemann
**Forest Inventory and Analysis Canopy Cover Activities**

- **1:00 PM**
  - The National Picture of Nonnative Plants in the United States According to FIA Data
    - Presenter: Sonja Oswalt

- **1:20 PM**
  - Distribution and Occupancy of Introduced Species: A Baseline Inventory from Phase 3 Plots Across the Country
    - Presenter: Beth Schulz

- **1:40 PM**
  - Nonnative Invasive Plant Inventory in the Northern Research Station: Patterns and Trends
    - Presenter: Keith Moser

- **2:00 PM**
  - Updating the Southern Nonnative Plant Watch List: The Future of NNIP Monitoring in the South
    - Presenter: Christopher Oswalt

- **2:20 PM**
  - Invasive Potential of Invasive Plants in the Forest of the Southern Region, United States
    - Presenter: Dawn Lemke

- **2:40 PM**
  - Invasive Plant Monitoring for Northern U.S. Forests
    - Presenter: Will McWilliams

#### Room: Baltimore
**Session 15**
Contributed / Moderator: Christopher Oswalt
**The Past, Present, and Future of Nonnative Plant Monitoring by the Forest Inventory and Analysis Program**

- **1:00 PM**
  - The National Picture of Nonnative Plants in the United States According to FIA Data
    - Presenter: Sonja Oswalt

- **1:20 PM**
  - Distribution and Occupancy of Introduced Species: A Baseline Inventory from Phase 3 Plots Across the Country
    - Presenter: Beth Schulz

- **1:40 PM**
  - Nonnative Invasive Plant Inventory in the Northern Research Station: Patterns and Trends
    - Presenter: Keith Moser

- **2:00 PM**
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    - Presenter: Christopher Oswalt

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  - Invasive Potential of Invasive Plants in the Forest of the Southern Region, United States
    - Presenter: Dawn Lemke

- **2:40 PM**
  - Invasive Plant Monitoring for Northern U.S. Forests
    - Presenter: Will McWilliams

### ABSTRACTS:
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### Wednesday, December 5 — 3:30 to 5:30 PM

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<thead>
<tr>
<th>Room: Constellation D-F</th>
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<tr>
<td><strong>Session 16</strong>&lt;br&gt;USFS International Programs Activities Related to Forest Monitoring (Cont.)&lt;br&gt;Contributed / Moderator: Andrew Lister</td>
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<td><strong>Session 18</strong>&lt;br&gt;Integrating NFI Data with Remote Sensing and GIS Applications&lt;br&gt;Moderator: Mark Nelson</td>
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<td>3:30-5:30 PM</td>
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<td><strong>3:30 PM</strong></td>
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<tr>
<td>Transitioning from Phase 3 Vegetation Data to Phase 2+ Vegetation Data in the Northern Research Station&lt;br&gt;Presenter: Keith Moser</td>
<td>Characterizing Environmental Change in Interior Alaska (1982-2012) Using Multi-Temporal, Multi-Scale Remote Sensing Data and Field Measurements&lt;br&gt;Presenter: Hans-Erik Andersen</td>
<td>Transitioning from Phase 3 Vegetation Data to Phase 2+ Vegetation Data in the Northern Research Station&lt;br&gt;Presenter: Keith Moser</td>
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<td>4:00 PM</td>
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<tr>
<td>Developing an Advance Regeneration Model for Pennsylvania Hardwood Forest Ecosystems&lt;br&gt;Presenter: Marc McDill</td>
<td>Development and Applications of the LANDFIRE Forest Structure Layers&lt;br&gt;Presenter: Chris Toney</td>
<td>Developing an Advance Regeneration Model for Pennsylvania Hardwood Forest Ecosystems&lt;br&gt;Presenter: Marc McDill</td>
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## Thursday, December 6 — Session Overview

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<tr>
<th>Time</th>
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<tr>
<td>7:30-8:00 AM</td>
<td>Registration</td>
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<tr>
<td>8:00-8:15 AM</td>
<td>Welcome / Announcements</td>
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<tr>
<td>8:15-9:30 AM</td>
<td><strong>Plenary Session: Inventory and Monitoring for Current Issues: Cutting Edge Research</strong></td>
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<tr>
<td></td>
<td>Brad Doorn - Identifying NASA Earth Observations that Support Forestry/Agriculture Management</td>
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<td></td>
<td>Charlie Canham - Linking FIA Data to Models of Forest Dynamics: Balancing Empiricism and Theory</td>
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<td></td>
<td>Dave Cleaves - Informing Our Response to Climate Change: The Importance of Quality Information</td>
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<td>Jason Lynch - National Atmospheric Deposition Program: Importance of FIA in Assessing Forest Health</td>
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<tr>
<td>9:30-10:00 AM</td>
<td>Break</td>
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<td>9:30-10:00 AM</td>
<td>Concurrent Sessions</td>
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<td>10:00-12:00 PM</td>
<td><strong>Session 19:</strong> Climate Change and Forest Health: Methods for Improving Forest Inventory</td>
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<td><strong>Session 20:</strong> Methods for Improving Forest Inventory</td>
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<td><strong>Session 21:</strong> Challenges and Opportunities for Improved Biomass and Carbon Monitoring of US Tree Species</td>
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<td>12:00-1:00 PM</td>
<td>Lunch</td>
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<td>1:00-3:00 PM</td>
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<td><strong>Session 22:</strong> Role of FIA Data in Evaluating Forest Ecosystem Responses to Air Quality Stressors</td>
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<td><strong>Session 23:</strong> Mapping Forest Disturbance</td>
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<td><strong>Session 24:</strong> LiDAR</td>
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<td>3:00-3:30 PM</td>
<td>Break</td>
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<td>3:30-5:30 PM</td>
<td>Concurrent Sessions</td>
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<td><strong>Session 25:</strong> Models for Estimating Carbon and Biomass</td>
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<td>Informal Meetings</td>
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### Thursday, December 6 — 8:00 AM to 12:00 PM

#### Plenary Session – Inventory and Monitoring for Current Issues: Cutting Edge Research

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 19: Climate Change and Forest Health: Integrating FIA, Climate Data, and Spatial Technology for Long-Term Monitoring</th>
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<tbody>
<tr>
<td>8:15 AM</td>
<td>Plenary Session: Inventory and Monitoring for Current Issues: Cutting Edge Research</td>
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<tr>
<td>8:35 AM</td>
<td>Methods for Improving Forest Inventory</td>
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<tr>
<td>8:55 AM</td>
<td>National Atmospheric Deposition Program: Importance of FIA in Assessing Forest Health</td>
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#### CONCURRENT SESSIONS

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<tr>
<td>Session 19</td>
<td>Relationship Between Crown Dieback and Drought in the Southeastern United States</td>
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<tr>
<td>Session 20</td>
<td>Estimators Used in the New Mexico Inventory: Practical Implications of &quot;True&quot; Random Nonresponse Within Each Stratum</td>
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<td>Presenter: Paul Patterson</td>
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<tr>
<td>Session 21</td>
<td>Motivations for an Improved Volume, Biomass, and Carbon Database</td>
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#### LUNCH

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### Thursday, December 6 — 1:00 to 3:00 PM

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<td><strong>Session 22</strong></td>
<td><strong>Session 23</strong></td>
<td><strong>Session 24</strong></td>
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<tr>
<td>Contributed / Moderator: Jennifer Phelan</td>
<td>Moderator: Warren Cohen</td>
<td>Moderator: Demetrios Gatziolis</td>
</tr>
<tr>
<td><strong>Role Of FIA Data in Evaluating Forest Ecosystem Responses to Air Quality Stressors</strong></td>
<td><strong>Mapping Forest Disturbance</strong></td>
<td><strong>LiDAR</strong></td>
</tr>
<tr>
<td><strong>1:00 PM</strong> Predicting Nitrogen Deposition and Critical Loads from Lichens</td>
<td><strong>1:00 PM</strong> Understanding Trends in Observations of Forest Disturbance and their Underlying Causal Processes</td>
<td><strong>1:00 PM</strong> Improving LiDAR Based Prediction of Forest Biomass Using Models with Spatially Varying Coefficients</td>
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<tr>
<td>Presenter: Sarah Jovan</td>
<td>Presenter: Karen Schleeweis</td>
<td>Presenter: Chad Babcock</td>
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<td><strong>1:24 PM</strong> Lichen Responses to Different Forms of Nitrogen in the Los Angeles Basin: Implications for Critical Levels and Loads Science</td>
<td><strong>1:24 PM</strong> Improving Automated Disturbance Maps Using Snow-Covered Landsat Time Series Stacks</td>
<td><strong>1:24 PM</strong> Applying Inventory Methods to Estimate Aboveground Biomass from Satellite Light Detection and Ranging (LiDAR) Forest Height Data</td>
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<tr>
<td>Presenter: Jennifer Riddell</td>
<td>Presenter: Ian Housman</td>
<td>Presenter: Sean Healey</td>
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<tr>
<td><strong>1:48 PM</strong> Yellow Birch and Acid Deposition in the Southern Appalachians</td>
<td><strong>1:48 PM</strong> Constructing Southwestern Oregon FIA Plot History Using 25 Years of Landsat Satellite Observations</td>
<td><strong>1:48 PM</strong> Three-Dimensional Modeling of Tree Canopies Using Terrestrial LiDAR and 3D Image-Based Reconstruction</td>
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<td>Presenter: Keith Moser</td>
<td>Presenter: Peder Nelson</td>
<td>Presenter: Jonathan Dandois</td>
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<td><strong>2:12 PM</strong> Impacts of Nitrogen and Sulfur Deposition on the Growth of Red Spruce and Sugar Maple in the United States</td>
<td><strong>2:12 PM</strong> Adding Value to the FIA Inventory: Combining FIA Data and Satellite Observations to Estimate Forest Disturbance</td>
<td><strong>2:12 PM</strong> The Utility of LiDAR for Large Area Forest Inventory Applications</td>
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<tr>
<td>Presenter: Jennifer Phelan</td>
<td>Presenter: Todd Schroeder</td>
<td>Presenter: Nick Skowronski</td>
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<td><strong>2:36 PM</strong> Panel Discussion</td>
<td><strong>2:36 PM</strong> Panel Discussion</td>
<td><strong>2:36 PM</strong> Advancements in LiDAR-Based Registration of FIA Field Plots</td>
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<td>Presenter: Demetrios Gatziolis</td>
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<table>
<thead>
<tr>
<th>Time</th>
<th>Session 25</th>
<th>Informal Meetings</th>
<th>Informal Meetings</th>
</tr>
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</table>
| 3:30 PM| Verification of the Jenkins and FIA Sapling Biomass Equations for Hardwood Species in Maine  
          Presenter: Andrew Nelson | 3:30 PM           | 3:30 PM           |
| 3:54 PM| Assessing the Uncertainty of Forest Carbon Estimates Using the FVS Family of Diameter Increment Equations  
          Presenter: Matthew Russell |                   |                   |
| 4:18 PM| Ring Profiler: A New Method for Estimating Tree-ring Density for Improved Estimates of Carbon Storage  
          Presenter: David Vahey |                   |                   |
| 4:42 PM| Analysis of Tracheid Development in Suppressed-Growth Ponderosa Pine Using the FPL Ring Profiler  
          Presenter: Tim Scott |                   |                   |
| 5:06 PM| Cumulative Volume and Mass Profiles for Dominant Stems and Whole Trees Tested for Northern Hardwoods  
          Presenter: Neil Ver Planck |                   |                   |
| 5:30 PM| ADJOURN                              |                   |                   |

**AbSTRACTS: PG. 75**
# Session Abstracts

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<tr>
<th>Tuesday, December 4</th>
<th>Wednesday, December 5</th>
<th>Thursday, December 6</th>
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Session Overview

The forest sector has been reeling in the wake of a housing collapse, domestic and international financial crises, and the Great Recession of 2007–2009. These events have spawned cyclical as well as structural changes within industry, with virtually all components of the collective forest products industry enduring substantial losses since 2005. This panel presents data and analysis on the impacts to the industry from a national perspective, as well as regional perspectives from the western, northern, and southern United States.

10:00 AM
An Overview of the Forest Products Sector Downturn in the United States

Presenter: W. B. Smith

Author(s): W. B. Smith, C. W. Woodall, P. J. Ince, K. E. Skog, F. X. Aguilar, C. E. Keegan, C. B. Sorenson, D. G. Hodges

In recent years, the forest products sector of the United States experienced a downturn in output to levels not seen in decades, and employment losses in the hundreds of thousands in the forestry and related sectors of the economy. The pattern of the downturn varies by industry, impacted by structural changes in the overall economy. Globalization of manufacturing and expanded use of electronic communication media contributed to a decline in U.S. pulp, paper, and paperboard output since the late 1990s, while the collapse of housing construction since 2005 and off-shoring of furniture production contributed to declines in U.S. wood product output. The more recent global economic recession of 2007–2009 accentuated the downturn. This paper presents an overview of the extent of the downturn with a particular focus on trends in forest sector economic activity and employment across the United States. The paper points to structural changes that may be difficult to reverse, but also points to some potential prospects for growth in the future, including primarily increased forest product exports and wood-based biorefining.

10:24 AM
Effects of the “Great Recession” on the Forest Products Sector in the Northern Region of the United States

Presenter: Chris Woodall

Author(s): Christopher W. Woodall, William G. Luppold, Peter J. Ince, Ronald J. Piva, and Kenneth E. Skog

The forest industry within the northern region of the U.S. has demonstrated a notable decline in terms of employment, number of mills, wood consumption, and forest harvests since 2000—a downturn exacerbated by the “Great Recession” of 2007-2009. Long term industrial decline (since 2000) has been evidenced by reductions in secondary products (e.g., furniture) and print paper manufacturing, which can be attributed to the lack of global competitiveness of U.S. wages and access of electronic media. In contrast, more recent (since 2008), yet sharper declines can be found in industries such as composite panel production that service the housing industry. Despite a decade of decline, future prospects for this region’s forest industry may be viewed as positive. The region’s forests are predominantly within private ownership and represent some of the world’s most valuable sawtimber. Coupled with the natural resource is a present but underutilized industry with spare capacity and a highly skilled work force.

10:48 AM
Results and Issues Encountered While Investigating Southern Forest Industry and Market Responses to Changing Economic Conditions

Presenter: Andrew Hartsell

Author(s): Andrew J. Hartsell, Thomas J. Brandeis, James W. Bentley, Consuelo Brandeis, and Donald Hodges

Recent Forest Inventory and Analysis (FIA) studies revealed the impact that the recent economic downturn had on southern forest industries, markets, and forests. We used FIA data, timber product output (TPO) surveys, and IMpact analysis for PLANing (IMPLAN) output to quantify these impacts. This analysis involves comparing recent changes to the pre-downturn trend. IMPLAN analysis suggests that the total jobs associated with the wood products industry (direct, indirect, and induced employment) fell from 1.2 million jobs to 0.97 million jobs between 2004 and 2009. TPO results indicate that total softwood output declined 22 percent between 2005 and 2009, while hardwood total product output fell 30 percent over the same time period. Data collected from FIA Phase 2 plots suggests that landowners are performing less final harvests and more thinnings and other silvicultural treatments. Issues pertaining to correlating annual TPO data with moving average FIA inventory data will be discussed.

11:12 AM
Impact of the Great Recession on the Forest Products Industry in the Western United States

Presenter: Todd Morgan

Author(s): C. E. Keegan, C. B. Sorenson, T. A. Morgan, J. M. Daniels, and S. W. Hayes

Wood product prices and production fell dramatically in 2009 as a severe recession and massive decline in U.S. housing led to a global financial crisis. In 2009 and 2010, virtually every major western mill suffered curtailments and 30 large mills closed permanently. Sales value of wood and paper products in the West dropped from $49 billion in 2005 to $34 billion in 2009. Employment declined by 71,000 workers and lumber production fell by almost 50 percent from 2005 to 2009. Capacity utilization at sawmills and other timber-using facilities in the West fell from more than 80 percent in 2005 to just over 50 percent in 2009 and 2010. With the exception of exports and some paper markets, U.S. wood products markets have improved little since the recession officially ended in 2009. Modest improvements are expected in domestic markets in the short term, but substantial improvements are unlikely until 2014 or later, as U.S. home building recovers and global demand increases. Much of the West retains the bulk of its pre-recession (2006) capacity and mills could respond quickly to increased demand spurred by economic recovery.

11:36 AM
Southern “Wall of Wood”: What are Tree Size Dynamics Indicating?

Presenter: Richard Harper

Author(s): Richard A. Harper

Since the 1950s, timberland area in the Southern U.S. has remained relatively stable hovering just above 200 million acres. However, total volume has doubled! Softwood and hardwood volumes are at an all-time high and average annual net growth exceeds removals in the region. The South has been on a path of sustainable wood supply. In recent years, most wood procurement strategies have focused on small diameter wood supply. The presentation discusses a...
brief history regarding U.S. timber harvest share, Southern industrial roundwood output and tree planting, and the recent changes of harvested acres by harvest type. It will focus on changes by 2-inch diameter classes and stand size regarding volume, number of trees, and the average annual net change (net growth minus removals). It will also provide a brief discussion on the bias that results from methods used by Forest Inventory and Analysis to estimate growth and removals by tree size/diameter class. Perhaps monitoring dynamics within total volume can offer insight to future transformation of wood supply by roundwood products.
Assessing Forest Ownership Dynamics in the United States: Methods and Challenges

Author(s): Brett J. Butler, Brenton J. Dickinson, and Jaketon H. Hewes

The National Woodland Owner Survey (NWOS) is conducted by the U.S. Forest Service, Forest Inventory & Analysis (FIA) Program as the social complement to its biophysical inventory. The NWOS is aimed at understanding who owns the forests of the United States, why they own it, what they have done with it in the past, and what they plan to do with it in the future. On a recurring basis, self-administered surveys are sent to randomly selected private forest owners from across the U.S. The sample points correspond with plot center of the FIA Phase 2 field plots. For the first time, in 2011, the NWOS began to resurvey the sample points that were sampled between 2002 and 2006. If the same owner still owned the sample point, they were resurveyed and if there was a new ownership, they were surveyed for the first time. These results will provide the most comprehensive examination of forest ownership dynamics in the U.S. to date. Topics that will be explored include parcellation and changes in forest owners’ attitudes, behaviors, and demographics. This information should prove useful to state forestry agencies, policy makers, non-governmental organizations, forest industry, educators, researchers, forest landowner organizations, and anyone who is interested in understanding forest owners and/or interacting with them.

Forest Values and the Impact of the Federal Estate Tax on Family Forests

Author(s): Brenton J. Dickinson, Brett J. Butler, Michael A. Kilgore, Paul Catanzaro, John Greene, Jaketon H. Hewes, David Kittredge, and Mary Tyrrell

Previous research has suggested that heirs to family forest land may sell timber and/or land in order to pay estate taxes, which could result in land use conversion or other adverse ecological impacts. We estimated the number of Minnesota family forest landowners and the associated acreage that could be subject to estate taxes at various exemption levels. Using 2011 Minnesota forest land sale transactional data we calculated the minimum acreage that would trigger the federal estate tax at different hypothetical tax exemption levels and estate compositions (percent of gross estate whose value is comprised of forest land). Using the U.S. Forest Service’s National Woodland Owner Survey data for Minnesota and population mortality rates, we estimated the number of family forest ownerships and acres potentially affected under various scenarios.

Nontimber Forest Product Harvesting on Family Forests: Results from the National Woodland Owner Survey

Author(s): Marla R. Emery, Zhao Ma, Stephanie Snyder, and Brett J. Butler

The 2002-2006 National Woodland Owner Survey asked a series of three questions about nontimber forest products (NTFPs) to assess the current status of their use on family forests. We report on responses to those questions. Logit models showed positive relationships between NTFP use and other forms of active engagement with family forests. Higher age and lower levels of educational attainment correlated negatively with likelihood of gathering, although not strongly. A history of gathering was the best predictor of future plans to do so.

Nationally, field crews are denied access to approximately 11 percent of Forest Inventory and Analysis (FIA) forested plots that are privately owned. The denied access rate varies from less than 1 percent in Alabama, Georgia, Louisiana, Maine, South Carolina, and Virginia to more than 30 percent in Arizona, California, Colorado, Montana, New Jersey, Rhode Island, and Texas. The large disparity is due, in part, to state laws that govern access. We hypothesize that there are also significant differences in the socio-demographics of the private owners that are influencing access rates. The first part of this presentation will focus on the current patterns of denied access rates across the United States and present a model to help explain some of its causes. There is a rich body of literature, primarily related to surveys, that has theoretically and empirically examined ways for maximizing response rates. This literature deals with topics such as personalization of communications, financial and nonfinancial incentives, modes of contact, and timing of contacts to name but a few. We believe these findings may be very useful for minimizing FIA denied access rates. The second part of our presentation will focus on a literature synthesis and experiment that we are conducting to identify best practices for minimizing denied access rates.
Methods for Measuring and Assessing Landscape Change

The Landscape Change Monitoring System (LCMS) is an interagency remote sensing-based system under development for mapping and monitoring land cover and land use change in the United States. There is a growing need for landscape change information that is coherent across time, space, and different cover types. While a number of relevant datasets exist, work is needed to promote coordination and fill in critical gaps. Assessment of existing agency information requirements, data availability, and institutional activity suggests the greatest return on efforts to establish a national landscape change monitoring system will be in development of a Landsat-based information system. Characteristics that make Landsat data particularly well-suited to comprehensive change monitoring include the longest data record of any synoptic satellite sensor (1972 to present), relatively fine spatial resolution (30 m), spectral and radiometric properties that enable vegetation change detection, no-cost spatial availability and accessibility, future data continuity, and a rich history of scientific investigation. Current activities in the development of LCMS include an independent needs assessment and the formation of a science team, which will evaluate and recommend design criteria and available Landsat-based change detection methodologies. These developments will be described in the presentation.

10:00 AM
Development of a Remote Sensing-Based System for Monitoring Landscape Change
Presenter: Ken Brewer
Author(s): C. Kenneth Brewer, Sean P. Healey, Brian Schweid, Kevin A. Megown

The Chesapeake Bay, the largest estuary in the United States, has been designated by executive order as a national treasure. There is much interest in monitoring the status and trends in forest area within the bay, especially since maintaining forest cover is key to bay restoration efforts. The Chesapeake Bay Land Cover Data Series (CBLCD), a Landsat-based, multi-temporal change detection raster geographic information system (GIS) product was developed by the U.S. Geological Service (USGS) to monitor land cover change in the bay. The objective of this study was to assess relationships between the CBLCD dataset and Forest Inventory and Analysis (FIA) estimates of land use in order to provide a better understanding of the nature of the CBLCD and its potential for use in assessing forest cover dynamics. Data were summarized at different geographic scales, and differences between datasets were highlighted with the goal of providing information that will help users of the CBLCD interpret findings. Our analyses suggest there is a strong, positive relationship between the CBLCD forest information and that from the FIA data. Misclassifications can be explained by analyses created by integrating the CBLCD data with the FIA data and standard FIA reporting tools.

10:24 AM
Comparison of Forest Area Data in the Chesapeake Bay Watershed
Presenter: Tonya Lister
Author(s): Tonya W. Lister and Andrew J. Lister

10:48 AM
Assessment of Land Use Change in the Contiguous United States for Global Assessment of Forest Loss Conducted by the Food and Agricultural Organization of the United Nations
Presenter: Kevin Megown
Author(s): Tanushree Biswas, Mike Walterman, Paul Maus, Kevin Megown, Sean Healey, and Ken Brewer

The Food and Agricultural Organization (FAO) of the United Nations conducted a global assessment for forest change in 2010 using satellite imagery from 1990, 2000, and 2005. The U.S. Forest Service was responsible for assessing forest change in the United States. A polygon-based, stratified sampling design developed by FAO was used to assess change in forest area within 10 km by 10 km tiles at every 1° from 1990, 2000, and 2006 using Landsat TM and ETM+ data. The assessment included: 1) mapping land cover (tree and non-tree) and land use (forest and nonforest) within these tiles for each time period; 2) a segment-based analysis of land use transition between 1990 and 2000, and 2000 and 2005; 3) reporting forest change (area) by FAO ecoregions; and 4) comparing the estimates from segment-based analysis of land cover and land use change in the mainland United States between the study periods. The current paper summarizes the estimates of land use change by FAO ecoregions in the United States between 1990 and 2000, and 2000 and 2006 based on the survey and compares land cover and land use change estimates for the mainland United States. Our analysis shows that most forested and nonforested areas remained unchanged during each time period. Overall rate of forest loss was higher between 1990 and 2000 than between 2000 and 2006. Net forest loss in the United States for the entire study period was 0.79 percent. The ecoregion stratum subtropical humid forest showed the highest net forest loss, followed by temperate continental forest and temperate mountain system. Net forest and tree cover change was higher in 1990-2000 than 2000-2006 in the mainland United States and confirmed that land cover change does not necessarily indicate land use change.
11:12 AM
Image-Based Change Estimation for Land Cover and Land Use Monitoring

Presenter: Ken Brewer

Author(s): Jeremy Webb, Ken Brewer, Nicholas Daniels, Chris Maden, Randy Hamilton, Mark Finco, Kevin Megown, and Andrew J. Lister

The Image-based Change Estimation (ICE) project resulted from the need to provide estimates and information for land cover and land use change over large areas. The procedure uses Forest Inventory and Analysis (FIA) plot locations interpreted using two different dates of imagery from the National Agriculture Imagery Program (NAIP). In order to determine a suitable project workflow, interpretation methods and database options were explored. The results provide useful information for the change occurring between land cover and land use types across two prototype landscapes.

11:36 AM
Forecasting Sustainability: Growth to Removals Ratio Dynamics

Presenter: Natasha James

Author(s): Natasha A. James, Robert C. Abt, Karen L. Abt, Raymond M. Sheffield, and Fredrick W. Cubbage

The growth to removals ratio (G/R) is often used as a measure of forest resource sustainability and as a reference point to forecast future resource sustainability. However, little work has been done to determine if any relationship exists between G/R over time. Forest Inventory and Analysis data for 12 southern states were used to determine if any relationship exists between G/R at a given point in time and G/R in the future. Ordinary least squares results indicated a positive relationship over time, meaning a high G/R ratio in the past is associated with a high G/R ratio in the future. However, after removing the effects of differences across space through the use of fixed effects analysis, the results indicated G/R has a negative relationship with itself over time.
The North American Forest Dynamics (NAFD) project is a multi-faceted project that has involved collaborators from FIA, the University of Maryland, NASA, the Pacific Northwest Research Station, Canadian Forest Service, CONAFOR in Mexico, and others for nearly a decade. Now in its third phase, NAFD partners are processing the historic Landsat data record since 1985 in 1-year intervals for the conterminous U.S. In this session, we recap the history of NAFD and describe the current mapping, validation, attribution, and analysis components of the project.

Session Overview
Funded under the North American Carbon Program, the North American Forest Dynamics (NAFD) project is a multi-faceted project that has involved collaborators from FIA, the University of Maryland, NASA, the Pacific Northwest Research Station, Canadian Forest Service, CONAFOR in Mexico, and others for nearly a decade. Now in its third phase, NAFD partners are processing the historic Landsat data record since 1985 in 1-year intervals for the conterminous U.S. In this session, we recap the history of NAFD and describe the current mapping, validation, attribution, and analysis components of the project.

1:00 PM
The North American Forest Dynamics Study: A Decade of Learning about U.S. Forest Disturbance
Presenter: Samuel N. Gowd, Warren Cohen, Chengquan Huang, Jeffery Masek, Gretchen Moisen, Rama Nemani, Karen Schleeweis, and Nancy Thomas
Author(s): ---

The North American Forest Dynamics (NAFD) study is a core project of the interagency North American Carbon Program. The first step in the study, a prototype analysis carried out in the mid-Atlantic region, showed the potential of combining time series Landsat observations with the U.S. Forest Service Forest Inventory and Analysis (FIA) field measurements. With the assistance of FIA staff, the investigators began to explore merging the NASA/USGS Landsat observations with the FIA measurements in order to evaluate forest disturbance dynamics in the United States in the next 6 years. The study demonstrated the difficulties encountered in sampling Landsat locations as a means to estimate U.S. national rates in disturbance. What was found is that disturbances occurring in specific Landsat locations dominated estimated national rates in given years. Further by examining Landsat observations every other year, significant low intensity disturbance events were missed. These “lessons learned” have led to NAFD phase III, in which we will conduct an annual, wall-to-wall analysis of the conterminous U.S. disturbance rates and underlying processes and will explore the potential for estimating regrowth rates. Further, we are now developing validation methodology which should permit estimates of the accuracy and precision of these national forest dynamics.

Throughout this decade of research, the NAFD team has maintained a strong partnership with the FIA and related U.S. Forest Service activities. What began as solely North American Carbon Program science goal has now developed a strong relation between NASA research activities and U.S. Forest Service operational responsibilities.

1:24 PM
First Wall-To-Wall Mapping of U.S. Forest Disturbances Using Dense Time Series Landsat Observations
Presenter: Chengquan Huang
Author(s): Chengquan Huang, Samuel Gowd, Karen Schleeweis, Mary Lindsey, Jeffrey Masek, Ramakrishna Nemani, Warren B. Cohen

Forest disturbance and recovery are major processes controlling carbon fluxes between the forest carbon pool and the atmosphere. One of the primary goals of the multi-phase North American Forest Dynamics (NAFD) project is to quantify forest disturbance rates across the United States. In the first two phases, U.S. forest disturbance rates were estimated using a sampling approach, where each sample was the nominal area covered by a Landsat image, and forest disturbances over that area were mapped using biennial or annual Landsat observations. The derived forest disturbance rates varied greatly from year to year, but those estimates had large sampling errors. To remove such sampling errors, a wall-to-wall mapping approach is being used to derive estimates of national forest disturbance rates as part of the third phase of the NAFD activity. To reduce mapping errors, a number of improvements have also been made to the mapping approach, including use of annual observations, cloud clearing, compositing to maximize the number of usable pixels in each image year, and recent efforts to improve the vegetation change tracker (VCT) algorithm. This presentation will provide a summary of this national disturbance mapping effort, highlight major findings derived through this study, and discuss the lessons learned.

1:48 PM
Validation Strategy for NAFD Landsat Time Series Forest Change Maps
Presenter: Warren Cohen
Author(s): Warren B. Cohen, Steve Stehman, Susmita Sen, Peder Nelson, Chengquan Huang, Karen Schleeweis, and Gretchen G. Moisen

Landsat time series (LTS) contain detailed information about land use and cover change. To characterize forest disturbance, automated LTS algorithms are now being developed, tested, and applied over large areas. Because these algorithms are used over broad regions and periods up to 40 years, obtaining a statistically valid sample of independent reference data for map validation is both costly and prohibitively challenging. We present an alternative strategy based on human interpretation of the LTS for a sample of plots, both as image chip series and as spectral plots over time. In addition, we use Google Earth™ historical temporal snapshots of high resolution images to provide critical LTS interpretation support.

Our interpretation system, TimeSync, is being used for validation of Vegetation Change Tracker (VCT) maps for the conterminous United States as part of the North American Forest Dynamics (NAFD) project. Because the collection of validation data must precede the completion of map development, we designed a sequential two-step stratified-random approach with nonforest, undisturbed forest, and disturbed forest map strata. The first step in the sample selection is based on a preliminary VCT map, with approximately one half of the intended number of plots interpreted. When the VCT map stabilizes, after several iterations of the algorithm’s implementation, the second step in the selection process will round out the sample to obtain the desired distribution of plots per stratum.

Our validation strategy includes interpretation of each plot by two separate interpreters. A third interpreter arbitrates disagreements to provide a final high quality reference dataset, which has built in confidence scoring, based on the integration over all interpreters. Once the plots are interpreted, an agreement matrix is constructed to assess VCT map accuracy. In our presentation, we present the validation strategy, as described above, and present preliminary results from a set of 10 LTS scenes distributed across the United States.
Attributing Causal Agents to Nationwide Maps of Forest Disturbance
Presenter: Gretchen Moisen

Author(s): Gretchen G. Moisen, Todd A. Schroeder, Karen Schleeweis, J. Chris Toney, Warren B. Cohen, and Samuel N. Goward

Currently in its third phase, the North American Forest Dynamics (NAFD) project has launched nationwide processing of historic Landsat data to provide a comprehensive annual, wall-to-wall analysis of U.S. disturbance history over the last 30+ years. Because understanding the cause of disturbance is important to quantifying carbon dynamics, work is underway to attribute causal agents to these nationwide change maps. Developing empirical models of the diverse causal agents in this country involves many decisions. Alternative response designs (such as varying size, shape, quantity, and level of detail in training data) are being evaluated in terms of their costs and benefits for national mapping applications. Many classes of predictor variables such as spectral signatures, textural metrics, extant geospatial disturbance libraries, and bioclimatic information, are being tested for their contribution to classification models. Flexible modeling techniques, such as the Random Forests models used here, are powerful predictive tools but must be coupled with simple rule-based models reflecting expert knowledge. And decisions about appropriate modeling subpopulations are being made in light of available training data, diversity of ecological zones, and computational efficiency. We will be synthesizing results from our initial exploratory work as well as from pilot analyses conducted over 10 Landsat TM scenes representing diverse causal agents, forest types, and forest prevalence levels. We also discuss how these causal disturbance models will enable extensive analyses of temporal and spatial patterns in causal agents across the United States.

Post-Disturbance Recovery Analyzed from Remote Sensing Time Series and FIA Data
Presenter: Jeffrey Masek

Author(s): Jeffrey Masek, Khaldoun Rishmawi, and Samuel Goward

As part of the third phase of the North American Forest Dynamics project (NAFD), the fate of all patches disturbed between 1972 and 2010 in the conterminous United States is being investigated. While forest succession encompasses a wide range of ecological attributes, we are particularly interested in the accumulation rate of aboveground biomass during recovery from disturbance. Previous studies have noted the relative insensitivity of optical remote sensing for measuring biomass in mature stands. However, it has also been demonstrated that early recovery (e.g., the first 10-20 years following disturbance) can be tracked successfully via multispectral metrics. Our goal is to provide as much detail as possible on the early biomass recovery rate on a perpatch basis, while also providing spatially aggregated mean and variance of recovery rate across U.S. ecoregions. Of particular interest is whether recovery rates are changing through time (e.g., comparing the 1980s with the 2000s). Changes in management and growth enhancement in the eastern United States, as well as increased multiple interacting disturbances in the western United States, suggest the hypothesis that recovery rate distributions may not be stationary.

The project involves three approaches for assessing recovery rate: 1) empirical modeling using remeasured FIA plots and Landsat spectral trajectories; 2) physical modeling of observed reflectance using canopy radiative transfer models parameterized with FIA attributes; and 3) correlation of time-since-disturbance with contemporary structural information from Lidar and stereo imaging. One innovation of the work is that temporal trends in the Landsat timeseries (rather than single-date reflectances) will be used to model contemporary biomass and biomass change rate. This presentation will review the science context for characterizing post-disturbance recovery, and provide initial results for a set of pilot frames across the United States.
Cool Tools

Moderated by Rich Widmann

1:00 PM New Features Added to EVALIDator: Radio Estimation and County Chloropleth Maps
Presenter: Pat Miles
Author(s): Patrick D. Miles and Mark H. Hansen

The EVALIDator Web application, developed in 2007, provides estimates and sampling errors for many user selected forest statistics from the Forest Inventory and Analysis Database (FIADB). Among the statistics estimated are forest area, number of trees, biomass, volume, growth, removals, and mortality. A new release of EVALIDator, developed in 2012, has an option to select two statistics and generate a ratio estimate of the pair. The new feature can estimate statistics such as volume or growth per acre or the growth to removals ratio. Also, the program now makes county choropleth maps of all estimates. We provide information on the data and methods used along with sample output from a simple query that demonstrates these new features.

1:24 PM The Development of a Legacy FIA Report Simulator
Presenter: Stephen Prisley
Author(s): Stephen P. Prisley, Brad Smith, and John Coulston

The U.S. Forest Service Forest Inventory and Analysis Program (FIA) has a long history of providing crucial data on the nation’s forest resources. Since 1928, the Forest Service has periodically conducted forest inventories and compiled and published data on the status and trends of the nation’s forests. While more recent data is available digitally to the public, much of the historic data are available only in hardcopy publications, limiting its utility for computerized access and analysis. This presentation will describe a project begun in 2010 to compile information extracted from hundreds of published reports into a digital database we refer to as the FIA Legacy DB. This database contains tables of published estimates for common inventory parameters, such as timberland area by state and ownership, growing stock inventory, growth, removals, mortality, and species distributions. In addition to data tables containing estimates from published reports, interpolation routines were developed to provide estimates at common years by interpolation between report years. A set of reporting tools allows users to specify states or combinations of states, a time period, and then select from a variety of common reports. Example queries and reports will demonstrate the utility of this tool for quickly and easily delivering data previously available only in increasingly rare hardcopy reports.

1:48 PM Using FIESTA, an R-Based Tool for Analysts, To Look At Temporal Trends in Forest Estimates
Presenter: Tracey Frescino
Author(s): Tracey S. Frescino, Paul P. Patterson, Elizabeth A. Freeman, and Gretchen G. Moisen

FIESTA (Forest Inventory Estimation for Analysis) is a user-friendly R package that supports the production of estimates for forest resources based on procedures from Bechtold and Patterson (2005). The package produces output consistent with current tools available for the Forest Inventory and Analysis National Program, such as FIDO (Forest Inventory Data Online) and EVALIDator. FIESTA was developed as an alternative data retrieval and reporting tool that is functional within the R environment, allowing customized applications and compatibility with other R-based analyses. FIESTA generates estimates and percent sample errors of the estimates for area, population totals, and ratios, while allowing user-defined boundaries, stratification schemes, and data filters. The features of the tool are demonstrated using temporally sensitive data over diverse areas.

2:12 PM Area Change Reporting Using the Desktop FIADB
Presenter: Pat Miles
Author(s): Patrick D. Miles and Mark H. Hansen

The estimation of area change between two FIA inventories is complicated by the “mapping” of subplots. Subplots can be subdivided or mapped into forest and nonforest conditions, and forest conditions can be further mapped based on distinct changes in reserved status, owner group, forest type, stand-size class, regeneration status, and stand density. The boundaries of these mapped conditions may change from one inventory to the next, resulting in complex geometries when the two sets of boundaries are combined. The SUBP_COND_CHNG_MTRX (CMX) table was added in version 4.0 of the FIADB to “facilitate the tracking of area change” between annual inventories. The AreaChangeReports form (located within downloadable FIADB Microsoft Access databases) uses the CMX table to link remeasurement plots from two successive annual inventories to produce estimates of area change. An example is provided to illustrate shifts in land use over a 5-year remeasurement period. FIADB databases for each of the 48 contiguous states and southeast Alaska, along with built-in reporting tools including the AreaChangeReports form, are available for downloading from the FIADB DataMart (http://apps.fs.fed.us/fiadb-downloads/datamart.html) as Microsoft Access 2007™ databases.

2:36 PM Nontimber Forest Products Output Information System
Presenter: James Chamberlain
Author(s): James Chamberlain, John Munsell, Stephen Prisley, and Tom Hammitt

Nontimber forest products (NTPPs) are important commodities and critical components of healthy forests. They have not been sufficiently monitored to assess population status or trends in the dynamics of supply and demand. Over the last decade, U.S. Forest Service Forest Inventory and Analysis (FIA) of the Southern Research Station has reported on the status of NTPPs in particular states through state reports and at the national level through RPA assessment and the Sustainable Forests reports. In 2011, FIA and Virginia Tech initiated an effort to develop a nontimber product output (NTPO) information system similar to the timber product output (TPO) system. The protocol will systematically monitor harvested NTPPs. The initial focus of this project is on medicinal NTPPs in central Appalachia. This work provides a starting point for developing a replicable output system that can periodically report on medicinal NTPPs, which can be tracked regularly and more completely valued. Authors will present the status of NTPOs in the south and report progress on development of the NTPO system. We also will encourage dialogue and suggestions with the audience regarding future efforts.
Connecting Forest Inventory with Climate Data

1:00 PM
New Approaches to FIA Data for Understanding Distribution, Abundance, and Response to Climate Change

Presenter: Kai Zhu

Author(s): Kai Zhu, Soupmo Ghosh, Alan E. Gelfand, and James S. Clark

We are using Forest Inventory and Analysis data to examine evidence for tree responses to climate change. By comparing seedling and tree occurrence data, we found that there is not yet evidence that tree populations in the eastern half of the United States are shifting geographic ranges to higher latitude in response to warming temperature. We are developing novel statistical methods to quantify seedling abundance in relation to climate and biotic variables, and to compare seedling and tree responses. We summarize how combining abundance data for seedlings and trees is allowing us to identify differences in how trees respond to climate change in the eastern half of the United States.

1:24 PM
Investigating Forest Inventory and Analysis-Collected Tree-Ring Data from Utah as a Proxy for Historical Climate

Presenter: Justin DeRose

Author(s): R. Justin DeRose, W. Shih-Yu (Simon) Wang, and John D. Shaw

Increment cores collected as part of the periodic inventory in the Intermountain West were examined for their potential to represent growth and be a proxy for climate (precipitation) over a large region (Utah). Standardized and crossdated time-series created from pinyon pine (n=249) and Douglas-fir (n=274) increment cores displayed spatiotemporal patterns in growth differences between species and by region within Utah. However, the between-species interrelationship of growth was strong over much of the state and indicated both species respond similarly to climate variations. Indeed, pinyon pine and Douglas-fir exhibited a significant and spatially coherent response to instrumental precipitation data. Previous water year (5-month lag) exhibited the strongest relationship to tree-ring increment for both species. Results suggest increment cores collected by Forest Inventory and Analysis are excellent proxies for historical precipitation.

1:48 PM
Unlocking the Climate Riddle In Forested Ecosystems

Presenter: Greg Liknes

Author(s): Greg C. Liknes, Christopher W. Woodall, Brian F. Walters, and Sara A. Goeking

Climate information is often used as a predictor in ecological studies, where temporal averages are typically based on climate normals (30-year means) or seasonal averages. While ensemble projections of future climate forecast a higher global average annual temperature, they also predict increased climate variability. It remains to be seen whether forest ecosystems will respond more to changes in mean climate conditions or changes in climate variability. Our objective was to compare the relative importance of mean climate versus variability metrics as predictors of tree mortality and regeneration. Using the 4-km PRISM and 32-km NARR climate datasets, both mean and variability metrics were derived for Forest Inventory and Analysis (FIA) plot locations across the eastern United States. Tree mortality and seedling abundance data were obtained from FIA plots that were visited twice in the years from 2000 to 2010. A number of statistical approaches (including correlation analysis, and an algorithmic method, Random Forests) were used to examine the relative importance of mean versus variability of climate data in the context of evaluating changes in tree and seedling attributes.

2:12 PM
Adapt, Move or Die: FIA Data in Assessments of Forest Tree Genetic Degradation Risk from Climate Change and Other Threats

Presenter: Kevin Potter

Author(s): Kevin M. Potter, Barbara S. Crane, and William W. Hargrove

Changing climatic conditions may pose a severe threat to forest tree species, forcing three potential population-level responses: 1) tolerance/adaptation, 2) movement to suitable environmental conditions, or 3) extirpation. All could have negative genetic consequences. It will be important, therefore, to safeguard existing adaptedness and to create conditions conducive for future productivity and evolution. To efficiently conserve the genetic variation of species, it is necessary to understand where climate change pressure will be greatest, and what species and populations are more highly predisposed to genetic degradation from climate change and other threats. Forest Inventory and Analysis (FIA) data represent an unmatched resource for conducting broad-scale, spatially explicit assessments of the risk posed by climate change and other threats to the genetic integrity of forest tree populations and species. We used FIA data to 1) generate 4 km2 resolution maps predicting the genetic pressure that could be imposed by climate change on tree species; and 2) compile information about the biological attributes and genetic diversity of individual species. The first assessment tool, Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS), has generated climate change pressure maps for more than 300 North American tree species and quantifies potential climate change genetic pressure, as defined by the straight-line Minimum Required Movement (MRM) distance from the existing locations of each species to the nearest favorable future habitat. The second assessment tool, the Forest Tree Genetic Risk Assessment System (FORGRAS) framework, ranks the predisposition of forest tree species to genetic degradation, based on demographic and occurrence information, ecological and life-history traits, species-specific projections of climate change pressure, and predictions of pest and pathogen susceptibility. Both assessment tools should be valuable for scientists and managers attempting to determine which species and populations to target for monitoring efforts and for proactive gene conservation and management activities.

2:36 PM
Tree Species Migration in the Pacific Coastal United States

Presenter: Andrew Gray

Author(s): Heather Lintz, Andrew Yost, and Andrew Gray, and Vincente Monleon

We analyzed mean changes in longitude, latitude, and elevation for tree species in the Pacific coastal United States (California, Oregon, and Washington). Our analyses show that species migration distance and direction is highly variable, and Pinus monticola and Cornus nuttallii are leading the pack in polar opposite directions. All drought tolerant species are moving northward. Tree species producing the greatest seed abundance are moving the farthest. The distance and direction of migratory gradients correspond to changes in both means and anomalies of summer relative humidity, summer vapor pressure deficit, summer growing season length, and summer precipitation.
3:30 PM
The Myth of a Business-As-Usual Baseline: A Review of Forest Inventory Projections

Presenter: Stephen Prisley

Author(s): Stephen P. Prisley, Brad Smith, and John Coulston

With the advent of forest carbon accounting schemes that compare projected forest carbon sequestration against a baseline, there is an increasing demand to project forest inventories into the future. Often, the desired comparison baseline is termed “business as usual”, implying there is a known or anticipated trajectory of forest growth and harvests that will occur and against which we can compare alternate management scenarios. This raises the question “how well can we project forest inventories into the future?” The U.S. Forest Service has decades of experience with developing national projections of forest inventories for the Resources Planning Act (RPA) periodic assessments.

We have compiled some of the projections made in the 1965, 1974, 1982, and 1993 RPA assessments, including timberland area by region and ownership, and timberland growing stock, net growth, removals, and mortality by region and softwood/hardwood. These projections are compared with interpolated Forest Inventory and Analysis data for the same regions and years. Differences between projected and measured values are expressed as RMSEs to quantify the performance of projections by length of projection, spatial resolution (national versus regional), and quantity being projected (area, growth, removals, mortality, inventory).

Results demonstrate the challenge of making projections based on extrapolation of recent trends. We also discuss some of the primary reasons for discrepancies between projections and reality.

3:50 PM
Emerald Ash Borer Modeling Methods for Future Forest Projections

Presenter: Keith Moser

Author(s): Ryan D. DeSantis, W. Keith Moser, Robert J. Huggett, Ruhong Li, David N. Wear, and Patrick D. Miles

The emerald ash borer (Agrilus planipennis Fairmaire; EAB) is a nonnative invasive insect that has caused considerable damage to ash (Fraxinus spp.) in North America. Unlike invasive organisms that can be mitigated, contained, controlled, or even eradicated, EAB continues to spread across North America. The loss of the North American ash resource is possible considering literature suggests close to 100 percent probability of host tree mortality. We modeled future spatial and temporal changes in forest composition from 2010 to 2060 with and without ash mortality anticipated from EAB spread for the purpose of examining anticipated effects of EAB on tree species composition. To forecast midwest and northeast United States future forest conditions, we utilized Forest Inventory and Analysis (FIA) data, the extent of EAB in the United States and Canada, estimated EAB spread rate, estimated EAB host mortality probability, and models of human population, energy, consumption, land use, and economics. We found that in most cases, EAB will not substantially affect the ecosystem function of future forests measured by FIA because ash comprises a small proportion of midwest and northeast U.S. forests, and it will be replaced by associated species. Although the transition from ash to other species could take decades, forests may eventually recover when associated species replace ash.

4:10 PM
Implementation of the Reserved and Administratively Withdrawn Change Proposal by the Northern Research Station

Presenter: Dale Gormanson

Author(s): Dale D. Gormanson, Mark A. Hatfield, Paul A. Sowers, Richard A. McCullough, Scott A. Pugh, Jeffrey Wazenegger, Richard Grassetti, James Blehm, Brett J. Butler, Brian F. Walters, Kevin K. Nimerfro

The Forest Inventory and Analysis (FIA) program of the Northern Research Station (NRS) has developed and implemented a system to fulfill the required national objectives of the Reserved and Administratively Withdrawn Change Proposal (Proposal ID 01_01_2009_Reserved_AdminWithdrawn, revised 9/25/09). The required objectives are to identify forest land reserved from timber production according to an updated and nationally consistent reserve status definition; provide field crews with preliminary delineations of reserve status based on geographic information system (GIS) analysis; assess the accuracy and consistency of preliminary and field delineations; reclassify previous assignments (annual inventory plots) employing new definition; archive previous and corresponding updated reserve assignments; and report real change in reserved status versus change via new definition. The proposal also has optional/regional objectives which NRS-FIA is not implementing. A team of personnel from all major components of NRS-FIA (prefield production through data distribution and reporting) has been designing and testing the system since May 2012. By October 2012, initial versions of tools were completed to identify preliminary reserve status delineations with GIS, store and document GIS data, programmatically store the assignments (by previous and current definition) in the national information management system, store ancillary info, programmatically disseminate preliminary information to crews, store field delineations on portable data recorders, analyze accuracy and precision, correct misclassifications, and analyze real versus definitional change in reserve status. Improvements to the system are being incorporated and analysis comparing the previous and new reserve delineations should begin in December 2012. With the updated definition, all annual data thru 2013 will first be disseminated in whole through public data distribution tools in the spring of 2014. A collaborative effort from the major NRS-FIA components has worked effectively to implement a system that can be applied nationally.

4:30 PM
Recent Trends in Maple and Oak/Hickory Distribution for the U.S.

Presenter: Michael Farrell

Author(s): Michael Farrell

Many researchers predict that climate change will cause maple-dominated forests to move northward and be replaced with oaks and hickories throughout much of their current range. Whereas there is strong evidence that the climate has been changing and will continue to do so, the current trends in these species abundance and distribution over the past 30 years are in direct contrast with many stated predictions. To date, human management has played a much larger role than climate in shaping the distribution of these tree species throughout the northeast. This presentation utilizes Forest Inventory and Analysis (FIA) data for 25 states in the eastern United States to examine the diameter distributions for sugar and red maples, oaks, and hickories since the 1980s. Oaks and hickories have
had trouble regenerating throughout their established range whereas shade-tolerant sugar and red maples have been rapidly invading oak-hickory forest types. In fact, both sugar and red maples are becoming established much more rapidly along the southern and central states than they are in the northeast. Red maple is becoming even more dominant than sugar maple in almost every state, especially those along the southern and western ranges of sugar maple. This presentation explores the FIA data for the past 30 years on a state-level to determine what the future composition of maples, oaks, and hickories could be in the eastern United States if these trends continue. Implications for the maple syrup industry are explored, including where and what kind of trees will be tapped in the future.

4:50 PM
Project Trends in Forest Habitat Classes Under Climate and Land-Use Change Scenarios
Presenter: Brian Tavernia

Wildlife species have diverse and sometimes conflicting habitat requirements. To support diverse wildlife communities, natural resource managers need to manage for a variety of habitats across a large area and to create long-term management plans to ensure this variety is maintained. In these efforts, managers would benefit from assessments of potential climate and land use change effects on habitats. As part of the U.S. Forest Service’s Northern Forest Futures Project (NFFP), we assessed climate and land use driven changes in the areas of forest (≥66% canopy cover) and woodland (66% > canopy cover ≥ 10%) habitat across the Northeast and Midwest by 2060. Our assessments were made using NFFP projections based on three future storylines developed by the Intergovernmental Panel on Climate Change (IPCC). The total area of forest and woodland habitat is currently 173.4 million acres and is evenly split between forest and woodland (49% and 51%, respectively). Our assessments suggest that total forest and woodland habitat area will decrease in the future, but the magnitude of habitat loss differed among IPCC storylines, ranging from 5.9 to 11 million acres. Regardless of storyline, forest habitat was projected to gain area and woodland habitat was projected to lose area. As a result, forest was projected to represent a slight majority of the total habitat area (55% vs. 45% for woodland). Projected declines in woodland habitat represent a continuation of historical trends and have the potential to negatively affect woodland-dependent wildlife via reduced patch sizes, patch isolation, and edge effects.

5:10 PM
Site Productivity – Current Estimates, Change, and Possible Enhancements for the Northern Research Station
Presenter: Scott Pugh
Author(s): Scott Pugh

Site productivity (SP) is the inherent capacity to grow crops of industrial wood. SP identifies the potential growth in cubic feet/acre/year and is based on the culmination of mean annual increment of fully stocked natural stands. Changes in SP were summarized for timberland and the associated effects on net growth and removal estimates were investigated using data from the Forest Inventory and Analysis program from the early to late 2000s. Change in area by SP class ranged from 4.8 to 19.6 percent, depending on the state. Actual changes on the ground are not this common. Net growth credited to unproductive-to-productive change varied from 0.0 to 11.2 percent of total net growth depending on the state; removals due to productive-to-unproductive change varied from 0.0 to 38.7 percent of total removals, depending on the state. A comparison of SP derived from current methods versus complementing with net growth information shows 12.5 percent of currently classified unproductive area could be classified productive and 10.3 percent of forest land area could receive a more productive SP class. Artificial change in SP class should be minimized, especially for sites that are marginally productive or unproductive. Restricting new measurements of SI when valid measurements already exist will lessen erroneous change.
Tuesday, December 4
Session 8: 3:30–5:30 PM
Alternative Estimation Techniques for FIA Data
Contributed and Moderated by James Westfall

Session Overview
In addition to the standard moving-average method implemented by the Forest Inventory and Analysis (FIA) program, there are numerous other estimation techniques that may be employed. The moving-average method is simple, low-risk, intuitive for most users of FIA data, and it produces useful estimates whenever net rates of change are slow. However, there is a desire by some clients to apply more complex estimators that have different statistical properties and/or provide new types of information, especially for forestlands that are rapidly changing. In this session, several proposed alternative methods will be described and illustrated via example applications. Additionally, considerations for implementing alternative estimation techniques within standard FIA analytical tools are presented.

3:30 PM
Hot Deck Matching of Annual Inventory Plots to Enhance Trends and Projections
Presenter: Paul Van Deusen
Author(s): Paul C. Van Deusen

Annual forest inventory plots awaiting remeasurement can be matched with plots that can serve as pseudo remeasurements using various hot-deck matching schemes. It will be shown that some matching approaches allow for short-term projections that reflect a business as usual (BAU) scenario and require few assumptions. These methods also allow for creating scenarios that reflect increasing frequency of particular events relative to what occurs in the BAU scenario. Scenarios are generated where increasing future harvest levels are controlled to demonstrate this capability. The moving average, as applied by U.S. Forest Service Forest Inventory and Analysis (FIA), is typically linked to an evaluation group. It is noted that this linkage is unnecessary and limits the value and flexibility of the method. The combination of short-term projections with an n-year moving average is suggested to provide trend estimates that encompass the current year and a few years into the future. These methods are not difficult to implement and they expand the utility of FIA data.

3:50 PM
An Efficient Estimator to Monitor Rapidly Changing Forest Conditions
Presenter: Raymond L. Czaplewski
Author(s): Raymond L. Czaplewski, Michael T. Thompson, and Gretchen G. Moisen

Extensive expanses of forest often change at a slow pace. In this common situation, FIA produces informative estimates of current status with the Moving Average (MA) method and post-stratification with a remotely sensed map of forest-nonforest cover. However, MA “smoothes out” estimates over time, which confounds analyses of temporal trends and post-stratification limits gains from remote sensing. Time-series estimators, like the Kalman Filter (KF), better detect and analyze unexpected or rapid changes in dynamic forests. KF is a recursive multivariate model-based estimator that separates complex time-series of panel estimates and multi-sensor remotely sensed data into a sequence of smaller and more manageable components. Population-level results are disaggregated into expansion factors that assure additivity and simplify small area and small domain estimation. Other statistics gauge fit of alternative models to annual FIA panel data, which permits quantitative rankings among alternative cause-effect hypotheses.

4:10 PM
The Fourth Dimension in FIA
Presenter: Francis Roesch
Author(s): Francis A. Roesch

In the past, the goal of forest inventory was to determine the extent of the timber resource. Predictions of how the resource was changing were made by comparing differences between successive inventories. The general view of the associated sample design included selection probabilities based on land area observed at a discrete point in time. That is, time was not considered part of the sample design because it was not considered an element of the sampled population. Over the last few decades, the general goal of Forest Inventory and Analysis (FIA) has been changing to monitoring the dynamic forest ecosystem. However, much of the literature discussing FIA’s new annual monitoring system, its sample design, and estimators is still based on an areal probability paradigm. In Roesch (2008; Forest Science 54(4): 455-464), I pointed out why it is usually necessary to include the dimension of time when describing the sampled population and the sample design for FIA and similar forest inventory systems. Here, I further explore the inferential advantages of replacing the areal probability paradigm with a three-dimensional probability paradigm with an application.

4:30 PM
FIA Alternative Time Series Estimators: Criteria for FIA Hosting
Presenter: Greg Reams
Author(s): Gregory A. Reams, John Coulston

FIA currently uses a moving average estimator for inventory estimation. A number of alternative time series estimators have been proposed and published in the peer-reviewed literature. The alternative estimators specifically take into account that time-series design of the FIA program. To date, FIA does not host any of these estimators as FIA enabled tools on our Web site. Criteria for FIA providing alternative estimators are presented.

4:50 PM
Improving FIA Trend Analysis Through Model-Based Estimation Using Landsat Disturbance Maps and the Forest Vegetation Simulator
Presenter: Sean Healey
Author(s): Sean P. Healey, Gretchen G. Moisen, and Paul L. Patterson

The Forest Inventory and Analysis (FIA) Program’s panel system, in which 10-20 percent of the sample is measured in any given year, is designed to increase the currency of FIA reporting and its sensitivity to factors operating at relatively fine temporal scales. Now that much of the country has completed at least one measurement cycle over all panels, there is an immediate need for estimation strategies which make the best use of this sampling schedule. A primary obstacle is that only a fraction of plots can be considered current in any particular year. This leaves the analyst with a choice of ignoring annual trends or creating estimates on panel at a time and suffering precision losses which may render apparent year-to-year differences uninterpretable.
One option for increasing the temporal specificity of estimates is to update plot conditions for every year in a time series using the Forest Vegetation Simulator (FVS) and to use model-based estimation to create annual estimates using “observations” from every plot. The variance estimators used in such an approach would incorporate both sample and model uncertainty, the latter of which could be assessed at remeasured FIA plots. Disturbance maps created from time series of Landsat (or similar sensor) satellite imagery could be used to identify and appropriately alter FVS simulations for those plots which have been disturbed. Use of disturbance maps would allow sensitivity to year-to-year variation in the disturbance rate. FIA has recent experience in all of the components of the proposed approach including FVS, Landsat disturbance mapping, and model-based estimation. Further study to integrate these components into a production estimation system is warranted.

5:10 PM
Panel Discussion
No Abstracts
3:30 PM
Using Forest Inventory Data along with Spatial Lag and Spatial Error Regression to Determine the Impact of Southern Pine Plantations on Species Diversity and Richness in the Central Gulf Coastal Plain

Author(s): Andrew J. Hartsell

The North American Forest Dynamics project, now in its third phase, has launched nationwide processing of historic Landsat data to provide a comprehensive annual, wall-to-wall analysis of U.S. disturbance history over the last 50+ years. Because understanding the cause of disturbance is important to quantifying carbon dynamics, work is underway to attribute causal agents to these nationwide change maps. Developing empirical models of the diverse causal agents in this country involves many decisions. Alternative response designs (such as varying size, shape, quantity, and level of detail in training data) are being evaluated in terms of their costs and benefits for national mapping applications. Many classes of predictor variables (such as spectral signatures, textural metrics, extant geospatial disturbance libraries, and bioclimatic information) are being tested for their contribution to classification models. Flexible modeling techniques, such as the Random Forests models used here, are powerful predictive tools but must be coupled with simple rule-based models reflecting expert knowledge. Decisions about appropriate modeling of subpopulations are being made in light of available training data, diversity of ecological zones, and computational efficiency. The Forest Inventory and Analysis plots across the United States. It has been suggested that urban forestry tree planting practices are creating a homogenous urban forest, with the same limited number of species dominating urban landscapes across North America. There is also concern about urban forests as pathways for invasive pests and pathogens to adjacent natural forests. However, to date urban forest inventory data have been limited and data collected from different cities were often incompatible. To begin to address the issue of urban forest composition, tree species data were obtained 150 U.S. and Canadian cities which had conducted inventories for use with the i-Tree Eco (UFORE) or i-Tree Streets (STRATUM) models or which maintained comprehensive street tree databases. Relative basal area of each tree species was calculated by city and land use class and (where possible) for each city as a whole. Those data were combined with data from nearby natural forests from the U.S. Forest Service Forest Inventory and Analysis (FIA) Program. The data were then analyzed using PC-ORD to determine which cities’ urban forests were most similar to one another (using cluster analysis) and how species composition related to large-scale environmental variables (using non-metric multi-dimensional scaling). Environmental and geographic explanatory variables used included latitude, longitude, elevation, total annual precipitation, and plant hardiness zone.

Preliminary analysis of urban forest data alone showed that urban forests as a whole clustered by species composition data along rough geographic and climatic lines. More intensively managed portions of the urban forest (e.g., street trees) tended to cluster in ways less closely related to geography and climate. Analyses of the urban data together with natural forest data indicate that urban forests are generally more similar to one another than they are to nearby natural forests. Street tree populations were more similar in their species compositions while other components of the urban forest showed greater variation. The more intensively managed segments of the urban forest were also less similar to adjacent natural forests. Urban forests also tend to resemble the natural forests of the eastern United States more than they resemble western forests.
Expansion and Contraction Tension Zones in Western Piñon-Juniper Woodlands Under Projected Climate Change

Presenter: Jacob Gibson

Author(s): Jacob Gibson, Gretchen Moisen, Tracey Frescino, and Thomas C. Edwards, Jr.

Piñon and juniper vegetation types cover >30% of the Colorado Plateau. Two species and one variety of piñon pine (Pinus monophylla, edulis, monophylla var. fallax) and four species of juniper (Juniperus osteosperma, monosperma, deppeana, arizonica) are dominant and comprise a mosaic of overlapping distributions arranged primarily across a gradient of seasonal precipitation. Individual species have been found to respond uniquely to climate changes, causing shifts in the co-occurrence of species. This is reflected in the differential mortality among species caused by recent droughts, which appear to indicate long-term distribution shifts have already begun. We developed bio-climatic distribution models and applied climate change scenarios to gauge potential shifts in the distributions of individual species and their co-occurrence. The application of climate change scenarios resulted in, for each species/variety, the spatial depiction of currently inhabited areas no longer suitable for regeneration as well as currently uninhabited areas becoming suitable for colonization. Our results suggest individualistic responses of species to climate change will likely cause shifts in their spatial co-occurrence. For example, J. osteosperma is predicted to move northwest, whereas J. monosperma is predicted to move northeast resulting in a decrease of co-occurrence. P. edulis is predicted to increasingly co-occur with J. osteosperma, while P. monophylla is predicted to decrease or increase depending on the climate change scenario. The character of individual species distribution shifts and their resulting changes in co-occurrence will be largely determined by changes in the summer monsoon rains and in the minimum winter temperatures.

Effects of Projected Climate Change on Hybridization Zones of Piñon Pines and Junipers in Western North America

Presenter: Thomas Edwards

Author(s): Thomas C. Edwards, Jr., Jacob R. Gibson, Niklaus Zimmermann, Tracey S. Frescino, Gretchen G. Moisen

Over 30 species of pines and junipers occupy the Intermountain West of North America. Within this assemblage, numerous species hybridize when distributions overlap and environmental conditions are suitable for cross-fertilization. As individual species, each responds uniquely to climate change, causing shifts in the co-occurrence of species. This is reflected in the differential mortality among species caused by recent droughts, which appear to indicate long-term distribution shifts have already begun. We developed a series of models examining the projected changes in distributions due to climate shifts, exploring how these changes might increase hybridization. Five groups are candidates for hybridization: three of pines and two of junipers. Within the pines, P. edulis and monophylla are predicted to increase range overlap, which may lead to increased hybridization. For junipers, J. occidentalis and osteosperma should see reduced overlap, indicating a greater separation of these two species in the future. Models of J. deppeana and monosperma indicate little change in the areal extent of overlap.

Panel Discussion

No Abstracts
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Session Overview
Accurate accounting of the amounts and movements of carbon in and out of forests is becoming increasingly important for local landowners as well as for global assessments. The probabilistic sample of forestland by the Forest Inventory and Analysis (FIA) program has become the key source of estimates of carbon stocks and fluxes for the United States, and is used for official reports as well as to develop remote-sensing and physiological models. Carbon is ubiquitous in many forest pools, including live trees, standing dead trees, down wood, forest floor, mineral soil, stumps, and roots. Approaches for measuring and calculating carbon are better developed for some of these pools than others. In this session, we bring together current research on improvements to national carbon accounting, better estimation of non–live tree carbon pools, and improved methods of estimating change in carbon over time.

10:00 AM
Technical Aspects of the Forest Carbon Inventory of the United States: Recent Past and Near Future
Presenter: Chris Woodall

The Forest Inventory and Analysis program of the U.S. Forest Service has explicitly assumed responsibility for providing an inventory of the U.S. forests’ carbon stocks and stock change to the U.S. Environmental Protection Agency for numerous years to meet obligations to the United Nations Framework Convention on Climate Change. Recent improvements, plans for the future, and implications regarding use of the U.S. inventory both nationwide and at the project scale are discussed.

10:20 AM
Recent Changes in the Estimation of Standing Dead Tree Biomass and Carbon Stocks in the U.S. Forest Inventory
Presenter: Grant Domke

Author(s): Grant M. Domke, Christopher W. Woodall, and James E. Smith

Until recently, standing dead tree biomass and carbon (C) has been estimated as a function of live tree growing stock volume in the U.S. Forest Service, Forest Inventory and Analysis (FIA) Program. Traditional estimates of standing dead tree biomass/C attributes were based on merchantability standards that did not reflect density reductions or structural loss due to decomposition common in standing dead trees. In 1999, the FIA program began consistent nationwide sampling of standing dead trees. That data may now be used to supplant previous approaches to standing dead biomass and C stock estimation. The objective of this study was to incorporate density reductions and structural loss adjustments into standing dead tree biomass/C estimation procedures and assess differences in estimates at multiple spatial scales. The results suggest that accounting for density reductions and structural loss in standing dead trees substantially decreases estimates of standing dead tree biomass and C at tree, plot, and regional scales. Incorporating density reductions and structural loss adjustments may improve the accuracy of standing dead tree biomass and C estimates in the U.S. forest inventory as well as the consistency with FIA field methods and documentation.

10:40 AM
The Climate Change Performance Scorecard and Carbon Estimates for National Forests
Presenter: John Coulston

Author(s): John W. Coulston, Kellen Nelson, Christopher W. Woodall, David Meriwether, and Gregory A. Reams

The U.S. Forest Service manages 20 percent of the forest land in the United States. Both the Climate Change Performance Scorecard and the revised National Forest Management Act require the assessment of carbon stocks on these lands. We present circa 2010 estimates of carbon stocks for each national forest and recommendations to improve these estimates.

11:00 AM
Assessing Estimation Techniques for Missing Plot Observations in the U.S. Forest Inventory
Presenter: Grant Domke

Author(s): Grant M. Domke, Christopher W. Woodall, Ronald E. McRoberts, James E. Smith, and Mark A. Hatfield

The U.S. Forest Service, Forest Inventory and Analysis Program made a transition from state-by-state periodic forest inventories—with reporting standards largely tailored to regional requirements—to nationally consistent, annual inventory tailored to large-scale strategic requirements. Lack of measurements on all forest land during the periodic inventory, along with access issues and misidentification of forest plots as nonforest, have resulted in plot-level data gaps spread in the FIA database. In this study, we examined several approaches that compensate for missing observations with respect to the deviation and precision of stratified estimates of carbon stocks per unit area using data from the FIA database. Preliminary estimates of live tree carbon stocks per unit area calculated using all missing data approaches were well within one standard error of the baseline estimates for the Lake States study region.

11:20 AM
Gain-Loss Estimation of Components of Change in Forest Carbon: An Example from Oregon
Presenter: Andrew Gray

Author(s): Andrew N. Gray, Thomas R. Whittier, and David L. Azuma

Increases in carbon dioxide in the atmosphere are thought to be a main cause of changes in global temperature and sea level. There is thought to be a large carbon (C) sink on lands in the Northern Hemisphere, but the amounts and causes are not well known. Forests are a focus of efforts to understand changes in carbon storage over time because they accumulate larger amounts of carbon than other terrestrial ecosystems. Current “stock-change” estimates of forest carbon flux are based on a combination of field measurements, surveys, remote sensing classifications, and models. The goal of this study was to attempt to improve on existing carbon accounting methods by using the “gain-loss” method and directly tracking components of change in tree carbon across a large region with strong environmental gradients using field measurements. We used repeated Forest Inventory and Analysis (FIA) measurements on permanent plots to quantify tree carbon flux due...
to land use change, disturbance, and harvest on 1,067 plots across Oregon. Land use change resulted in a net increase of $1.1 \times 10^5$ ha of forest land in Oregon between 1986 and 1997. However, there was a net loss of 3.4 Tg of live tree C because most of the losses were on productive west-side forests and most of the gains were on east-side juniper woodlands. Live woody C decreased significantly in eastern Oregon (-14.4 Tg), with mortality and harvest exceeding growth. Much of the mortality and subsequent harvest was associated with severe defoliation by western spruce budworm. However, C stores increased significantly in western Oregon (19.2 Tg) due to large accumulations from growth on public lands, and harvest being balanced by growth on private lands. Patterns of C density associated with stand age differed by site productivity class and forest type. The increase in C density with stand age was greater on more productive sites due to higher growth rates in young stands, but contribution of those sites to growth decreased as harvest rates increased with stand age. We demonstrate that gain-loss accounting from a probabilistic field sample can produce detailed estimates of carbon flux that identify causes and components of change, and have the potential to produce more consistent estimates than combining alternative approaches.

NOTES

11:40 AM
Managing for Climate Benefits in Dry Mixed-Conifer Forests: Tracking the Carbon Implications of Fuel Treatments at Landscape Scale
Presenter: Jeremy Fried
Author(s): Jeremy S. Fried, Theresa Jain, Jonathan Sandquist, and Larry D. Potts

Building on the statistically representative sample of a complex of forest types, often described as dry mixed conifer, provided by over 5000 annual Forest Inventory and Analysis (FIA) plots in seven western states, we modeled multiple indices of existing fire hazard and the extent to which implementation of mechanically focused fuels management programs could substantially improve these indices with respect to a range of objectives. Design of the generic/stylized fuel treatments tested in this study was guided by multiple, sometimes conflicting objectives: 1) leave behind a healthy, resilient stand; 2) reduce surface fire intensity; and/or 3) reduce crown fire potential, though results varied by pretreatment stand structure and forest type. Fuel treatment costs, including costs of on-site activities and transportation of harvested materials, and yields and values of merchantable and energy wood resulting from treatments under alternative policy scenarios were modeled or calculated, allowing estimation, by forest type, ecoregion, landowner class, stand density and size class of: 1) the area over which fuel treatment is capable of achieving one or more objectives and at what cost [or net revenue]; 2) the amount of carbon that fuel treatment can move into long-term storage as harvested wood products or into utilization as fossil-carbon-emission offsetting bioenergy; 3) the amount of live tree carbon remaining at risk in treated stands and the likelihood of that carbon leaving the live-tree pool in the event of a fire; and 4) the potential carbon dynamics of post-fire recovery that includes salvage harvest in treated or untreated stands. Results reveal that less than half of the dry mixed-conifer forest would benefit from the kinds of fuel treatments simulated in this study; however, nearly all the acres with potential benefit are on federal lands, and most can be treated so as to generate net revenue, useful products and carbon benefits. Although markets for energy wood are essentially absent in some regions where these forest types occur, most of the value derived from effective treatments flows from the sale of merchantable wood products, so markets for energy wood are rarely the determining factor as to fuel treatment feasibility. While clearly linked to fire incidence and return interval, the extent to which fuel treatments produce net carbon benefits also depends on how post-treatment carbon accumulation capacity is impacted by stocking reduction, the reduction in mortality achieved in the event of fire, and assumptions about the feasibility of post-fire salvage harvest.
10:00 AM
Mapping Forest Soil Organic Matter on New Jersey’s Coastal Plain
Presenter: Brian Clough
Author(s): Brian J. Clough, Edwin J. Green, and Richard G. Lathrop
Managing forest soil organic matter (SOM) stocks is a vital strategy for reducing the impact of anthropogenic carbon dioxide emissions. However, the SOM pool is highly variable, and developing accurate estimates to guide management decisions has remained a difficult task. We present the results of a spatial model designed to map soil organic matter for all forested land in the Coastal Plain physiographic province of New Jersey. SOM stocks from 60 sampling locations, distributed across the region in a stratified random design based on vegetation type and drainage class, were used in a kriging model that incorporated several indices derived from Landsat Thematic Mapper data as predictor variables. This model reduced mean squared error at validation plots (n=26) by 10 to 23 percent when compared to kriging models that did not use a predictor variable. Our results suggest that this approach, combining SOM inventory and remote sensing data in a geostatistical framework, is a useful method for reducing uncertainty in forest SOM estimates.

10:20 AM
Beech Status in New England’s Aftermath Forests
Presenter: Randall Morin
Author(s): George L. McCaskill and Randall S. Morin
American beech (Fagus grandifolia) is one of the three most dominant tree species occupying the northern hardwoods forest of New England. We studied Maine, New Hampshire, Vermont, and New York to capture those areas with higher concentrations of beech. The status of beech in the northern hardwood forests is important because of the long-term impacts of beech bark disease (BBD) (Neomectria ssp.) on the composition and regeneration of aftermath forests within the region. We assessed the current conditions of beech trees at the stand level by comparing 2011 Forest Inventory and Analysis survey data with the previous survey conducted on the same set of plots (2006). To understand the current impacts of BBD on forests, we compared the number of growing-stock trees, number of rough cull trees, number of rotten cull trees, number of standing dead trees, and number of mortality trees with an important associative species, sugar maple (Acer saccharum). To evaluate the impacts of BBD on stand regeneration, we also assessed the number of sapling-size trees of American beech and three of its close associates, sugar maple, yellow birch (Betula alleghaniensis), and eastern hemlock (Tsuga canadensis). Beech trees had 40 percent of their stocking classified as defective or dead; sugar maple stocking had less than 15 percent. Mortality tree numbers for American beech were highest in the larger diameter trees (11.0 inches diameter at breast height and larger) where BBD had been detected for less than 35 years, but were more equally distributed in older aftermath forests where BBD had been present for more than 60 years. The number of beech saplings increased while the numbers of its three associate tree species did not change significantly. Net growth of beech was increasing as a proportion of net growth for sugar maple.

10:40 AM
Estimating Tree Cavity Distributions from Historical FIA Data
Presenter: Mark Nelson
Author(s): Mark D. Nelson and Charlotte Roy
Tree cavities provide important habitat features for a variety of wildlife species. We describe an approach for using historical FIA data to estimate the number of trees containing cavities during the 1990s in seven states of the Upper Midwest. We estimated a total of 280 million cavity-containing trees. Iowa and Missouri had the highest percentages of cavity-containing trees; Michigan and Minnesota had the lowest. The percentage of trees containing cavities was higher for the hard hardwood species group and dead trees, and it generally increased with increasing diameter at breast height. Abundance of cavities decreased with increasing cavity entrance diameter and increasing aboveground cavity height.

11:00 AM
Building Improved Models of Sugar Maple Mortality
Presenter: Charles Perry
Author(s): Charles H. Perry and Patrick L. Zimmerman
The decline of sugar maple (Acer saccharum Marsh.) in the northern United States is causing concern, and several studies have identified soil properties that are linked to the observation of dead/dying trees. Unfortunately, the sample of trees supporting these studies is purposive in nature; soil properties are assessed only on those plots where dead trees are observed. In this study, we used the U.S. Forest Service’s FIA database (FIADB) to conduct an exploratory analysis of a broader population of sugar maple (live and dead) across a wide range of soil types. This population of plots has a highly skewed, zero-inflated distribution: the number of plots in the sample without dead trees is an order of magnitude greater than the number of plots with dead trees. One effective method of analysis is a hurdle—or conditional—model approach. In the first phase, the response variable is the presence or absence of dead sugar maple and the inferential space is the entire population of plots with sugar maple trees. The second phase uses the relative abundance of dead sugar maple as the response variable; in this case, inference is restricted to those plots where dead sugar maple trees are observed. In both sets of models, basal area and geology are significant predictors of dead sugar maple, but the most significant soil variables vary between these two inferential spaces. Our study highlights important analytical considerations when using FIADB for analysis of forest health conditions and presents simple methods to create a more comprehensive space for statistical inference.

11:20 AM
Utility of Tree Crown Condition Indicators to Predict Tree Survival Using Remeasured Forest Inventory and Analysis Data
Presenter: Randall Morin
Author(s): Randall S. Morin, Jim Steinman, and KaDonna C. Randolph
The condition of tree crowns is an important indicator of tree and forest health. Crown conditions have been evaluated during surveys of Forest Inventory and Analysis (FIA) Phase 3 (P3) plots since 1999. In this study, remeasured data from 39,357 trees in the northern United States were used to assess the probability of mortality among various tree species using the suite of crown condition variables. Logistic regression procedures were employed to assess the importance of individual crown condition variables.
alone and in combination for predicting tree survival. Results of the regression analyses indicated that crown dieback was the most important crown condition variable for predicting tree survival for all species combined and for the 10 individual species in the study. Additionally, one-way analysis of variance (ANOVA) results identified differences among the ability of different tree species to survive varying levels of crown dieback. The results provide statistical evidence for selecting crown dieback as one of the crown condition variables to be collected on a subset of Phase 2 plots (P2+) starting in 2012.

11:40 AM
Using the New Tree Growth, Removal and Mortality Estimation Table in FIADB to Summarize Change in Estimates by Diameter Class

Presenter: Jeff Turner

Author(s): Jeffery A. Turner

A new data table that stores tree level growth components is being added to FIADB. The table stores the tree component (survivor, ingrowth, cut, mortality, reversion, diversion, etc.), estimation type (all live, growing-stock, sawlog), land basis (forestland, timberland), stored units (cubic feet, board feet), and beginning, end, threshold, and mid-point volume estimates. This new tree table provides users with additional details than exist in the current FIADB tree table. It will provide users with a new method to summarize change in tree estimates on remeasured sample plots by classified attributes (e.g. diameter class, ownership class, etc.). The new table structure allows for the inclusion of estimates of growth, removals, and mortality (GRM) for the sawlog portion of the stem in cubic feet, as well as new GRM estimates for the portion of the merchantable stem on sawlog trees between the top of the sawlog up to the 4-inch top. Finally, the table has the flexibility for the future addition of tree level GRM estimates of biomass and carbon. SQL code using the new table to account for changes in volume by diameter class will be provided, as well as examples using the on-line EVALIgDa-tor tool.
Wednesday, December 5
Session 12: 10–12 PM

Large Landscape Assessments

Moderated by Tonya Lister

10:00 AM
Use of FIA Data for Large Scale Biomass and Carbon Assessment Projects
Presenter: James McCarter
Author(s): James B. McCarter

FIA inventory data has been very important for a series of large scale biomass and carbon assessment projects. An overview and challenges associated with three projects will be presented.

The Fire and Carbon Project examined carbon sequestration and fire risk for eleven western states. Each candidate inventory plot (latest inventory and target forest type) for the eleven western states was simulated under ten management alternatives. The simulation results represent a modeling database that can be mined for management alternatives that provide a synergy between management objectives.

The WA Biomass project used Landscape Ecology, Modeling, Mapping and Analysis (LEmma) Project outcomes as starting inventory condition for a statewide biomass assessment for WA Department of Natural Resources. The combination of results from two LEMMA projects provided 30 m pixel resolution forest cover typing with associated tree list inventory information, largely sourced from FIA inventory plots. This inventory data was used to assess biomass over time with respect to forest type, ownership, management zone, transportation constraints, hauling distance, and potential biomass price. Modeling results were loaded into the constructed spatial database, where rapid assessment under different management alternatives can be performed.

The Biomass and Carbon Assessment Project examines biomass availability and carbon sequestration for the continental US. This project expands the carbon sequestration assessment of the Fire and Carbon Project to the continental US. In addition, it provides biomass estimates and area by forest type based on FIA population estimation factors. Each project provides its own challenges with respect to managing the amount of information, extracting information properly from FIADB, formatting properly for growth models, mapping site quality information for use by growth models, and finding ways to present the complex results.

10:20 AM
Monitoring Trends and Burn Severity (MTBS): Monitoring Wildfire Activity for the Past Quarter Century Using Landsat Data
Presenter: Mark Finco
Author(s): Mark Finco, Brad Quayle, Yuan Zhang, Jennifer Lecker, Kevin Megown, and Ken Brewer

The Monitoring Trends in Burn Severity (MTBS) project is mapping the extent, size, and severity of all large fires greater than 1,000 acres in the west and 500 acres in the east over the conterminous United States (CONUS), Alaska, and Hawaii. In 2012 the project reached a milestone, completing the mapping for all fires between 1984 and 2010. The MTBS project produces geospatial and tabular data using a consistent protocol for fire trend analysis at a range of spatial, temporal, and thematic scales. This paper reviews the objectives of the MTBS project, describes the data sets and information provided, and presents results of the analysis of the 1984-2010 MTBS data set for the United States.

10:40 AM
Remote Sensing Applications Center (RSAC): Supporting Vegetation Mapping, Inventory, and Monitoring
Presenter: Kevin Halverson
Author(s): Kevin Halverson

The U.S. Forest Service’s Remote Sensing Applications Center provides a wide variety of support for forest inventory, analysis, monitoring, and mapping. The utilization of remotely sensed data such as Lidar, aerial, and satellite data is core to our mission. We also work closely with other organizations to look toward new and innovative technological solutions to support hardware and software needs of the Agency. These include mobile GIS, server–based information management, imagery and GIS software, and application development.

11:00 AM
Approaches for Landscape-Scale Forest Carbon Assessment
Presenter: Richard Birdsey
Author(s): Richard Birdsey, Yude Pan, Kris Johnson, Fangmin Zhang, and Jing Chen

Increasingly, public and private forest landowners need to estimate their carbon stocks and analyze the impacts of alternate management plans. Here we describe approaches designed to work at landscape scales: one involves estimating carbon stocks from existing Forest Inventory and Analysis (FIA) data; another involves downscaling results from a continental-scale biogeochemistry model known as InTEC; and the third uses Lidar remote sensing to provide high resolution biomass maps. Combining FIA data with a biogeochemistry model gives the most useful information for analyzing causes of historical trends, while the biomass maps support implementation of management decisions. Application of these approaches is illustrated by pilot studies in the eastern United States. Analysis of FIA data for northern Wisconsin revealed that private landowners held more than half of the forest carbon but that the rate of carbon sequestration had slowed dramatically over two decades. Causes of the decline were hypothesized to include increased harvesting, aging forests, and increasing disturbances. The InTEC model for the same region revealed trends over a much longer historical period as well as providing information about changes in soil C that are lacking in the FIA data analysis. The effects of long-term forest age dynamics and higher inter-annual climate variability became evident, and the model results suggest a significant increase of soil C stocks. Using this information base, we identified several ways to increase landscape-scale average forest carbon stocks: allow some forests to reach full maturity and highest carbon stocks; manage other forests to maximize carbon uptake and transfer of harvested carbon into wood products; and avoid conversion of existing forests to nonforest land uses. Strategic implementation of these kinds of management decisions can be facilitated with high resolution biomass maps.

11:20 AM
Panel Discussion
No Abstracts

11:40 AM
Panel Discussion
No Abstracts
Wednesday, December 5  
Session 13: 1–3 PM

USFS International Programs Activities Related to Forest Monitoring

Contributed and Moderated by Andrew Lister

Five 20-Minute Sessions

No Abstracts

Participants (which will include resource professionals from Peru, Colombia, Indonesia, the Philippines, Mexico and possibly others) will discuss specifics of their existing or proposed national forest inventories and answer questions. Sessions will correspond temporally with presentations in other rooms to facilitate transfer between sessions. The specific order of presentations and presenters’ names will be provided the day of the symposium after foreign visitors’ travel arrangements have been finalized.
Moving From Status To Trends

**Wednesday, December 5**
**Session 14: 1–3 PM**

**Forest Inventory and Analysis Canopy Cover Activities**

Contributed and Moderated by Rachel Riemann

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**Session Overview**

Information on tree canopy cover is an essential component of volume, biomass and carbon estimates, definitions of forest cover, and characterization of wildlife habitat. It is a variable that is collected both in the field and from aerial photography and additionally is being used to model tree canopy cover over the entire U.S., which itself becomes another data source for many purposes. Coordination between these different sources of canopy cover data could increase both the utility and accuracy of each. This contributed session will cover a variety of canopy cover related activities within the FIA program.

The session begins with a demonstration of a tool designed to help photo interpreters assign percent canopy cover to FIA plots and is the result of coordinating the modeling and prefield data collection efforts. The session then transitions to work aimed at developing the potential for collecting high resolution canopy cover data in a more automated fashion using cutting edge technology, including LiDAR. Differences in canopy cover estimates calculated from field, photo interpretation, and LiDAR sources are examined. Next, a presentation on estimating the canopy cover of individual trees to provide more detail for applications such as wildlife habitat assessments is discussed. The session closes with examples of the application of FIA-based canopy cover to estimate habitat abundance for specific forest associated wildlife species.

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**1:00 PM**

**A GIS-Based Tool for Estimating Tree Canopy Cover on Fixed-Radius Plots Using High-Resolution Aerial Imagery**

Presenter: Sara Goeking

Author(s): Sara A. Goeking, Greg C. Liknes, Erik Lindblom, John Chase, Dennis Jacobs, and Robert Benton

Recent changes to the Forest Inventory and Analysis (FIA) Program’s definition of forest land precipitated the development of a geographic information system (GIS)-based tool for efficiently estimating tree canopy cover for all FIA plots. The FIA definition of forest land has shifted from a density-related criterion based on stocking to a 10 percent tree canopy cover threshold. This definitional change required a consistent method of estimating tree canopy cover, which is now a core FIA variable, using a combination of field-based and image-based assessments. In order to accomplish the image-interpretation task for thousands of plots annually, the FIA program, working in collaboration with the Remote Sensing Applications Center, developed a GIS-based canopy cover tool. Design considerations for the tool include the following: desired precision of the tree canopy cover estimate, seamless use across regions, compatibility with existing data sources (including nonforest), and ease-of-use for image interpreters. Data from this image interpretation effort will not only serve the needs of FIA, but will also be used to update the National Land Cover Dataset tree canopy data layer.

**1:20 PM**

**Building Capacity for Providing Canopy Cover and Canopy Height at FIA Plot Locations Using High-Resolution Imagery and Leaf-Off LiDAR**

Presenter: Jarlath O’Neil-Dunne

Author(s): Rachel Riemann, Jarlath O’Neil-Dunne, and Greg Liknes

Tree canopy cover and canopy height information are essential for estimating volume, biomass, and carbon; defining forest cover; and characterizing wildlife habitat. The amount of tree canopy cover also influences water quality and quantity in both rural and urban settings. Tree canopy cover and canopy height are currently collected at FIA plots either in the field or by dot-grid interpretation of digital aerial imagery. These techniques can be time-consuming and costly. The University of Vermont’s Spatial Analysis Laboratory has developed an automated approach using Object-Based Image Analysis (OBIA) techniques for extracting canopy cover, canopy height, and land cover from readily available high resolution aerial imagery and leaf-off LiDAR. We used datasets generated by the OBIA approach for 10 different counties spread across 4 states, representing a range of conditions. Canopy cover, canopy height, and land cover information were computed for each FIA plot, at scales of 144-foot-radius (plot circle) and 3,280-foot-(1-km)-radius, and compared to FIA estimates at the plot level. Results are discussed in terms of the comparative assessment of the three canopy cover data sources (including what is missing when nonforest plot data are not available), and the prognosis for using the OBIA techniques to extract this type of information at the county and state levels. Acquiring tree canopy cover data using the OBIA approach would allow FIA to apply a consistent method for acquiring canopy cover to both visit and non-visit plots, and even potentially increase the reliability of the canopy cover data available. This approach also provided valuable data on canopy height for FIA plots not visited in the field and additional data on landscape context for all FIA plots, improving capacity to characterize and analyze forest characteristics with respect to local levels of urbanization.

**1:40 PM**

**Canopy Cover Estimates for Individual Tree Attributes**

Presenter: James Westfall

Author(s): James A. Westfall and Randall S. Morin

In most forest inventory data, it is not feasible to estimate the canopy coverage of trees having certain characteristics due to the lack of information on crown size. In this study, data from the Forest Inventory and Analysis (FIA) program was used to assign crown sizes to individual trees using published crown width models. This process effectively links trees to area such that canopy cover area estimates can be made using domains that include tree-level attributes (e.g., canopy cover of red maple having total height >80 feet). Advantages of implementing this approach are: the ability to estimate canopy cover area from FIA data, and the ability to assign crown sizes to individual trees. Two examples are provided to illustrate the approach.

**2:00 PM**

**Relating FIA Data to Habitat Classifications Via Tree-Based Models of Canopy Cover**

Presenter: Mark Nelson

Author(s): Mark D. Nelson, Brian G. Tavernia, Chris Toney, and Brian Walters

Wildlife species-habitat matrices are used to relate lists of species with abundance of their habitats. The Forest Inventory and Analysis Program provides data on forest composition and structure, but these attributes may not correspond directly with definitions of wildlife habitats. We used FIA tree data and tree crown diameter models to estimate canopy cover, from which we assigned FIA conditions to NatureServe forest and woodland habitat domains and NLCD forest classes within the 20-state northern FIA region. Hardwood and softwood types were most abundant for FIA, least abundant for NLCD, and intermediate
for NatureServe classes. NatureServe hardwood types were evenly distributed between forest and woodland, but softwood types were more abundant in NatureServe woodland than forest. Mixed types were substantially more abundant for NLCD, intermediate for NatureServe (equally distributed between forest and woodland), and least abundant for FIA. Area of woody wetlands, which were defined only for NLCD, exceeded area of NLCD softwoods. These habitat assignments are useful for estimating current and potential future abundance of habitats for forest-associated terrestrial vertebrate wildlife species in the region.

2:20 PM
**Densiometers and Canopy Density Measurements**

*Presenter: Keith Moser*

*Author(s): Kenneth W. Stolte, Stanley J. Zarnoch, and Robert L. Easton*

The productivity and vitality of forest ecosystems is dependent on the condition of tree canopies. Canopy cover and density are components in estimations of tree growth efficiency, fish and wildlife habitat, urban tree cover, composition of understory vegetation, soil erosion susceptibility, pollutant deposition, and other ecological factors. We found that a simple modification of a convex densiometer with standardized protocols eliminated two of three multiplicative measurement error factors and improved repeatability among observers. We tested this modification using FIA plot protocols under 3 scenarios in three geographical areas of North Carolina. One scenario consisted of 23 NCSU undergraduate forestry students’ measurements on 3 subplots in a pine seed orchard (piedmont). Another was the evaluation of pre and post-harvest of 60 plots of loblolly pine in Croatan NF (coastal plain). The third was the number of points on an FIA subplot adequate to measure canopy density on 2 FIA subplots in each of 8 long-term vegetation monitoring plots in pine and mixed-hardwood forests at Coweeta experimental forest (mountains). We found that the variance components due to persons, points on subplots, and azimuth position of points was 5.3, 34.3, and 60.3 percent, respectively, indicating observer differences were a very small percentage of the overall measurement variance. We observed an average canopy density drop from 90 percent to 64 percent over 60 plots at Croatan NF following an average thinning intensity of 42 percent of the number of trees in all plots, showing the modified densiometer reflects known changes in canopy density. Four of 7 sample points tested on FIA subplots were found to be adequate for measurement of canopy density at Coweeta LTER in western North Carolina. Only 4 of the 7 points initially tested on FIA subplots reduces the amount of time needed for data collection. These modifications of a convex densiometer meet criteria for a good indicator: high signal/noise ratio; applicable to large areas of different forest types; directly related to crown condition; and logistically feasible (e.g., weight, cost, time on plot).

2:40 PM
**Panel Discussion**

*No Abstracts*
Moving From Status To Trends

Session Overview
Nonnative invasive plant species (NNIPS) are threats to United States forests through the displacement of native species (Mooney and Cleland 2001), the alteration of soil physical and chemical properties (Bruce and others 1995, Jose and others 2002), and the disruption of successional pathways (Oswalt and others 2007) among other potential impacts (Gordon 1998, Jose and others 2002). Environmental impacts coupled with attempts to control and/or eradicate NNIPS are costly, as exemplified by the estimated $3 to $6 million spent annually by the State of Florida to manage the highly invasive Melaleuca (Melaleuca quinquenervia; Fimientel and others 2005). Because of the environmental and ecological burdens posed by these species, NNIPS inventory and monitoring is considered a priority in many parts of the US.

NNIPS can be found invading forests across all of the United States. Eastern US forests, however, currently exhibit high levels of NNIP occupancy. Major US travel corridors and areas of considerable forest fragmentation that are often coupled with the large human population in the eastern US can be important drivers of NNIP distributions. Travel corridors are known to play a profound role in the spread and growth of invasive plants. That fact is evident in maps of NNIP species where major U.S. interstates are apparent. For example, the I-85 corridor from Virginia to Alabama is an area of intense invasive plant abundance. When forests are divided into smaller and smaller parcels (fragmented), the biological diversity of native animals and plants is diminished, water cycles are altered, and often nonnative invasive plants are introduced. This could help explain the high degree of plant invasions in the heavily agriculture dominated landscapes of the middle southern and middle western United States.

This session is intended to provide updates on the current distribution of select NNIPS, updates to FIA NNIP monitoring across the nation, and current and future analyses using the data collected by the FIA program.

1:00 PM
The National Picture of Nonnative Plants in the United States According to FIA Data
Presenter: Sonja Oswalt

Author(s): Sonja N. Oswalt and Christopher M. Oswalt

Data collected by the U.S. Forest Service Forest Inventory and Analysis Program was assembled from each region of the United States. Occurrence, measured as the percentage of forested subplots within a county with observed nonnative invasive plant (NNIP) species, was calculated across the continental United States and Hawaii. Each region, and in some cases each state, maintains a specific watch list to constrain monitoring to only the most important NNIP species within a given area. Therefore, occurrence is based on regionally important species and is inconsistent across the United States. NNIP can be found invading forests across all of the United States. Eastern U.S. forests, however, currently exhibit high levels of NNIP occurrence. Major U.S. travel corridors and areas of considerable forest fragmentation that are often coupled with the large human population in the eastern United States can be important drivers of NNIP distributions. Travel corridors are known to play a profound role in the spread and growth of invasive plants. That fact is evident in maps of NNIP species where major U.S. interstates are apparent. For example, the I-85 corridor from Virginia to Alabama is an area of intense invasive plant abundance. When forests are divided into smaller and smaller parcels (fragmented), the biological diversity of native animals and plants is diminished, water cycles are altered, and often nonnative invasive plants are introduced. This could help explain the high degree of plant invasions in the heavily agriculture dominated landscapes of the middle southern and middle western United States.

1:10 PM
Distribution and Occupancy of Introduced Species: A Baseline Inventory from Phase 3 Plots Across the Country
Presenter: Beth Schulz

Author(s): Bethany K. Schulz and W. Keith Moser

Invasive plant species have significant negative impacts in many ecosystems and are found in many forests around the world. Although not all introduced species become invasive, there are numerous examples of species escaping cultivation and invading natural ecosystems years or even decades after their initial introduction. Regional distributions of invasive species are influenced by climatic and physical conditions; within the landscape, fragmenta-

1:40 PM
Nonnative Invasive Plant Inventory in the Northern Research Station: Patterns and Trends
Presenter: Keith Moser

Author(s): W. Keith Moser and Cassie M. Kurtz

Nonnative invasive plants (NNIPs) are an important component of suite of biological disturbances that are influencing forests in the 24 state region of the Northern Research Station (NRS) of the U.S. Forest Service. Along with locally high deer populations and nonnative earthworms, NNIPs have the potential to impact the biodiversity of the ground flora, site productivity, wildlife habitat, and the composition and structure of forests, present and future. Northern Research Station Forest Inventory and Analysis Program (FIA) has several sets of data that can be used to evaluate NNIP. A select list of 25 species were measured on 100 percent of the panels in the 11 midwestern states from 2005 through 2006. About 20 percent of all plots were inventoried for the presence of 43 species from 2007 through 2010 for all 24 states of NRS-FIA. Our presentation discusses the results and the slightly different methodologies between the 2005-6 and 2007+ inventories, and examines the implications specifically for tree regeneration and future stand development.
Updating the Southern Nonnative Plant Watch List: The Future of NNIP Monitoring in the South
Presenter: Christopher Oswalt

Author(s): Christopher M. Oswalt, Sonja N. Oswalt, and Lewis Zimmerman

The Southern Research Station (SRS) Forest Inventory and Analysis (FIA) Program began monitoring nonnative invasive plant (NNIP) species in 2001 in response to a growing desire to track potential forest health threats on United States forest land. The SRS-FIA NNIP program has produced significant results and contributed considerably to the understanding of the distribution and spread of NNIP in the southern United States. However, opportunities to improve NNIP monitoring in the South do exist. Specifically, the SRS-FIA program monitors only a select number of NNIP species. Given the importance of monitoring nonnative invasive plants in southern forests coupled with the emergence of newly detected plant invaders, the emergence of previously known invasive species as problematic species, and incomplete knowledge of accurately predicting exotic invasives, the select list of NNIP required updating. The SRS-FIA watch list was thoroughly reviewed with respect to potential removal of some species from the list of monitored plants. For example, a recent analysis found that out of over 33,000 subplots, some plant species were detected on 3 or fewer subplots. While such small detection rates do not indicate a lack of needed monitoring, with limited resources, the SRS-FIA program must review the importance of monitoring such species in the future. The watch list must also reflect current knowledge and account for newly discovered important southern forest invaders. Both scientists and land managers have identified numerous regionally and nationally important nonnative invasive plant species not currently on the SRS-FIA watch list. A group of regional and national NNIP experts (internal and external to FIA) were assembled with the task of evaluating and updating the SRS-FIA watch list. The proposed new watch list for SRS-FIA is presented.

Invasive Potential of Invasive Plants in the Forest of the Southern Region, United States
Presenter: Dawn Lemke

Author(s): Dawn Lemke, John W. Coulston, Philip Hulme, Clint Paterson, and Jennifer A. Brown

Alien plants introduced for commercial or landscaping use have caused substantial problems as invaders of natural and managed ecosystems. The magnitude of the problem has dramatically increased over the past few decades with accelerated land disturbance, land use changes, and global and internal transportation. In the southern region of the United States, invasive plants are one of the threats to the long-term sustainability of our forest ecosystems along with climate change and land use change. We assessed the potential distribution of invasive plants in forests of the southern region using data from the invasive species component of the U.S. Forest Service Forest Inventory and Analysis (FIA) Program and freely available digital data including elevation, climate, and land use. Using an ensemble modeling approach, we integrated maximum entropy algorithms, logistic regression, random forest, boosted regression trees, and support vector machine. Areas of agreement between models were considered areas of high probability. This suggests the importance of adaptive management and long-term monitoring programs and the need for further development of methods for assessing probable future climate conditions. We have used this approach to evaluate the relative importance of dependent variables and the application and selection of modeling techniques.

Invasive Plant Monitoring for Northern U.S. Forests
Presenter: Will McWilliams

Author(s): William H. McWilliams, Randall S. Morin, Katherine Johnson, W. Keith Moser, and James A. Westfall

Invasive plants are monitored through canopy cover estimates for a list of species developed by FIA for the northern region of the U.S. that is integrated with a national list. Nearly all of the invasive plants on the NRS-FIA list are exotic species, but a few native species are listed. Highly invasive native species such as rhizomatous fern are absent, making the list limited in scope. Some useful applications include describing all vegetation other than trees, competing vegetation, as well as indices for “invasiveness,” “native-ness,” and others. The major advantage of the invasive survey is a fourfold increase in sample size. The primary disadvantage is that the list of invasive species does not include several important native species at the regional level. The invasive protocols offer a flexible system for estimating occurrence and abundance that can be segmented to address a wide array of questions.
Continuation of Session 13

No Abstracts

A group discussion led by the presenters on topics related to design of forest inventories in developing countries, REDD, use of remote sensing for monitoring, and other topics that emerge during the sessions.
Wednesday, December 5
Session 17: 3:30–5:30 PM

Modeling Regenerative Capacity across the Eastern U.S.: Can FIA Inform Contemporary Models

Session Overview
The need for credible information on regenerative capacity of US forests mounts as forests mature, stressors increase, and future climate scenarios are broad and subject to high variance. Models of regenerative capacity provide valuable information to scientists developing knowledge systems that evaluate the current composition and structure of understory trees to provide an estimate of future conditions. These knowledge systems have been developed for some of the more complicated and well-studied forest ecosystems, such as northern hardwoods of the Mid-Atlantic or mixed oak systems of the Southern Appalachian Mountains. This session is designed to describe how information on forest regeneration measurements are being used in state-of-the-art regeneration models. The session will include exciting news in the area of needs of regeneration modelers and knowledge based developers; examples of relevant broad-scale regeneration models, knowledge models, etc.; and actual use of FIA data for regeneration, sampling approaches, etc.

3:30 PM
Transitioning from Phase 3 Vegetation Data to Phase 2+ Vegetation Data in the Northern Research Station

Presenter: Keith Moser

Author(s): W. Keith Moser, Katherine Johnson, Cassie M. Kurtz, Cassandra Olson, and William H. McWilliams

Phase 3 (P3) vegetation diversity and structure was measured in the Northern Research Station (NRS), U.S. Forest Service, intermittently between 2000 and 2010. Varying in intensity and location, these data provide a glimpse of native and invasive plants across portions of 24 states. Between 2007 and 2010, all NRS states were sampled largely on the same schedule and intensity. In 2011, an NRS-Forest Inventory and Analysis team evaluated a new sampling protocol (NRS Phase 2+ [P2+]), which includes vegetation composition and structure variables from the Phase 2 vegetation profile and the invasive plants protocols, combined with a regeneration sampling scheme first developed for the Pennsylvania “Regeneration Study.” To compare the P3 and P2+ sets of variables, our presentation will apply NRS P2+ vegetation profile, invasive plants, and advance tree seedling regeneration variables to the previously collected P3 vegetation diversity and structure data and we will discuss the implications for customers of these data.

4:00 PM
Developing an Advance Regeneration Model for Pennsylvania Hardwood Forest Ecosystems

Presenter: Marc McDill

Author(s): Marc McDill, Laura Leites, Michael DiCarlo

Models to predict the composition, size, and quantity advance regeneration for northeastern hardwood forests from readily available data are not currently available; however, a unique database exists with detailed information about tree regeneration for a subset of Pennsylvania’s FIA plots. Our project focuses on using these data to test whether advance regeneration is persistent in the absence of significant disturbances to the overstory; and identify and evaluate commonly available variables – such as overstory composition, age and stocking, competing vegetation, and climatic and physiographic conditions – and modeling methods that can be used to predict the presence, quantity, and size of advance regeneration in Pennsylvania forests. We will present a description of this unique dataset and discuss preliminary results from this project.

4:30 PM
Sampling Forest Regeneration Across Northern U.S. Forests: Filling a Void in Regeneration Model Input

Presenter: Will McWilliams

Author(s): William H. McWilliams, Charles D. Canham, Randall S. Morin, Katherine Johnson, Paul Roth, and James A. Westfall

The Forest Inventory and Analysis Program of the Northern Research Station (NRS-FIA) has re-designed Phase 3 measurements and intensified the sample intensity following a study to balance costs, utility, and sample size. The sampling scheme consists of estimating canopy-cover percent for six vegetation growth habits on 24-foot-radius subplots in four height classes as an aerial view, and measuring tree saplings and seedlings on 6.8-foot-radius microplots. In the past two years, all of the basic area models in SORTIE, an individual-tree-distance-dependent model, were parameterized for the 50 most common tree species in the eastern U.S. by using FIA data. A significant challenge for modelers is that goodness of fit measures, such as the coefficient of determination, for the resulting growth models are often relatively low. Opportunities for using NRS-FIA data for broad-scale models include use of a non-spatial model of seedlings as a function of basal area of the entire subplot, ability to use a mortality model for seedlings, and improvement in knowledge of the impact of the species of neighboring trees. The major benefit of the new NRS-FIA sample design is a fourfold increase in sample size and integration of all vegetation measurements on the subplot (i.e., adult trees, competing vegetation, and seedlings). The primary limitation of using FIA samples is that the subplot area is too small for full analysis of distance-dependent seedling dispersion around parent trees.
3:30 PM
Characterizing Environmental Change in Interior Alaska (1982-2012) Using Multi-Temporal, Multi-Scale Remote Sensing Data and Field Measurements

Presenter: Hans-Erik Andersen

Author(s): Hans-Erik Andersen and Robert Pattison

We investigate how vegetation in the Tanana Valley of interior Alaska (120,000 km²) has responded to a changing climate over the preceding three decades (1982-2012). Expected impacts include: 1) drying of wetlands and subsequent encroachment of woody vegetation into areas previously dominated by herbaceous and bryoid vegetation types, 2) changes in forest composition resulting from succession processes within burned areas, 3) mortality and defoliation from increased insect activity attributable to a warming climate, 4) effects on tree growth attributable to drought stress and/or reduced photosynthetic capacity, and 5) expansion of woody vegetation at the tree line. To characterize and quantify these changes occurring over the full range of environmental conditions present in this vast region, we plan to use a unique resource of multi-temporal and multi-scale remote sensing data to analyze changes observed between 1) field data and large-scale photographs collected in 1982 over a selection of inventory plots within the western Tanana Valley region, and 2) low-altitude airborne digital imagery collected over these same inventory plots in 2012. Detailed stand- and plant-level changes observed over 40-ha remeasured photograph plots will be scaled up and used to inform an analysis of changes in vegetation condition observed in spectral trajectories obtained from a time series of Landsat Thematic Mapper / Enhanced Thematic Mapper Plus imagery over this 30-year period.

4:00 PM
Development and Applications of the LANDFIRE Forest Structure Layers

Presenter: Chris Toney

Author(s): Chris Toney, Birgit Peterson, Don Long, Russ Parsons, and Greg Cohn

The LANDFIRE program is developing 2010 maps of vegetation and wildfire fuel attributes for the United States at 30-meter resolution. Currently available vegetation layers include ca. 2001 and 2008 forest canopy cover and canopy height derived from Landsat and Forest Inventory and Analysis (FIA) plot measurements. The LANDFIRE canopy cover layer for the conterminous United States is the first of its kind developed with FIA tree measurements as the source of ground reference data. The mapping process is based on regression tree models with FIA plot values as the dependent variables (canopy cover, canopy height), using predictor variables derived from reflectance, terrain, and a Shuttle Radar Topography Mission-based height metric. Base vegetation maps are updated beginning with a set of annual disturbance maps that combine extensive fire severity mapping with Landsat time-series disturbance and polygon data describing management activities on Federal and state lands. FIA plot data are used in the Forest Vegetation Simulator to model disturbance effects on forest vegetation for each disturbance type and severity class. Updated 2010 products are scheduled for delivery during early 2013. The 2010 products include a new tree list layer in which stand structure is depicted explicitly by approximating a representative list of trees occurring at each 30-m pixel. The tree list layer provides a more detailed characterization of canopy fuel structure than is available with standard LANDFIRE products, facilitating new applications and research in fire behavior and fire effects simulation.

4:30 PM
A Comparison of Methods for Mapping Tropical Forest Tree Species and Biophysical Characteristics with Small Forest Inventory Plots and Multiscale Remotely Sensed Imagery

Presenter: Eileen Helmer

Author(s): Eileen H., Helmer, Thomas S. Ruzycki, Barry T. Wilson, Christopher Daly, Kirk R. Shermill, Thomas A. Brandeis, Michael A. Lefsky, Heather E. Erickson, Bonnie Rufenacht

Monitoring of warm temperate, temperate, and boreal forests over large areas would have been a priority in developing the design of the U.S. Forest Service’s Forest Inventory and Analysis (FIA) program. For species-rich subtropical and tropical forests, especially those in island landscapes where forest types change drastically over small areas, the design seems sparse and the plots seem small. Can these plots be used to map tree species distributions and biophysical characteristics in tropical landscapes of the U.S.? We sought to help answer this question with FIA data from Puerto Rico and the U.S. Virgin Islands. We produced or assembled many geospatial datasets to consider as potential predictor variables. Satellite imagery included a new time series of gap-filled Landsat MSS, TM and ETM+ imagery that extends from Mona Island to the British Virgin Islands, a panchromatic SPOT image mosaic, and a Fourier-smoothed intra-annual MODIS image time series. Climate data included a new PRISM dataset that maps long-term monthly temperature and precipitation for the Virgin Islands. We also mapped forest height with coarsely-scaled lidar data. We tested three approaches to mapping forest attributes from forest inventory data: the decision tree software See5, the regression tree software Cubist, and the phenological Gradient Nearest Neighbor approach.
5:00 PM
A Model for Quantifying Forest Variables over Landscapes with Uncertain Forest Areas

Presenter: Andrew Finley
Author(s): Andrew O. Finley, Sudipto Banerjee, and David W. MacFarlane

We are interested in predicting one or more continuous forest variables (e.g., biomass, volume, age) at a fine resolution (e.g., pixel level) across a specified domain. Given a definition of forest/nonforest, this prediction is typically a two-step process. The first step predicts which locations are forested. The second step predicts the value of the variable for only those forested locations. Rarely is the forest/nonforest status predicted without error. However, the uncertainty in this prediction is typically not propagated through to the subsequent prediction of the forest variable of interest. Failure to acknowledge this error can result in biased estimates of forest variable totals within a domain. In response to this problem, we offer a modeling framework that will allow propagation of this uncertainty. Here we envision two latent processes generating the data. The first is a continuous spatial process while the second is a binary spatial process. The continuous spatial process controls the spatial association structure of the forest variable of interest, while the binary process indicates presence of a possible nonzero value for the forest variable at a given location. The proposed models are applied to geo-referenced National Forest Inventory (NFI) data and spatially coinciding remotely sensed predictor variables. Due to the large number of observed locations in this dataset, we seek dimension reduction not just in the likelihood, but also for unobserved stochastic processes. We demonstrate how a low-rank predictive process can be adapted to our setting and reduce the dimensionality of the data and ease the computational burden.
## Thursday, December 6

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**Thursday, December 6**  
**Session 19: 10–12 PM**  
**Climate Change and Forest Health: Integrating FIA, Climate Data, and Spatial Technology for Long-Term Monitoring**

**Session Overview**  
Changing climatic conditions have the potential to adversely affect the health of forests in the United States. As such, a variety of research projects have been undertaken in an attempt to understand the extent of the impact of a variety of climatic variables on forested areas. The United States Forest Service’s Forest Inventory and Analysis (FIA) program provides a continuously updated inventory of the country’s forests measuring a variety of variables. Combining the FIA data with long-term records of climate data regarding average annual temperatures and precipitation, it is possible to determine baseline effects of climate on a variety of forest issues such as region-wide non-competition caused mortality, invasive species propagation, down woody material, regeneration, and monitoring forest health through Forest Health Monitoring (FHM) data (e.g., crown dieback). This session will focus on efforts to determine what, if any, relationships exist between climate and forest health. Presentations will be made by four separate lead authors including Michael K. Crosby, Joseph Z. Fan, Shirley Fan, and Weiming Yu. Presentations in this session will discuss a variety of methodologies used in the analysis of forest health (FIA and FHM data). Implications for continued climate change will also be discussed.

**10:00 AM**  
**Relationship Between Crown Dieback and Drought in the Southeastern United States**  
**Presenter:** Michael Crosby  
**Author(s):** Michael K. Crosby, Zhaofei Fan, Martin A. Spetich, Theodor D. Leininger, and Xingang Fan

Forest Health and Monitoring (FHM) and Palmer’s Drought Severity Index (PDSI) data were obtained for 11 states in the southeastern United States to assess the relationship between drought and crown dieback. Correlation analyses were performed at the species group and ecoregion levels within the study area. The results indicate a negative correlation between drought and crown dieback within 3 to 5 years of the onset of drought conditions.

**10:20 AM**  
**Assessing Forest Mortality Patterns Using Climate and FIA Data at Multiple Scales**  
**Presenter:** Michael Crosby  
**Author(s):** Michael K. Crosby, Zhaofei Fan, Xingang Fan, Theodor D. Leininger, and Martin A. Spetich

Forest Inventory and Analysis (FIA) and PRISM climate data from 1991-2000 were obtained for 10 states in the southeastern United States. Mortality was calculated for each plot, and annual values for precipitation and maximum and minimum temperature were extracted from the PRISM data. Data were then stratified by upland/bottomland for red oak species, and classification and regression tree (CART) analysis was used to determine the influence of climate variables on mortality at ecoregion province and section levels. The results presented here will provide a basis for future research on the causal factors related to red oak mortality.

**10:40 AM**  
**Incorporating Local Statistics Based Spatial Weight Matrix into Simultaneous Autoregressive Model to Predict the Distribution of Nonnative Invasive Shrubs in the Upper Midwest**  
**Presenter:** Weiming Yu  
**Author(s):** Weiming Yu, Zhaofei Fan, and W. Keith Moser

In this study, we extended the spatial weight matrix defined by Getis and Aldstadt to a more general case to predict the distribution of invasive shrubs among the Upper Midwest counties in a simultaneous autoregressive (SAR) model context. The modified spatial weight matrix performs better than the original spatial weight matrix since it adjusts weights of observations based on the distance from other observations but still maintains the locally adaptive nature of the latter. Both the simulation study and the application to the Forest Inventory and Analysis (FIA) plot data for invasive shrubs collected in 2005-2006 proved that the modified spatial weight matrix outperforms its original case in diagnostic statistics (e.g., AIC) and resultant invasion maps. Our results provided further evidence that misspecification of spatial autocorrelation structure in spatial data will result in misinterpretation of real ecological processes and bias estimation of coefficients for important covariates involved. The geographical distribution of invasive shrubs in the Upper Midwest was significantly associated with latitude; local clusters (a group of counties) of high abundance/presence of invasive shrubs was significantly determined by TRPF (a ratio of road density to percent of forest cover at the county level), a variable reflecting the intensity of human disturbance. Both the multiple linear regression model and the SAR model with the original spatial weight matrix incorporated tended to overestimate the effect of forest type (community) on invasive shrubs. However, the SAR model with the modified spatial weight matrix showed that distribution of invasive shrubs among forest types was only marginally different at the significance level of $p = 0.05$. This result conforms to the plot level study and is favorably supported by the data. As a conclusion, the SAR model incorporating the modified spatial weight matrix provides an applicable solution to map spatial data and estimate spatial autocorrelation structure and covariate effect in ecological studies.

**11:00 AM**  
**Projecting Climate Change Impacts on Down Woody Materials in the Eastern U.S. Forests**  
**Presenter:** Zhaofei Fan  
**Author(s):** Zhaofei Fan, Christopher W. Woodall, and Stephen R. Shifley

Down woody material (DWM) is dead biomass that originates from tree/plant mortality in forest ecosystems. DWM is an indicator of forest ecosystem health and can be used to evaluate fire risk, wildlife habitat, and forest carbon stocks. Total DWM and components (coarse woody debris, fine woody debris, litter, and duff) are measured on the Forest Inventory and Analysis (FIA) Phase 3 plots. In this study we employed a two-stage modeling strategy to combine the Phase 2 and Phase 3 plots to map the distribution of major DWM components across the eastern United States. We first used data from the Phase 3 plots to develop a set of semiparametric penalized spline functions to estimate DWM components based on a set of covariates that were measured for both the Phase 3 and the Phase 2 plots. Then we used the derived spline models to estimate DWM components for all Phase 2 plots and map the distribution of DWM components at selected resolutions that are pertinent to management needs. We used multivariate classification and regression tree to evaluate the impact of climatic variables on distributional patterns of DWM components. By integrating design-based information and model-assisted inference this approach improves the efficiency of the estimators of DWM components compared to the design-based estimators. Finally, we explored the ecological implications of current patterns of DWM (by components) for major forest cover types and ecoregions in the eastern United States and discussed the potential impacts of management practices on hardwood forest ecosystems.
11:20 AM
Spread of Chinese Tallow in East Texas Using FIA Data

Presenter: Zhaofei Fan
Author(s): Zhaofei Fan

Chinese tallow tree (*Triadica sebifera* (L.) Small) is an invasive species that is replacing native ecosystems in areas of eastern Texas. It is imperative that the spatial pattern of the spread of this species be identified, as well as causal mechanisms. To that end, we seek to determine factors that contribute to the spread of Chinese tallow using autologistic regression. We also attempt to identify current locations and spread rates across eastern Texas using Forest Inventory Analysis (FIA) data within major forest types. Distance to roads, disturbances (natural and anthropogenic), and low slope were identified as major factors for the occurrence of Chinese tallow. The highest probability of occurrence and spread rate of Chinese tallow were found in the oak/gum/cypress forest type. Continued disturbance, from harvest events or natural disasters will allow the species to continue to spread throughout the region and could threaten overall forest productivity. We also discuss some implications of the continued spread of Chinese tallow on forest management. Forest managers could benefit from this analysis and use it as a guide for monitoring forest types with the highest risk of invasion.

11:40 AM
Tempo-Spatial Trends of Oak Decline and Mortality Under Periodic Regional Droughts in the Ozark Highlands of Arkansas and Missouri

Presenter: Shirley Fan
Author(s): Shirley X. Fan, Zhaofei Fan, W. Keith Moser, Matin A. Speich, and Stephen R. Shifley

Oak decline and mortality trends for major oak species (groups) was explored in the Ozark highlands of Arkansas and Missouri at the forest landscape/region level, based on annual FIA plot data from 1999 to 2010. Oak decline has elevated cumulative mortality of red oak species to 11 and 15 percent in terms of relative density and basal area of standing dead oak trees, respectively; this rate is two to three times higher than for white oak group and non-oak species.

Oak decline and associated escalating mortality have occurred primarily within red oak species while white oak group maintain a relatively stable mortality rate comparable to non-oak species. Cross-correlation analyses indicate that mortality was significantly correlated with the growing season Palmer Drought Severity Index (PDSI) and usually lagged 2 to 3 years following single drought events. Moreover, based on the past 17 year’s PDSI data, it appears that the cumulative impacts of drought may last up to 10 years. The Ozark highlands experienced a severe drought extending from 1998 to 2000 and another milder drought from 2005 to 2006. These drought events triggered the escalation of mortality starting around year 2000. Spatially, high mortality of red oak (hot spots proportional basal area mortality > 0.15) occurred mainly in the central area of the Ozarks. Moderate mortality (proportional basal area mortality of 0.10 to 0.15) was widely dispersed over most of the Ozark highlands, while low mortality was distributed around the outer perimeter of the Ozarks. In contrast, in the white oak group and nonoak species, high mortality was rare and moderate mortality was sporadic. Cumulative mortality of these species was predominant throughout the Ozarks.
Methods for Improving Forest Inventory

Moderated by Frank Roesch

10:00 AM
Estimators Used in the New Mexico Inventory: Practical Implications of “Truly” Random Nonresponse Within Each Stratum
Presenter: Paul Patterson
Author(s): Paul L. Patterson and Sara A. Goeking

The annual forest inventory of New Mexico began as an accelerated inventory, and 8 of the 10 Phase 2 panels were sampled between 2008 and 2011. The inventory includes a large proportion of nonresponse. FIA’s estimation process uses poststratification and assumes that nonresponse occurs at random within each stratum. We construct an estimator for the New Mexico inventory and derive an estimated variance based on the missing-at-random assumption.

10:20 AM
Remeasured Forest Inventory and Analysis Plots
Author(s): Michael Thompson

Tree diameter growth models are widely used in many forestry applications, often to predict tree size at a future point in time. Also, there are instances where projections of past diameters are needed. An individual tree model has been developed to estimate diameter growth of multi-stem woodland tree species where the diameter is measured at root collar. The model was built from radial growth data on trees sampled from plots measured in Utah, Arizona, and Nevada. Individual tree growth can be predicted from the ratio of live woodland stems to all stems and from mean past 10-year radial growth of trees by ecological subsection, section, or province. Coefficients were estimated for four woodland tree species groups that cover most tree species in the Southern Interior West region.

10:40 AM
The Improvement of Precision for Estimating the Abundance of Standing Dead Trees Using Auxiliary Information Under The FIA Plot Design
Presenter: Hong Su An
Author(s): Hong Su An, David W. MacFarlane, and Christopher W. Woodall

Standing dead trees are an important component of forest ecosystems. However, reliable estimates of standing dead tree population parameters can be difficult to obtain due to their low abundance and spatial and temporal variation. After 1999, the Forest Inventory and Analysis (FIA) Program began collecting data for standing dead trees at the Phase 2 stage of sampling. However, the estimates have relatively large variations compared to the estimates of live trees. The results represent that EZ-Hurdle method shows better precision than the FIA method for both spatial patterns and densities of standing dead trees.

11:00 AM
Optimized Endogenous Post-Stratification in Forest Inventories
Presenter: Paul Patterson
Author(s): Paul L. Patterson

An example of endogenous post-stratification is the use of remote sensing data with a sample of ground data to build a logistic regression model to predict the probability that a plot is forested and using the predicted probabilities to form categories for post-stratification. An optimized endogenous post-stratified estimator of the proportion of forest has been recently proposed in the literature, but there are no known literature results describing the operating characteristics of this estimator. This study reports the results of a detailed Monte Carlo investigation of the performance of the optimized and another endogenous post-stratified estimator under a variety of realistic scenarios and compares their performance with earlier approaches.

11:20 AM
Properties of the Endogenous Post-Stratified Estimator Using a Random Forests Model
Presenter: John Tipton
Author(s): John Tipton, Jean Opsomer, and Gretchen Moisen

Post-stratification is used in survey statistics as a method to improve variance estimates. In traditional post-stratification methods, the variable on which the data is being stratified must be known at the population level. In many cases this is not possible, but it is possible to use a model to predict values using covariates, and then stratify on these predicted values. This method is called endogenous post-stratification estimation (EPSE). In this paper, we investigate methods to automatically select the number of poststrata for EPSE. We do this in the context of models fitted by Random Forests with the stratum boundaries set at quantiles of the predicted distribution.

11:40 AM
Improved Prediction of Hardwood Tree Biomass Derived from Wood Density Estimates and Form Factors for Whole Trees
Presenter: David MacFarlane
Author(s): David W. MacFarlane and Neil R. Ver Planck

Data from hardwood trees in Michigan were analyzed to investigate how differences in whole-tree form and wood density between trees of different stem diameter relate to residual error in standard-type biomass equations. The results suggested that whole-tree wood density, measured at breast height, explained a significant proportion of residual error in standard-type allometric equations, but whole-tree form factors explained more. However, such form factors are highly variable from tree to tree and may be difficult to predict with any precision from simple tree measurements. Whole-tree form factors were found to be highly correlated with the percentage of total aboveground mass in tree branches, which likely relates to the allometric scaling of the deliquescent hardwood growth form. These results suggest that further studies are needed to understand whole-tree form factors and incorporate them into tree biomass equations.
Session Overview
Across North America, there is a strong and growing need for accurate models of tree biomass and carbon that can be applied at regional to national scales. Besides models for traditionally merchantable tree species and stem wood components, shifts in forest management emphasize emerging bio–energy markets and mitigation of wildfire hazards have created critical demand for credible estimates of bark, branch, and foliage biomass. Moreover, the latter information is increasingly being queried for a wide array of species, size classes, and for both live and standing dead trees. The shifts in forest management that have sparked these demands speak directly to a sharpened need for regional and national monitoring of forest biomass and carbon stocks. At the same time, calls for improved and expanded biomass and carbon estimators provide an opportunity for improving such monitoring programs.

Presently, there is broad consensus that the biomass and carbon estimators used by the US Forest Inventory and Analysis (FIA) program require further evaluation. Around this consensus, a collaborative project linking FIA scientists and researchers at partner universities across the US has been initiated. The objectives of the project are to examine the limitations of existing biomass and carbon estimation techniques and data sources; and to evaluate opportunities for assembling more integrated data sets and developing more accurate biomass and carbon estimators. The proposed session is themed by this ongoing project. It will consist of a set of linked presentations that describe the dominant regional and national challenges to improving tree biomass and carbon estimation in each FIA region. Topics discussed range from mensuration (e.g., methods of direct biomass and carbon assessment), to sampling (distribution and protocols), to modeling (estimation of hierarchical and geographic components of variation).

By integrating techniques development with cutting–edge mensuration and modeling in a federal–academic–industry collaboration across regions, the proposed session directly addresses the identified goals of the 2012 Symposium. The session will also provide a forum for communicating and discussing how FIA can move forward with its biomass and carbon monitoring programs.

10:00 AM  Motivations for an Improved Volume, Biomass, and Carbon Database
Presenter: John Coulston
Author(s): John Coulston, Jim Westfall, and Greg Reams
The U.S. Forest Service Forest Inventory and Analysis program recently invested in key volume, biomass, and carbon research. This multi–year collaborative research effort includes key partner from the Forest Service, academia, and forest industry. We present the primary motivating factors for this national effort to set the stage for more in depth discussions provided by the research team.

10:20 AM  Biomass Measurement and Modeling Challenges for Hardwood Species in the Northern Region
Presenter: James Westfall
Author(s): James A. Westfall, David W. MacFarlane, and Aaron R. Weiskittel
Biomass models for most commercially important hardwood species in the northern region of the U.S. are often based on data of very limited spatial extent and range of tree characteristics, suggesting uncertain accuracy when applied at regional scales. Also, the current models can have poor predictive ability for the proportions of biomass found in major tree components considered for utilization, namely the merchantable bole, bole tops, tree branches, and foliage. The Forest Inventory and Analysis Program of the U.S. Forest Service is currently undertaking a project to obtain regionally representative data to develop new volume/biomass models. This paper outlines issues related to challenges in data collection and subsequent modeling of biomass components for hardwood species.

11:00 AM  Strategies for Assessing Inter- and Intra-Specific Variation in Tree Biomass in the Interior West
Presenter: David Affleck
Author(s): David L. R. Affleck, John M. Goodburn, and John D. Shaw
Wildfire hazard mitigation and bioenergy harvesting have emerged as forest management priorities throughout the Interior West (IW) of the USA. Regional forest inventory and forecasting applications are therefore increasingly focused on tree biomass, including biomass in traditionally non-merchantable components. Yet accurate biomass equations for the latter components are typically lacking, even for major commercial species. This is because previous assessment efforts have focused on distinct components, have used inconsistent methodologies, or have relied on data with limited spatial or biophysical extents. Here we review and contrast the current state of knowledge related to this topic for southern region tree species and identify a plan to fill knowledge gaps.
in biomass allometry and to the high costs of collecting biomass data, an important element of new data collection efforts will be the development of standardized and accurate subsampling procedures. We describe these subsampling strategies and discuss potential adaptations for two-needle pinyon in the southwest.

11:20 AM  
Estimating Biomass and Carbon in Forests of the Pacific States: Statistical Issues  
Presenter: Andrew Gray  
Author(s): Andrew N. Gray and Hailemariam Temesgen

Increasingly, large-scale estimates of biomass and carbon play significant roles in providing critical information to forest resource management and policy decisionmaking. Biomass and carbon estimates are required to monitor CO2 mitigation projects, characterize forest productivity, and estimate carbon flux. Yet, estimating biomass and carbon for large-scale inventory and monitoring is a difficult task. The amount of bias introduced by using locally developed equations to estimate biomass and carbon across large regions is not known. Equations are either not available or poorly developed for important species and important components of carbon storage like standing dead trees. In addition, the Pacific states are characterized by some of the largest trees and most remote landscapes in the country, which complicates sampling and measurement.

Using ground data collected from across a range of major forest types in Pacific Northwest, we demonstrate selected approaches that might improve regional biomass and carbon estimates. In this presentation, we discuss 1) the suitability and predictive abilities of selected methods to quantify biomass and carbon in different forest types of the Pacific Northwest; 2) the use of selected methods to quantify types and frequency of dead trees/snags and their contributions to biomass/carbon pools; and 3) the challenges and opportunities in estimating biomass and carbon. In addition, we will discuss existing gaps and emerging technologies that might offer opportunities to quantify biomass and carbon inventories.

11:40 AM  
National Biomass Estimator Library  
Presenter: Yingfang Wang  
Author(s): Yingfang Wang and Leah Rathbun

Reliable estimates of biomass are needed by forest managers, researchers, timber purchasers and required by national programs such as Timber Cruise Processing System, Forest Vegetation Simulator (FVS), and Forest Inventory Analysis (FIA). Most biomass equations are species and site specific, amounting to thousands of equations nationwide. In many cases the ability to determine which equation to use requires detailed knowledge of multiple equations. Generalized equations have been developed for use across the country (e.g. Jenkins et al. 2003) which, while simple to use, may not provide an accurate estimate of biomass. The National Biomass Estimator Library (NBEL) was created to compile biomass equations from across the country into a database which can be queried. The NBEL contains a graphical user interface which allows the user to easily query biomass equations. In addition, the NBEL allows a user to select multiple biomass equations for estimate comparison. The NBEL integrates with the National Volume Estimator Library (NVEL), a similar library developed for volume and taper equations; this allows for the estimates of biomass based on conversion from tree volume. The NBEL was compiled as a DLL making it integratable for use in other applications.
Human activity, especially fossil fuel combustion and food production, has greatly enhanced the nitrogen (N) cycle worldwide. Atmospheric deposition of N-containing pollutants contributes to eutrophication and acidification of ecosystems. Specific effects on vegetation include species composition shifts and reduced diversity. Although N deposition is generally holding steady in the western US and decreasing in the eastern US since 1994, some areas still experience deposition levels that are enhanced ten-fold relative to background sites. How much is too much? We summarize recent and on-going western U.S. studies that demonstrate that levels of nitrogen deposition above 4 kg N ha\(^{-1}\) yr\(^{-1}\) are likely to be associated with adverse impacts to lichen communities. We also present a useful tool for rapid on-site estimation of total nitrogen deposition in forested ecosystems using dry weight %N of common lichens. These estimates are especially accurate in difficult to model mountainous terrain with low to medium deposition (\(<5\) kg N ha\(^{-1}\) yr\(^{-1}\)), typical of major landscapes of the western U.S.
2:12 PM
Impacts of Nitrogen and Sulfur Deposition on the Growth of Red Spruce and Sugar Maple in the United State

Presenter: Jennifer Phelan

Author(s): Jennifer N. Phelan, Paramita Sinha, George Van Houven, Marion Deerhake, Randall G. Waite, Anne W. Rea, and Ginger M. Tennant

Total nitrogen (N) and sulfur (S) deposition in forest systems can have either positive or negative impacts on tree growth. The growth of many forests in North America is limited by N availability (Chapin et al. 1993, Klimk 1994). Therefore, N fertilization is often a key component of forest management (Allen 2001), and in areas of N deposition, tree growth may be stimulated. However, N additions can sometimes be greater than what trees require and can negatively impact tree health and growth (Aber et al. 1995, Driscoll et al. 2001, McNulty et al. 2005). Systems where atmospheric deposition of N and S is greater than the critical load may be examples of such forest conditions. When critical loads are exceeded, tree health and growth may be compromised both directly and indirectly due to soil nutrient imbalances caused by leaching of base cations from the soil. Trees may have an increased susceptibility to drought and pest damage, aluminum (Al) toxicity in roots, reduced tolerance to cold, and a greater susceptibility to frost injury (Cronan and Grigal 1995, Driscoll et al. 2001, Fenn et al. 2006, McNulty et al. 2005, Ouimet et al. 2008). In the context of acidifying deposition of N and S, whether deposition has a positive or negative impact on tree growth may depend largely upon whether the critical load is exceeded by the deposition level, and it may follow an inverted U-shaped relationship similar to that which was hypothesized by Aber et al. (1995) for temperate forest systems that receive chronic, long-term N additions.

To examine the relationships between N and S deposition and tree growth, preliminary analyses comparing the growth of sugar maple (Acer saccharum var. saccharum) and red spruce (Picea rubens) and critical acid load exceedances (positive and negative) were conducted for the full geographical ranges of both species in the United States. Sugar maple and red spruce were selected as the test species because both have experienced decline in areas of high N and S deposition (Ouimet et al. 2008, Shortle et al. 1997, Wathamough 2002). Annual tree growth estimates for sugar maple and red spruce were obtained from the Forest Inventory and Analysis (FIA) database, and critical acid loads were calculated using the simple mass balance model (United Nations Economic Commission for Europe 2004) and three different levels of protection to tree health (base cation/Al soil solution ratio = 0.6, 1.2, and 10.0).

The critical loads were compared against 2002 N and S deposition to estimate critical load exceedances. A series of multivariate ordinary least squares regressions were then conducted to examine the relationship between tree growth and N and S deposition. A quadratic functional form was used to test for evidence of the inverted U-shaped relationship between critical load exceedance and tree growth.

In addition, we conducted separate linear regression analyses relating N deposition and tree response in plots where critical load exceedance values were negative (i.e., plots where deposition levels did not exceed the critical loads), and analyses evaluating critical load exceedance and volume growth on plots where N and S deposition levels exceeded the critical loads. These separate analyses were conducted to test the hypotheses that tree growth is stimulated or “fertilized” by N when critical loads are not exceeded, and tree health and growth are impaired when the benefits of N deposition are replaced by the negative acidifying impacts of N and S deposition. The statistical results suggested that both species exhibited a quadratic functional form relationship between critical load exceedance and growth, although not significant at the p = 0.05 level. Based on critical loads determined using the base cations/Al ratio of 10.0, the linear regressions showed that growth of sugar maple was stimulated by N deposition on plots where critical loads were not exceeded (p = 0.0013), and red spruce growth was reduced on plots where 2002 N and S deposition levels exceeded the critical loads (p = 0.0223).

The objectives of this study will be to expand and improve on the preliminary analyses and further our understanding of the relationships between N and S deposition and red spruce and sugar maple growth. Parameters including initial tree volumes, plot elevation, stand basal area, and plot latitudes and longitudes will be included in the analyses to account for other sources of variation in the growth response. The ability to indirectly determine species-specific soil solution base cation/Al ratios will also be explored. It may be possible to calculate the base cation/Al ratio critical limit for red spruce and sugar maple based on the point of inflection in the quadratic relationship determined for each species. Previous comprehensive synthesis efforts have reported that the growth of red spruce and sugar maple seedlings was reduced by 20 percent, relative to controls at base cation/Al ratios of 1.2 and 0.6, respectively (Sverdrup and Warfvinge 1993). To date, however, the ability to test or confirm these species-specific critical limits for trees in the field has been limited. Furthermore, these exposure-response models of red spruce and sugar maple growth to N and S deposition may potentially be applied to evaluate the impacts of altered deposition levels on tree growth, and consequently, on provisioning ecosystem services through the use of the Forest and Agricultural Sector Optimization Model—Green House Gas version. If successful, these analyses and novel approach may prove to be a very effective way to evaluate the current condition of U.S. forests in response to N and S deposition, and how forest health could be improved with decreased deposition levels.

2:36 PM
Panel Discussion
No Abstracts
1:00 PM
Understanding Trends in Observations of Forest Disturbance and their Underlying Causal Processes
Presenter: Karen Schleeweis

Author(s): Karen Schleeweis, Samuel N. Goward, Chengquan Huang, Jeffrey G. Masek, and Gretchen Moisen

Estimates of forest canopy areal extent, configuration, and change have been developed from satellite-based imagery and ground-based inventories to improve understanding of forest dynamics and how they interact with other Earth systems across many scales. The number of these types of studies has grown in recent years, yet few have assessed the multiple change processes underlying observed forest canopy dynamics across large spatio-temporal extents. To support these types of assessments, a more detailed and integrated understanding of the geographic patterns of forest change processes across the contiguous United States (CONUS) is needed.

This work uses forest age estimates from U.S. Forest Service ground inventory data and a novel data set from the North American Forest Dynamics project, which provides a dense temporal record (1984-2005) of forest canopy history across the United States, as well as ancillary geospatial data sets on forest change processes (wind, insect, fire, harvest, and conversion to suburban/urban land uses) across the CONUS. Forest area is estimated and causal processes of forest change are shown through time across multiple scales.

1:24 PM
Improving Automated Disturbance Maps Using Snow-Covered Landsat Time Series Stacks
Presenter: Ian Housman


Snow-covered winter Landsat time series stacks are used to develop a nonforest mask to enhance automated disturbance maps produced by the Vegetation Change Tracker (VCT). This method exploits the enhanced spectral separability between forested and nonforested areas that occurs with sufficient snow cover. This method resulted in significant improvements in Vegetation Change Tracker outputs at the 95 percent confidence interval. An estimated 34 percent of the world’s forests receive sufficient snowfall to use this method.

1:48 PM
Constructing Southwestern Oregon FIA Plot History Using 25 Years of Landsat Satellite Observations
Presenter: Peder Nelson

Author(s): Peder Nelson, Warren B. Cohen, Susmita Sen, Eric J. Pfaff, William C. Clark, Alissa Moses, Kate Fickas

Landsat time series (LTS) contain detailed information about land use and cover change. We present a strategy based on human interpretation to characterize the recent 1984–2008 vegetation history of 1,155 southwest Oregon FIA plots using the LTS. Two separate interpreters evaluated each plot using an interpretation system, TimeSync, consisting of a graphical user interface for annual series of zoom-capable LTS image chips, visualizing time trajectories of various spectral indices for a plot, and historical high-resolution images within Google Earth. They identified persistent forest, agents and year of forest disturbances, forest recovery, and regeneration. A third interpreter arbitrated disagreements between initial interpretations, thus providing a final high quality reference dataset, which has built-in confidence scoring based on the integration over all interpreters. In this talk, we present the interpretation strategy, as described above, and present preliminary results.

2:12 PM
Adding Value to the FIA Inventory: Combining FIA Data and Satellite Observations to Estimate Forest Disturbance
Presenter: Todd Schroeder

Author(s): ---

In addition to being one of the primary drivers of the net terrestrial carbon budget, forest disturbance also plays a critical role in regulating the surface energy balance, promoting biodiversity, and creating wildlife habitat. With climate change and an ever growing human population poised to alter the frequency and severity of disturbance regimes across the globe, improved monitoring of forest disturbance, especially at the landscape scale has taken on renewed importance. Because forest disturbance manifests at a variety of spatial and temporal scales and has varying impacts which affect the canopy, understory, and forest floor, effective monitoring will likely require a composite approach where localized field data collected by the Forest Inventory and Analysis (FIA) Program are combined with repeat observations from remote sensing satellites such as Landsat. As Landsat offers nearly 40 years of well calibrated and systematically collected imagery at no cost, it is now economically feasible to monitor year to year trends in forest disturbance over large areas. In addition to its use in mapping forest change, Landsat data can also serve as a valuable backdrop for collecting detailed human interpretations of disturbance. When collected over a design-based sample such as FIA plots, these manually derived interpretations offer a wealth of potential uses ranging from map validation to estimation of new disturbance-related attributes. Here satellite observations and FIA data are used to estimate the area impacted by several types of forest disturbance occurring in the Uinta Mountains of northern Utah. This study aims to evaluate two types of satellite observations in the context of FIA’s estimation procedure, including the use of human interpretations as an augmented response variable and the use of disturbance maps for stratified variance reduction.

2:36 PM
Panel Discussion

No Abstracts
Moving From Status To Trends

Thursday, December 6
Session 24: 1–3 PM

LiDAR

Moderated by Demetrios Gatziolis

1:00 PM
Improving LiDAR Based Prediction of Forest Biomass Using Models with Spatially Varying Coefficients

Presenter: Chad Babcock

Author(s): Chad Babcock, Andrew O. Finley, and John B. Bradford

Many studies and production inventory systems have shown the utility of coupling covariates derived from Light Detection and Ranging (LiDAR) data with forest variables measured on geo-referenced inventory plots through regression models. The objectives of this study were to propose and assess the use of 1) a new technique for LiDAR variable extraction using Singular Value Decomposition to obtain uncorrelated covariates; and 2) a Bayesian hierarchical modeling framework that accommodates both residual spatial dependence and non-stationarity of model covariates through the introduction of spatial random effects. We explore these objectives using three forest inventory datasets that are part of the North American Carbon Program each comprising point-referenced measures of aboveground forest biomass and discrete LiDAR. For each dataset, we considered three LiDAR variable extraction methods and three regression model specifications. Models were assessed based on fit criteria and predictive performance using a leave-one-out cross-validation. Results showed that among the LiDAR variable extraction methods, no single set of covariates offered a consistent advantage across the datasets. The addition of spatial random effects to the regression model intercept only improved fit and predictive performance in the presence of substantial residual spatial dependence. Allowing all regression slope parameters to vary spatially, via the addition of spatial random effects, greatly improved model fit and predictive performance across all datasets. The proposed Bayesian modeling framework also provides access to pixel-level posterior predictive distributions that are useful for uncertainty assessment.

1:24 PM
Applying Inventory Methods to Estimate Aboveground Biomass from Satellite Light Detection and Ranging (LiDAR) Forest Height Data

Presenter: Sean Healey

Author(s): Sean P. Healey, Paul P. Patterson, Sassan Saatchi, Michael A. Lefsky, Andrew J. Lister, Elizabeth A. Freeman, and Gretchen G. Moisen

Light Detection and Ranging (LiDAR) returns from the spaceborne Geoscience Laser Altimeter (GLAS) sensor may offer an alternative to solely field-based forest biomass sampling. Such an approach would rely upon model-based inference, which can account for the uncertainty associated with using modeled, instead of field-collected, measurements. Model-based methods have been thoroughly described in the statistical literature, and an increasing number of model-based forestry applications use tactically acquired airborne LiDAR. Adapting these methods to GLAS’s irregular acquisition pattern requires a strategy for identifying a subset of GLAS “shots” that can be considered a simple random sample. We have developed a flexible method of dividing the landscape into equal-area polygons from which a GLAS shot can be chosen at random as a member of the sample. This process bears similarities to the approach used by the Forest Inventory and Analysis (FIA) Program as it moved toward its current hexagonal sample grid.

Although the ultimate application of this approach would be production of consistent biomass estimates across different countries, well-calibrated FIA estimates over the United States provide a convenient testing ground. Applied to California, this approach produced almost exactly the same estimate of biomass density (Mg/ha) as the FIA sample. The GLAS-based estimate had a considerably higher standard error than FIA’s estimate, but it comes at a much lower cost and is based upon globally available GLAS measurements.

1:48 PM
Three-Dimensional Modeling of Tree Canopies Using Terrestrial LiDAR and 3D Image-Based Reconstruction

Presenter: Jonathan Dandois

Author(s): Jonathan Dandois, Zhao Dan, Xu Guangcai, Yong Pang, Erin Ellis, and John Hom

This research aims to demonstrate accurate measurement of tree stem and canopy volume using state-of-the-art laser scanning and image–based computer vision (CV) 3D reconstruction. Terrestrial laser scanning (TLS) provides accurate measurements of tree structural traits for measuring stem diameter, stem location, and modeling canopy material in 3D, although at a substantial cost for equipment purchase (~$150K) or rental (~$5K/wk). CV offers a very low cost (~$500) alternative to laser scanning by enabling virtual reconstruction of forest sites from overlapping images taken with regular digital cameras, generating 3D–multispectral point clouds using automated algorithms. These approaches complement existing techniques by enabling the measurement of forest parameters that are difficult to obtain without destructive sampling. Such techniques will enable measurement of tree allometry and forest canopy structural traits without destructive sampling, offering a practical solution to evaluate urban forest canopy models in wildland/urban interface landscapes.

TLS scans are generated of individual pitch pines and at a stand level plot in the New Jersey pine barrens at a single time and of deciduous street trees in Baltimore, Maryland in winter and summer. Each tree is scanned from four orthogonal positions, and scans are merged to create a full 3D model of each tree. CV point clouds are made of deciduous trees based on photographs taken by an individual walking in a circle around the tree. TLS and CV point clouds are analyzed within a 3D voxel data environment to estimate stem and canopy volume. Estimates of stem and canopy volume of pitch pine trees are compared to destructive measurements of tree weight and existing allometric equations. Urban deciduous trees are not destructively sampled and instead CV 3D models of stem and canopy volume are compared to TLS as reference.
2:12 PM
The Utility of LiDAR for Large Area Forest Inventory Applications
Presenter: Nick Skowronski
Author(s): Nicholas S. Skowronski and Andrew J. Lister

Multi-resource inventory data are used in conjunction with Light Detection and Ranging (LiDAR) data from the Pennsylvania Department of Natural Resource’s PAMAP Program to assess the utility of extensive LiDAR acquisitions for large area forest assessments. Background, justification, and initial study designs are presented. The proposed study will involve three phases: 1) characterization of relationships between LiDAR cloud metrics and statistical summaries of tree information on forest inventory plots, 2) use of the inventory data to calibrate LiDAR-based forest biomass models, and 3) use of subsets of the LiDAR dataset as part of a ground-based forest inventory. Initial results of the first phase indicate moderate relationships between various combinations of ground inventory and LiDAR data.

2:36 PM
Advancements in LiDAR-Based Registration of FIA Field Plots
Presenter: Demetrios Gatziolis
Author(s): Demetrios Gatziolis

Meaningful and useful integration of National Forest Inventory field plot information with spectral imagery acquired from satellite or airborne platforms requires precise plot registration. Global Positioning System–based plot registration procedures, such as the one employed by the Forest Inventory and Analysis (FIA) Program, yield plot coordinates that, although adequate for the mandates of the Program, often contain substantial error. Conversely, the registration of Light Detection and Ranging (LiDAR) data is accurate and precise. Considering the proliferation of high–density LiDAR data availability, there is potential in using them to improve the registration of FIA plots present in scanned areas. Earlier attempts have not been particularly successful, mainly because they only relied on the relative location of mapped tree stems and local maxima in vegetation surfaces generated from the LiDAR data. In this approach, registration is achieved by examining, in a raster support, the weighted correlation between moving instances of two–dimensional representations of tree crowns modeled from the field plot tally and the corresponding, stationary representation of the LiDAR–derived vegetation surface. Correlation weights are adjusted dynamically to stand structure conditions. The approach is independent of plot shape, and it does accommodate FIA’s cluster plot configuration. Gains in computational efficiency are realized via parallelization. Results from central and eastern Oregon indicate that more than half of the investigated FIA plots located in stands with medium canopy cover or exhibiting spatially heterogeneous crowns or openings were registered with sub–meter precision.
Models for Estimating Carbon and Biomass

Moderated by Grant Domke

3:30 PM
Verification of the Jenkins and FIA Sapling Biomass Equations for Hardwood Species in Maine

Presenter: Andrew Nelson

In 2009, the Forest Inventory and Analysis Program (FIA) updated its biomass estimation protocols by switching to the component ratio method to estimate biomass of medium and large trees. Additionally, FIA switched from using regional equations to the current FIA aboveground biomass equations that predict woody sapling (2.5 to 12.4 cm d.b.h.) biomass using the Jenkins et al. (2003) equations (Forest Science 49 (1): 12-35) and then multiplying predictions by species-specific adjustment factors. The new equations have not been verified for saplings in eastern Maine. Results demonstrate the FIA sapling equations underestimated observed aboveground woody biomass by between 15 and 37 percent. Our results suggest that the amount of uncertainty as predictions from FVS are used by managers and researchers will continue to provide information for those attempting to quantify the intricate processes of forest C dynamics.

3:54 PM
Assessing the Uncertainty of Forest Carbon Estimates Using the FVS Family of Diameter Increment Equations

Presenter: Matthew Russell

Methods for estimating present and future carbon storage in trees and forests rely on measurements or estimates of tree volume or volume growth multiplied by specific gravity. Wood density can vary by tree ring and height in a tree. If data on density by tree ring could be obtained and linked to tree size and stand characteristics, it would be possible to more accurately predict changes in density and weight of tree biomass with projected changes in tree size and stand characteristics. Ring Profiler is a patented method for characterizing the structure of softwood tracheids and their changes from one tree ring to another over time. Measurements can be converted to density and can be multiplied by volume to estimate total weight and weight of carbon by ring. A sample displaying pith-to-bark ring structure is prepared from a radial core and scanned beneath a microscope as images are taken. Despite the sample’s thickness (up to 6mm) it is possible to image it with light transmitted from below using a single light-emitting diode (LED) for illumination. Near-infrared radiation (NIR) from the LED is captured by tracheid walls and travels efficiently to the viewing surface, much as light travels through an optical fiber. NIR captured by lumens tends to be absorbed by particulate matter introduced during sample preparation. The result is a high-contrast image in which tracheid walls are bright, lumens are dark and the interface is sharp. Images containing approximately 400 tracheids each are processed by ImageJ, public software available from the National Institutes of Health (NIH). Measurements include the distribution of radial and tangential diameters and wall thicknesses, from which local density can be estimated and applied to improved estimates of carbon storage. Over time, measurements from Ring Profiler can increase our understanding of tree response to stress.

4:18 PM
Ring Profiler: A New Method for Estimating Tree-Ring Density for Improved Estimates of Carbon Storage

Presenter: David Vahey

Methods for estimating present and future carbon storage in trees and forests rely on measurements or estimates of tree volume or volume growth multiplied by specific gravity. Wood density can vary by tree ring and height in a tree. If data on density by tree ring could be obtained and linked to tree size and stand characteristics, it would be possible to more accurately predict changes in density and weight of tree biomass with projected changes in tree size and stand characteristics. Ring Profiler is a patented method for characterizing the structure of softwood tracheids and their changes from one tree ring to another over time. Measurements can be converted to density and can be multiplied by volume to estimate total weight and weight of carbon by ring. A sample displaying pith-to-bark ring structure is prepared from a radial core and scanned beneath a microscope as images are taken. Despite the sample’s thickness (up to 6mm) it is possible to image it with light transmitted from below using a single light-emitting diode (LED) for illumination. Near-infrared radiation (NIR) from the LED is captured by tracheid walls and travels efficiently to the viewing surface, much as light travels through an optical fiber. NIR captured by lumens tends to be absorbed by particulate matter introduced during sample preparation. The result is a high-contrast image in which tracheid walls are bright, lumens are dark and the interface is sharp. Images containing approximately 400 tracheids each are processed by ImageJ, public software available from the National Institutes of Health (NIH). Measurements include the distribution of radial and tangential diameters and wall thicknesses, from which local density can be estimated and applied to improved estimates of carbon storage. Over time, measurements from Ring Profiler can increase our understanding of tree response to stress.

4:42 PM
Analysis of Tracheid Development in Suppressed-Growth Ponderosa Pine Using the FPL Ring Profiler

Presenter: Tim Scott

The Ring Profiler was developed to examine the cross-sectional morphology of wood tracheids in a 12.5 mm core sample. The instrument integrates a specially designed stage apparatus with an optical imaging system to obtain high-contrast, high-resolution images containing about 200-500 tracheids. These images are further enhanced and analyzed to extract tracheid cross-sectional properties such as shape, double-wall thickness, and lumen area. Subsequently, localized density can be calculated for specific regions of interest (e.g., earlywood and latewood), as it varies throughout the tree.

We showed that tracheid development in trees can be closely examined with the Ring Profiler. In particular, we showed that for the same core sample, recent periods of “suppressed” growth result in very narrow growth rings containing as few as 2-10 radial fibers/year (Fig. 1). In contrast, normal periods of growth may contain 20 or more radial fibers/year, resulting in dramatically different tracheid development (Fig. 2). This was observed in ponderosa pine (Pinus ponderosa Dougl. Ex Laws.) trees of various diameters harvested from an even-aged, high density stand in the Pringle Falls Experimental Forest near Bend, OR. For this study, sample disks were extracted from each tree at diameter at breast height (d.b.h.) and every 6 m up the tree. Radial strips (Fig. 3) were then prepared for examination by the Ring Profiler. The entire strip was scanned and image algorithms were applied to calculate tracheid cell wall area, relative proportion of earlywood and latewood, and local density in select growth rings. A calculation of yearly mass accumulation was made by assuming that the tree volumetric growth can be approxi-
mated by a sequence of concentric cones. Measures of stored carbon were then estimated based on the chemical composition of the wood.

5:06 PM  
Cumulative Volume and Mass Profiles for Dominant Stems and Whole Trees Tested for Northern Hardwoods  
Presenter: Neil Ver Planck  
Author(s): Neil R. Ver Planck and David W. MacFarlane

New models were presented to understand the relationship between the dominant stem and a whole tree using cumulative, whole-tree mass/volume profiles which are compatible with the current bole taper modeling paradigm. New models were developed from intensive, destructive sampling of 32 trees from a temperate hardwood forest in Michigan. The species in the sample were primarily American beech (*Fagus grandifolia* Ehrh.) and sugar maple (*Acer saccharum* Marsh.). The new profile models allowed for both mass and volume of both the dominant stem and branches to be estimated from ground level to the top of the tree. Nonlinear mixed effects models were used in the model development to account for the correlations among multiple measurements of an individual tree. Allometric scaling relationships between the dominant stem and branches can be directly derived from the new models and can be used to define sampling approaches to localize predictions of generalized whole-tree models via measurements of simple branch parameters.
Eastern Larch Beetle Using FIA Data

Tamarack in Minnesota: Investigating Mortality from Eastern Larch Beetle Using FIA Data

Susan J. Crocker, Jana Albers, Fraser R. McKee, Brian Aukena, and Greg C. Liknes

Prior to European settlement, tamarack dominated the bogs, peatlands, and uplands of Minnesota’s North Woods. Still a major component of Minnesota’s forests, the extent and volume of tamarack has since waned. Mortality of tamarack has increased over the past decade. The majority of this mortality has been attributed the activity of the eastern larch beetle (Dendroctonus simplex LeConte, Coleoptera, Scolytidae; ELB), a pest native to North America. Outbreaks of ELB have been documented in Minnesota since 1938. Largely separated by decades, the current outbreak of ELB has been ongoing since 2000. ELB frequently colonizes trees weakened by defoliators, however, within the current outbreak, it appears to be acting as the primary cause of mortality. While conditions that predispose stands to ELB attack are not well understood, physiological stress is often associated with infestation (Seybold et al. 2002). Factors related to the current outbreak are undetermined. However, drought, which has been a fixture in 9 of the past 10 years, could be playing an important role. Using data from the Forest Inventory Analysis program of the U.S. Forest Service, we analyzed trends in tamarack area and mortality over time. Additionally, tamarack mortality was aggregated by climate division to examine the relationship between mortality and drought. Future work will attempt to quantify the relative contribution of predisposing factors to tree mortality.

Agent-specific Tree Mortality Rates in the Eastern United States from FIA Data

Alan V. Di Vittorio and Jeffrey Q. Chambers

Forest tree mortality plays an important role in the global carbon budget through so-called “background” mortality rates and larger, less frequent mortality events. The actual mortality turnover rates of forest biomass are not well understood and can vary with forest type, stand characteristics, and environmental conditions. Different agents, such as fire, insects, disease, and weather, operate on different time scales with effects varying across different ecosystems. This variability makes it difficult, but important, to determine patterns of agent-specific mortality for model projections of forest carbon balance. However, many regional and global ecosystem models assume a single, nonfire mortality rate for all forests, which introduces bias to projections of forest carbon balance. Using the U.S. Forest Service Forest Inventory Analysis database (FIADB), we estimate annual average mortality rates, on a per-tree basis, for eastern U.S. forests between 2000 and 2010 (except for 1974-1984 Louisiana estimates). We present spatially explicit estimates of total mortality and of agent-specific mortality due to animals, disease, insects, fire, harvest, weather, vegetation, and unknown agent. These estimates include all trees greater than or equal to 1 inch in diameter in remeasured forest- or timberland plots, and exclude plots with annual average harvest rates greater than 3.5 percent. Estimated annual average mortality rates vary from 0.2 percent to 7.5 percent across the eastern United States. Removing fire and harvest effects limits this range to 0.2 percent to 4.9 percent. The unweighted regional average is 3.3 percent for total annual average mortality (30 states), and removing fire and harvest effects lowers this average to 2.4 percent. Unknown agents dominate the northern state estimates and vegetation encroachment dominates southern state estimates. Weather mortality estimates can be up to 98 percent, but are generally on the order of disease and fire estimates. These estimates indicate that uniform mortality rates in ecosystem models would be improved by spatially explicit values.

Trends in Standing Biomass in Interior West Forests: Revisiting Baseline Data from Periodic Inventories

Sara Goeking

Trends in U.S. forest biomass and carbon are assessed using Forest Inventory and Analysis (FIA) data relative to baseline assessments from the 1990s. The integrity of baseline data varies by state and depends largely on the comparability of periodic versus annual forest inventory data. In most states in the Interior West FIA region, the periodic inventory’s sample design, plot configuration, estimation procedures, and definitions were different from those for the annual inventory, which are nationally consistent. Direct comparisons of periodic versus annual inventory data are therefore tenuous and may reflect changing protocols rather than actual changes, yet they comprise the best available method of assessing recent trends in some states. This study attempts to clarify trends in aboveground tree biomass in the Interior West region by comparing estimates at matched plots that were sampled during both periodic and annual inventories. To illustrate the ramifications of ignoring changes in inventory protocols, mean trends at paired plots were compared to those demonstrated by unpaired comparisons of entire periodic and annual inventories. In some states, the results produced by the two methods are contradictory. This demonstrates the importance of reassessing the use of estimates based on periodic forest inventories as reference conditions.

Is Lodgepole Pine Mortality Due to Mountain Pine Beetle Linked to the North American Monsoon? Sara A. Goeking and Greg C. Liknes

Regional precipitation patterns may have influenced the spatial variability of tree mortality during the recent mountain pine beetle (Dendroctonus ponderosa) (MPB) outbreak in the western United States. Data from the Forest Inventory and Analysis (FIA) Program show that the outbreak was especially severe in the state of Colorado where over 10 million lodgepole pines (Pinus contorta Dougl. Ex Loud.) succumbed to MPB between 2002 and 2009. Aerial detection maps of MPB-related mortality show that the infestation was initially widespread and evenly distributed throughout the range of lodgepole pine in Colorado, but gradually became more severe in the northern portion of the state. Because southern Colorado receives relatively high summer precipitation due to the effects of the North American monsoon (NAM), the spatial pattern of MPB-related mortality suggests that infestation severity was lower in areas with the higher summer precipitation. This study investigated the link between lodgepole pine mortality
due to MPB and seasonal precipitation patterns associated with the NAM in Colorado. Data regarding insect-related tree mortality and damage data were summarized from FIA data collected between 2002 and 2009, and gridded precipitation data were acquired from the North American Regional Reanalysis Project. Results indicated that while absolute NAM-related precipitation was not an important predictor of infestation severity, the deviation of a five-year average of summer and fall precipitation relative to climatic means was important.

Detailed Maps of Tropical Forest Types are Within Reach: Forest Tree Communities for Trinidad and Tobago Mapped with Multiseason Landsat and Google Earth

Eileen H. Helmer, Thomas S. Ruzycki, Jay Benner, Shannon M. Vogessler, Barbara P. Scobie, Courtenay Park, David W. Fanning, and Seepersad Ramnarine

Tropical forest managers need detailed maps of forest types for REDD+, but spectral similarity among forest types, cloud and scan-line gaps, and scarce vegetation ground plots complicate producing such maps from satellite imagery. How can these challenges be overcome? We describe a case study of mapping tropical forests to floristic classes for Trinidad and Tobago with gap-filled Landsat imagery by judicious combination of field and remote sensing work (Helmer et al. 2012). Recent and forthcoming developments are making such mapping with Landsat imagery far more accessible to nonspecialists. We highlight some key steps to mapping tropical forest habitats with cloudy Landsat and related insights from this study.

In the study area, class characteristics like “deciduousness” allowed discrimination of floristic classes. We also discovered that the extensive training data needed for mapping tropical forest types with “noisy” gap-filled imagery can be collected by learning to identify tree communities in 1) imagery with fine spatial resolution of ≤1 m; 2) multiseason fine resolution imagery (usually only viewable on Google Earth™); or 3) Landsat imagery from different dates, particularly imagery from drought years, even if decades old. Further, we show that gap-filled, synthetic multi-season Landsat imagery significantly improves class-level accuracy for several seasonal forest associations (by 14 to 21 percent for deciduous, 7 to 36 percent for semi-evergreen, and 3 to 11 percent for seasonal evergreen associations, and by 5 to 8 percent for secondary forest and woody agriculture). Moreover, in some cases the seasonal spectral patterns in multiseason Landsat imagery have much more spatial detail than available ancillary maps of environmental variables, making them more useful when mapping tropical forest tree communities with Landsat. These detailed mapping efforts can lead to new views of tropical forest landscapes. Here we learned that the xerophytic rain forest of Tobago is closely associated with ultramafic geology, helping to explain its unique physiognomy.

Preliminary Estimates of Whole Tree Biomass of Pitch Pine (Pinus rigida) with 3D Terrestrial Laser Scanning

John Hom, Jonathan Dandois, Pasi Raumanen, Mikko Kaasalainen, Ansii Krooks, Dan Zhao, Matthew Patterson, Guangcai Xu, Kenneth Clark, Nicholas Skowronske, and Michael Gallagher

As part of an international collaboration, six single Pinus rigida trees and small plots with multiple stems were scanned with the help of the Chinese Academy of Forestry and University of Maryland, Baltimore County scientists using a Riegl VZ400 Terrestrial Laser Scanner (TLS) in urban and rural locations. Additional TLS point cloud data was recently obtained with a FARO 3D 120 on single and multiple trees in the New Jersey Pine Barrens. Advanced algorithms have been developed by Finnish modelers which allows for reconstructing single tree architecture from TLS point clouds (but not yet for multiple stems), to calculate the volume of woody stems. This 3D method gives locations, lengths, and widths/taper functions of branches in addition to the main stem. Biomass can be calculated using species-specific wood density. In order to validate the algorithms developed by our Finnish collaborators, we are using data from whole tree harvesting and obtaining biomass by 1 m bin heights as part of an ongoing Forest Service study funded by the Joint Fire Science Program. We will present preliminary estimates of single whole tree biomass using 3D TLS volume estimates, in comparison with traditional allometric equations (Whittaker and Woodwell, 1968) and with the current whole tree harvesting. The use of 3D terrestrial scanning laser for estimating biomass supports our current research in tree and canopy structure, fire and fuels, characterizing urban and rural tree carbon sequestration, and forest health monitoring in disturbed systems.

Dots and Plots

Dennis M. Jacobs and Joseph M. McCollum

Fixed-radius circles provide fixed-area plots for sampling. An array of dots within circles provides secondary sampling points within fixed-area plot circles. The hexagonal grid offers an elegant equidistant array of points that will deliver a balanced association between the circular area and number of points. A chosen target is 100 points within the circular plot and no less than 100, to approximate the mental process that one dot is about 1 percent. Equidistant integer spacing provides a minimal 109 hexagonal points with one dot on the plot center, but the visual weight is not well balanced along the circle perimeter. However, the centers of 102 hexagons can be strategically placed inside the circle by using the inscribed and circumscribed radii of hexagons, and will provide equal weighting between the dot spacing and each dot’s representative area. Dividing the area of the circle by 102 gives the area of each small hexagon. We can then determine the non-integer spacing for the equidistant dot grid, which has no point at the center of the circular area, but with the first ring of three dots balanced around the plot center placed upon the vertex of the three central hexagons. By the use of Cartesian coordinates and the Pythagorean Theorem, we present the numerical balance of the points bounding the circle perimeter. Solutions of 104 and 100 dots may be obtained by balancing upon the bisector of two hexagon centers.

Balancing Utility, Sample Size, and Costs for Broad-Scale Forest Health Monitoring: A Proposed “Phase 2-plus” Design for NRS-FIA

William H. McWilliams, Randall Morin, Keith W. Moser, Charles H. Perry, James Westfall, Christopher W. Woodall

The original seven forest health indicators adopted in 2000 by the US Forest Service, Forest Inventory and Analysis (FIA) program were soils, vegetation composition and structure, tree crowns, tree damage, down woody material, ozone damage, and lichens. The Northern Research Station FIA (NRS-FIA) ceased collection of these “Phase 3” (P3) indicators in 2011 for budgetary reasons and to consider options. A revamped design for the 2012 field season now includes revisions to existing indicators and a tree seedling survey. The ozone and lichen data are no longer collected. This new suite of indicators is referred to as Phase 2-plus (P2-plus) because the sampling intensity will be up to 1/24,000 acres, which is between 1/96,000 acres for P3 samples and 1/6,000 for standard P2 samples. This intensity is based on the maximum number of plots that can be measured during the leaf-on summer window. The advantage of increasing overall sample size is offset somewhat by loss of specific species information in the vegetation survey. This paper provides an overview of the revised sampling scheme with further discussion of balancing advantages and disadvantages with the costs and utility of the information.
Progression of the Inventory and Monitoring of Nonforest Lands with Trees

Dacia M. Meneguzzo, Greg C. Liknes, and Charles H. (Hobie) Perry

Since its inception more than 80 years ago, the Forest Inventory and Analysis (FIA) Program has evolved from a timber-based inventory to an enhanced inventory that includes all forest land. However, FIA’s definition of forest land requires areas of tree cover to be 120 feet wide and 1 acre in size. As a result, small scattered patches and linear plantings of trees are excluded from the inventory yet they are of ecological and economic importance. In the Great Plains region, it is these types of nonforest lands with trees that make up much of the total tree cover. In Nebraska, for example, past inventory reports have contained information only about the extent of nonforest tree cover but it has not been included consistently and explicit spatial information is lacking. Moving to an all-tree inventory would be ideal but ground-based data collection is cost prohibitive. Advances in remote sensing offer a promising solution to this problem. Our poster presents a timeline of past methodologies and area estimates of nonforest lands with trees as well as a new methodology for an image-based inventory of all tree cover using freely available, digital aerial photography from the National Agriculture Imagery Program (NAIP). Furthermore, the repeat availability of NAIP imagery will make it possible to continuously monitor tree cover in the Great Plains.

Forest Atlas of the United States

Charles H. Perry, Linda R. Smith, Mary A. Carr, Randy Vreeke, and others

The United States has a tremendous forest resource—more than 750 million acres of native and planted forests managed by public and private landowners for forest products, recreation, wilderness, wildlife habitat, and many other purposes. Over the past 150 years, basic surveys of United States forests have evolved into a rigorous inventory program that is used to share information about the value of these forests and the challenges that confront them. More recent technological and methodological advancements make it possible to create spatial products (maps) from the inventory data and other spatial data, such as digital elevation models and satellite imagery. The Forest Atlas of the United States uses these maps to highlight the value of our nation’s forest in a graphic and novel manner. In the Forest Atlas of the United States, we explore these questions and many more: Where do forests grow? What else lives in forests? What shapes forests? What benefits do forests provide? What is in the future for our forests? This project represents a strategic partnership between several parts of the Forest Service, integrating FIA inventory data with remote sensing and GIS applications. Our poster provides a sample of the content that will be included in the forthcoming atlas and highlight the use of maps, graphics, accessible text, and images to communicate forest monitoring information with the public.

Assessing Changes in Vegetation Composition and Structure: What Can We Learn from 500 Plots?

Bethany K. Schultz and W. Keith Moser

Using remeasurement data from more than 500 plots measured by the Northern Research Station’s Forest Inventory and Analysis Program, we assess changes in vegetation indicator estimates, including species richness, vegetation composition, and structure. We highlight changes in the frequency of introduced species at the plot, subplot, and quadrat levels. Most introduced species are increasing in constancy, with a few exceptions.

Logging Residue Utilization in the State of Idaho 2008 and 2011

Eric A. Simmons, Erik C. Berg, Todd A. Morgan, Charles B. Gale, Stanley J. Zarnoch, and Steven W. Hayes

The purpose of this study was to respond to land managers’ need for better information on growing-stock removals, utilization of trees, and logging residues as a result of harvesting timber.

A two-stage sampling design was used to select felled trees for measurement within active Idaho logging sites in 2008 and 2011. Fifty percent of the harvested trees were ≤12 inches diameter at breast height (d.b.h.) and accounted for 18 percent of the total growing-stock volume removed and 19 percent of the mill-delivered (utilized) volume. Trees in this range produced 20 percent of the logging residue. About 49 percent of the harvested trees were between 12.1 and 27 inches d.b.h. and accounted for 80 percent of the total growing-stock volume removed and 80 percent of the mill-delivered volume. Trees in this range produced 78 percent of the logging residue. Removal factors quantifying impacts on growing stock revealed that harvesting efforts removed 1,011 cubic feet of timber volume from growing stock for every thousand cubic feet delivered to the mill, with just 24 cubic feet left in the forest as logging residue.

Weight estimates in green tons for the tops and limbs were added to the bole residues to obtain a total tree residue factor to be used as a biomass estimation tool. This tool can provide forest planners and managers the ability to predict potential feasibility of utilizing residues, and to gauge the impact on air quality or fire behavior if the residues burned.

Mining Historical FIA Reports to Develop Estimates of Forest Land through Time in the North Central Region of the United States

Paul A. Sowers

The Forest Inventory and Analysis (FIA) Program began collecting inventory data in the early 1930s. While contemporary data (from approximately the last decade) is actively managed in a relational database system and readily accessible with a variety of software tools, older data was previously available only in printed reports for many parts of the United States. For 11 states in the North Central United States, printed reports spanning the 1940s to the 1980s were scanned and made available on demand as a series of CD-ROMs. These scanned reports have now been manually converted to data files and assembled as county-level, GIS compatible datasets.

Data from the first annual FIA inventory were acquired using FIA’s online EVALIDator tool and combined with the historical data. A series of county-level choropleth maps are presented showing forest land area change across the 11 state region. The maps are portrayed in a matrix depicting the pairwise changes across the different inventory combinations.

The Effect of Fuzzed Plot Coordinates on the Distribution of Soil Parent Material, Climate, and Topographic Variables: A Case Study in the Inland Northwest

Roberto Volfovicz-Leon, Mark Kinsey, and Mark Coleman

Tree and stand level plot data is usually merged with a geospatial representation of climate, topography, and soils to define site productivity and model forest growth. The geographic locations of the publically available plots from the US Forest Service, Forest Inventory and Analysis (FIA) program are “fuzzed” by FIA to a position typically within 1.6 km of the actual location to protect the integrity of the plot. We investigated the influence this manipulation has on population estimates and the distributions of soil parent material, topographic, and climate variables using data from Idaho as an example. This study utilized 1,671 paired fuzzed/un-fuzzed FIA plots containing 47,919 individual trees representing 14 species. Twenty-two variables associated with climate, topography, and soil parent material
were merged with the stand data. Paired-t tests showed that there was no significant difference between the means of fuzzed and un-fuzzed data for all climate and topography variables (p-values > 0.30). Coefficients of variation of the mean differences ranged from 93% to 446%. Aspect (%) and Slope (%) showed the lowest correlation between fuzzed and un-fuzzed data (Pearson R coefficients were 0.21 [p-value < 0.001] and 0.51 [p-value < 0.001], respectively). All other variables showed correlation coefficients larger than 0.95. Fuzzing caused 18% of the plots being assigned to an erroneous soil parent material. Multidimensional species self-thinning models that included soil parent material, climate, and topographic variables as covariates were fitted to both fuzzed and un-fuzzed data. No significant differences in the parameter estimates and the predicted values of max SDI were observed between the datasets. Fuzzed plot coordinates appeared to have a greater impact on categorical variables (soil parent material) and continuous topographic related variables (aspect and slope).

Comparison of FIA Plot Data Derived from Image Pixels and Image Objects
Charles E. Werstak, Jr.

The use of Forest Inventory and Analysis (FIA) plot data for producing continuous and thematic maps of forest attributes (e.g., forest type, canopy cover, volume, and biomass) at the national level from remote sensing data can be challenging due to differences in scale. Specifically, classification errors that may result from assumptions made between what the field data represent and what the corresponding spectral information of the image pixels depict. This investigation aimed at determining whether image objects derived from Landsat TM imagery can be used as an alternative to a 3 by 3 neighborhood of pixels for characterizing forest data. Results showed strong positive correlations between the different scales of base map units across all of the image derivatives. Further examination of the data using the Wilcoxon signed rank test for paired samples indicated that in most cases, finer level image objects were a better representation of the 3 by 3 neighborhood of pixels than coarser ones and some image derivatives performed better than others. The same tests were applied to a subset of plots dominated by quaking aspen (Populus tremuloides Michx.) with similar results.

Information gained may provide further insight into object based segmentation and classification methods using FIA plot data, satellite imagery, and ancillary geospatial data.

Mapping Aspen in the Interior West
Charles E. Werstak, Jr.

Quaking aspen (Populus tremuloides Michx.) is a critical species that supports wildlife and livestock, watershed function, the forest products industry, landscape diversity, and recreation opportunities in the Interior West (Bartos and Campbell 1998). Studies have indicated that changes in fire regimes, an increase in herbivore presence in young aspen stands, and recent drought episodes have been the main factors for increased mortality rates in aspen stands (Deblander et al. 2010). Forest Inventory and Analysis (FIA) plot data are a consistent source of ground-based information that if used appropriately, can be extremely valuable for mapping and modeling forest attributes such as forest type and canopy cover. GEO-object based image analysis, or GEOBIA, is a relatively new subdiscipline of geographic information systems (GIS) focused on developing automated techniques for partitioning remotely sensed imagery into image objects and accessing them for use in a variety of mapping applications (Hay and Castilla 2008). Spatial data mining is an automatic or semiautomatic exploration to identify patterns in data that have a geographic component (Shekhar et al. 2005). Random ForestsTM is an ensemble classifier that uses multiple decision trees to predict target variables from input variables (Breiman and Cutler 2003). To help understand the current status and extent of quaking aspen across the Interior West, efficient and repeatable mapping and modeling techniques need to be further established. This investigation aims at exploring viable methods for creating canopy cover maps of quaking aspen for several different locations across Utah. FIA plot data for inventory years 2000-2009 that correspond to image objects derived from Landsat TM imagery will be analyzed along with other ancillary geospatial data using spatial data mining and Random ForestsTM. Information gained from this investigation may provide further insight into object based segmentation and classification techniques using FIA plot data, satellite imagery, and ancillary geospatial data.

Sustainability of Oaks in West Virginia
Richard H. Widmann

There is growing concern for the sustainability of the oak resource in West Virginia. A look at the U.S. Forest Service’s Forest Inventory and Analysis data over the 12 million acres of timberland in West Virginia shows that oak volume has continued to increase, but all of this increase has been due to growth on large-diameter trees. High mortality in the lower diameter classes and low recruitment has resulted in oaks being underrepresented in the lower diameter class. Oak species now represent 46 percent of trees more than 20 inches in diameter, but only 7 percent of the trees less than 9.0 inches in diameter. In 2- and 4-inch diameter classes, oaks represent 5 and 6 percent of trees in these classes, respectively. Because of this disparity, volumes of oak will likely decrease across the State as large trees are harvested or die and recruitment into large-diameter classes decreases. Loss of this keystone species will affect wildlife populations and wood-using industries that now depend on oak.

Biomass and Carbon Attributes of Down Woody Materials Across Forests of the United States
Christopher W. Woodall, Brian J. Walters, Grant M. Domke, Christopher Toney, Andrew Gray, Sonja N. Oswalt, and James E. Smith

In past decades, down woody material (DWM) has emerged as central to wildlife habitat, a controlling factor of forest nutrient cycles, facilitator of tree regeneration, a carbon store, and fire hazard. Using the first ever national empirical inventory of DWM across forests of the United States, the biomass and carbon attributes of DWM were assessed. Results indicated that DWM are ubiquitous in forests; however, they are only found in large amounts in certain specific ecosystems subject to unique climatic or disturbance attributes (e.g., slow decay or recent tree mortality). It is suggested that the national empirical inventory of DWM carbon stocks replace the simulated stocks used in past national greenhouse gas inventories.

Framework for Assessing Climate Change Risks to Forest Carbon Stocks
Christopher W. Woodall, Grant M. Domke, Karin L. Riley, Christopher M. Oswalt, Susan J. Crocker, and Gary W. Yohe

Efforts to negotiate the role of forest carbon stocks in global efforts to mitigate potential climate change effects has highlighted the need to quantify risks to forest carbon stocks such as massive disturbance events. As risk may be conceptualized around the magnitude of an event and its associated probability, this study examined potential changes to forest carbon stocks following major disturbance (e.g., hurricane) and proposed a framework for assessing the probability of climate change risks to these stocks. Results suggest that a valid framework for conceptualizing risk may be centered on the various forest carbon pools (e.g., forest floor and belowground), the variability of the associated stocks across large scales, and the magnitude of the stocks themselves. Furthermore, given the diversity of the forest pools involved, the nature of massive disturbances themselves (e.g., insects versus wildfires) can have divergent effects of forest carbon stocks resulting in major research unknowns.
Does Standing Water or Snow Packs Bias Measurements of Tree Regeneration Within Large-Scale Forest Inventories?

Christopher W. Woodall, James A. Westfall, Brian J. Walters, Daniel J. Johnson, and Kai Zhu

A critical component of large-scale assessments of forest ecosystem sustainability and function is that of tree regeneration. As forest inventory measurements may occur year round at high latitudes, winter snow banks and subsequent spring floods may impede measurement of tree seedlings (<1 inch diameter at breast height [d.b.h.]), especially at high latitudes/elevations. Using FIA’s measurements of seedlings across eastern states, potential biases of tree seedling measurements as affected by snow depth and water obstruction was assessed. It was found that there is a general trend of a decrease in average annual seedling density across time as stand density increases across the eastern United States—a trend that is potentially exacerbated within plots where there is substantial snow/water obstruction (>10 cm) to seedling measurement. Assessments of seedling surveys should not be biased if a sufficient temporal and spatial scales are used relying on the unbiased spatial and temporal allocation of field plot measurement to eliminate potential bias. However, seedling assessments may be biased if they occur at the plot-level with snow/water present on the plot with the greatest potential bias found on plots with no obstruction at time one but with substantial snow/water obstructions at time two.

Rates of Coarse Woody Debris Biomass Loss and Carbon Debt Implications in Eastern U.S. Forests

Christopher W. Woodall, Matthew B. Russell, Anthony W. D’Amato, Shawn Fraver, and Brian F. Walters

Emerging questions from bioenergy policy debates have highlighted knowledge gaps regarding the carbon and biomass dynamics of individual pieces of coarse woody debris (CWD) across the diverse forest ecosystems of the United States. Using a subset of CWD pieces remeasured across eastern U.S. forests, the rate of biomass loss was estimated over time using decay class transition models coupled with volume and wood density loss trajectories. Results indicate that biomass loss is related to the genera of the species considered, its size, and location within the broad climatic regions of the eastern United States. This biomass loss may be broadly summarized as CWD “half-life’s” across the eastern U.S. FIA’s inventory of CWD may provide carbon debt policy discussions with objective assessments of CWD biomass/carbon loss.
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<td>540-231-3611</td>
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<td></td>
<td>Fort Collins, CO</td>
<td>970-218-5907</td>
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<tr>
<td>Name</td>
<td>Institution</td>
<td>Address</td>
<td>Email</td>
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NOTES
Baltimore Information

Visit Baltimore:
http://baltimore.org/

Baltimore Attractions
http://baltimore.org/attractions/

Frommer’s Baltimore Attractions

Frommer’s Interactive Map of Baltimore

Trip Advisor: Things To Do In Baltimore
http://www.tripadvisor.com/Attractions-g60811-Activities-Baltimore_Maryland.html
## Restaurants

**Within Walking Distance From Hotel**

<table>
<thead>
<tr>
<th>Restaurant</th>
<th>Cuisine</th>
<th>Phone</th>
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<tbody>
<tr>
<td>Blue Agave</td>
<td>Mexican</td>
<td>410.576.3938</td>
</tr>
<tr>
<td>Capital Grill</td>
<td>American</td>
<td>443.752.3810</td>
</tr>
<tr>
<td>Edo Sushi</td>
<td>Asian</td>
<td>410.843.9804</td>
</tr>
<tr>
<td>Fogo de Chao</td>
<td>Steak</td>
<td>410.528.9292</td>
</tr>
<tr>
<td>Kona Grill</td>
<td>Seafood</td>
<td>410.244.8994</td>
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<tr>
<td>La Scala</td>
<td>Italian</td>
<td>410.783.9209</td>
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<td>La Tasca</td>
<td>Spanish</td>
<td>410.209.2563</td>
</tr>
<tr>
<td>La Tavola</td>
<td>Italian</td>
<td>410.685.1859</td>
</tr>
<tr>
<td>M &amp; S Grill</td>
<td>American</td>
<td>410.547.9333</td>
</tr>
<tr>
<td>McCormick &amp; Schmick's</td>
<td>Seafood</td>
<td>410.234.1800</td>
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</table>

### Pickup Service & Per Diem Menus

- **Amici's (Per Diem Menu Only)**
  - *Italian*
  - 231 S. High Street
  - 410.528.1096

### Short Taxi Ride From Hotel

- **Adela**
  - Tapas
  - 814 S. Broadway
  - 410.534.6262

- **Ambassador**
  - *Indian*
  - 3811 Canterbury Road
  - 410.366.1484

- **Annabel Lee**
  - *American*
  - 601 S. Clinton Street
  - 410.522.2929

- **Arcos**
  - *Mexican*
  - 129 S. Broadway
  - 410.522.4777

- **Bertha's Mussels**
  - *Seafood*
  - 734 S. Broadway
  - 410.522.0033

- **Brewer's Art**
  - *Western European*
  - 1106 N. Charles Street
  - 410.547.6925

- **Charleston**
  - *American*
  - 1000 Lancaster Street
  - 410.332.7373

### $$$ - expensive

- **Ding How**
  - *Asian*
  - 631 S. Broadway
  - 410.327.8888

- **Fleming's**
  - *Steak*
  - 720 Aliceanna Street
  - 410.332.1666

- **Hard Rock Cafe Baltimore**
  - $$$

- **Helmand**
  - *Afghan*
  - 806 N. Charles Street
  - 410.752.0311

- **John Stevens LTD**
  - *Seafood*
  - 1800 Thames Street
  - 410.327.5561

- **Kali's Court**
  - $$$

- **Kali's Cut**
  - *Seafood*
  - 1606 Thames Street
  - 410.276.5480

### $$ - moderate

- **M & S Grill**
  - *American*
  - 201 E. Pratt Street
  - 410.547.9333

- **Miguel's**
  - *Tapas*
  - 1700 Beason Street
  - 443.438.3139

- **Minato**
  - *Asian*
  - 1013 N. Charles Street
  - 410.332.0332

- **Pazo**
  - *Tapas*
  - 1425 Aliceanna Street
  - 410.534.7171

- **The Prime Rib**
  - $$$

- **Ruff Texas Barbeque**
  - *American*
  - 1843 Light Street
  - 410.244.5667

- **Salt**
  - *American*
  - 2177 E. Pratt Street
  - 410.276.5480

- **Tio Pepe**
  - *Spanish*
  - 10 E. Franklin Street
  - 410.539.4675

### $ - reasonable

- **Amici's**
  - *Italian*
  - 231 S. High Street
  - 410.962.5503

- **Brewer's Art**
  - *Western European*
  - 1106 N. Charles Street
  - 410.547.6925

- **Charleston**
  - *American*
  - 1000 Lancaster Street
  - 410.332.7373

- **Mezze**
  - *Tapas*
  - 1606 Thames Street
  - 410.563.7600

- **Matsuri**
  - *Asian*
  - 720 Aliceanna Street
  - 410.327.5561

- **Rocco's Capriccio**
  - *Italian*
  - 846 Fawn Street
  - 410.685.2710

- **Roy's**
  - *Asian*
  - 720 Aliceanna Street
  - 410.685.1859

### $ - inexpensive

- **Adela**
  - Tapas
  - 814 S. Broadway
  - 410.534.6262

- **Ambassador**
  - *Indian*
  - 3811 Canterbury Road
  - 410.366.1484

- **Annabel Lee**
  - *American*
  - 601 S. Clinton Street
  - 410.522.2929

- **Arcos**
  - *Mexican*
  - 129 S. Broadway
  - 410.522.4777

- **Bertha's Mussels**
  - *Seafood*
  - 734 S. Broadway
  - 410.522.0033

- **Brewer's Art**
  - *Western European*
  - 1106 N. Charles Street
  - 410.547.6925

- **Charleston**
  - *American*
  - 1000 Lancaster Street
  - 410.332.7373

- **Mezze**
  - *Tapas*
  - 1606 Thames Street
  - 410.563.7600

- **Matsuri**
  - *Asian*
  - 720 Aliceanna Street
  - 410.327.5561

- **Rocco's Capriccio**
  - *Italian*
  - 846 Fawn Street
  - 410.685.2710

- **Roy's**
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  - 410.685.1859

- **Salt**
  - *American*
  - 2177 E. Pratt Street
  - 410.276.5480

- **Tio Pepe**
  - *Spanish*
  - 10 E. Franklin Street
  - 410.539.4675
### Books / Cafes

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Within Walking Distance From Hotel</strong></td>
<td></td>
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</tr>
<tr>
<td><strong>Barnes &amp; Noble - The Power Plant</strong></td>
<td>601 E. Pratt Street</td>
<td>410.385.1709</td>
<td><a href="http://www.barnesandnoble.com">www.barnesandnoble.com</a></td>
</tr>
<tr>
<td><strong>Short Taxi Ride From Hotel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Au Bon Pain Cafe / Bakery</strong></td>
<td>1 South Street</td>
<td>410.837.9814</td>
<td><a href="http://www.aubonpain.com">www.aubonpain.com</a></td>
</tr>
<tr>
<td><strong>Java Joe’s Bistro</strong></td>
<td>8 E. Baltimore Street</td>
<td>410.727.8647</td>
<td>/www.javajoesbaltimore.com/</td>
</tr>
<tr>
<td><strong>Koffee Therapy Cafe</strong></td>
<td>6 E. Franklin Street</td>
<td>877.764.5241</td>
<td><a href="http://www.koffeetherapy.com/">www.koffeetherapy.com/</a></td>
</tr>
<tr>
<td><strong>Red Emma’s Bookstore Coffeehouse</strong></td>
<td>800 St. Paul Street</td>
<td>410.230.0450</td>
<td><a href="http://www.redemmas.org">www.redemmas.org</a></td>
</tr>
<tr>
<td><strong>Walters Art Museum</strong></td>
<td>600 N. Charles Street</td>
<td>410.547.9000</td>
<td><a href="http://www.thewalters.org">www.thewalters.org</a></td>
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</table>

### Attractions

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Within Walking Distance From Hotel</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Geppi’s Entertainment Museum</strong></td>
<td>301 W. Camden Street</td>
<td>410.625.7060</td>
<td><a href="http://www.geppismuseum.com">www.geppismuseum.com</a></td>
</tr>
<tr>
<td><strong>Maryland Science Center</strong></td>
<td>601 Light Street</td>
<td>410.685.2370</td>
<td><a href="http://www.mdsci.org">www.mdsci.org</a></td>
</tr>
<tr>
<td><strong>National Aquarium in Baltimore</strong></td>
<td>501 E. Pratt Street</td>
<td>410.576.3800</td>
<td><a href="http://www.aqua.org">www.aqua.org</a></td>
</tr>
<tr>
<td><strong>Short Taxi Ride From Hotel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>American Visionary Art Museum</strong></td>
<td>800 Key Hwy</td>
<td>410.244.1900</td>
<td><a href="http://www.avam.org">www.avam.org</a></td>
</tr>
<tr>
<td><strong>Babe Ruth Birthplace Museum</strong></td>
<td>216 Emory Street</td>
<td>410.727.1539</td>
<td>baberuthmuseum.org</td>
</tr>
<tr>
<td><strong>Baltimore &amp; Ohio Railroad Museum</strong></td>
<td>901 West Pratt Street</td>
<td>410.752.2490</td>
<td><a href="http://www.borail.org">www.borail.org</a></td>
</tr>
<tr>
<td><strong>Camden Yards / Oriole Park</strong></td>
<td>333 West Camden Street</td>
<td>888.848.BIRD (2473)</td>
<td>baltimore.orioles.mlb.com</td>
</tr>
<tr>
<td><strong>Harbor Place</strong></td>
<td>200 East Pratt Street</td>
<td>410.332.4191</td>
<td><a href="http://www.harborplace.com">www.harborplace.com</a></td>
</tr>
<tr>
<td><strong>Lexington Market</strong></td>
<td>400 W. Lexington Street</td>
<td>410.685.6169</td>
<td><a href="http://www.lexingtonmarket.com">www.lexingtonmarket.com</a></td>
</tr>
</tbody>
</table>

### Conveniences

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone</th>
<th>Website</th>
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</thead>
<tbody>
<tr>
<td><strong>CVS Pharmacy</strong></td>
<td>31 Light Street</td>
<td>410.685.4843</td>
<td><a href="http://www.cvs.com">www.cvs.com</a></td>
</tr>
</tbody>
</table>

### Taxi / Shuttles

<table>
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<tr>
<th>Name</th>
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<th>Phone</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Apollo Transportation</strong></td>
<td>131 E. Redwood Street</td>
<td>410.929.5466</td>
<td><a href="http://www.apollosedan.com/">www.apollosedan.com/</a></td>
</tr>
<tr>
<td><strong>Yellow Cab</strong></td>
<td>2100 Huntingdon Avenue</td>
<td>410.685.1212</td>
<td><a href="http://www.yellowcabofbaltimore.com/">www.yellowcabofbaltimore.com/</a></td>
</tr>
</tbody>
</table>
## 2012 FIA Science Symposium – Agenda Overview & Room Maps

### Mon., December 3
- **Area:** Ballroom Hallway
- **Time:** ALL DAY
- **Activity:** All Day Poster Exhibit

### Tuesday, December 4
- **Area:** Ballroom Hallway
- **Time:** 7-8 AM
  - **Activity:** Registration (7:30-8 AM)
- **Time:** 8-9:30 AM
  - **Activity:** Welcome / Intros - Plenary Session 1
- **Time:** 9:30-10 AM
  - **Activity:** Welcome / Announce - Plenary Session 2
- **Time:** 10-12 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit
- **Time:** 12-1 PM
  - **Activity:** LUNCH
- **Time:** 1-3 PM
  - **Activity:** The North American Forest Dynamics Research Project, Establishing Baselines and Projecting Trends
- **Time:** 3:30-5:30 PM
  - **Activity:** Alternative Estimation Techniques for FIA Data
- **Time:** 6-8 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit

### Wednesday, December 5
- **Area:** Atrium
- **Time:** 7-8 AM
  - **Activity:** Registration (7:30-8 AM)
- **Time:** 8-9:30 AM
  - **Activity:** Welcome / Intros - Plenary Session 1
- **Time:** 9:30-10 AM
  - **Activity:** Welcome / Announce - Plenary Session 2
- **Time:** 10-12 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit
- **Time:** 12-1 PM
  - **Activity:** LUNCH
- **Time:** 1-3 PM
  - **Activity:** The North American Forest Dynamics Research Project, Establishing Baselines and Projecting Trends
- **Time:** 3:30-5:30 PM
  - **Activity:** Alternative Estimation Techniques for FIA Data
- **Time:** 6-8 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit

### Thursday, December 6
- **Area:** Atrium
- **Time:** 7-8 AM
  - **Activity:** Registration (7:30-8 AM)
- **Time:** 8-9:30 AM
  - **Activity:** Welcome / Intros - Plenary Session 1
- **Time:** 9:30-10 AM
  - **Activity:** Welcome / Announce - Plenary Session 2
- **Time:** 10-12 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit
- **Time:** 12-1 PM
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- **Time:** 1-3 PM
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- **Time:** 3:30-5:30 PM
  - **Activity:** Alternative Estimation Techniques for FIA Data
- **Time:** 6-8 PM
  - **Activity:** Social / Mixer / Poster Setup / Poster Exhibit

### Hyatt Regency Maps

1. **15th Floor**
   - **Room:** Pisces (15th floor)
   - **Activity:** Social / Mixer

2. **2nd Floor**
   - **Room:** Atrium Lobby
   - **Activity:** FIDO/FIA Tools Training Session

---

**ELEVATORS**

- **M W**
- **PISCES ROOM**

**Freight Elevator**

**UP Escalator**

**DOWN Escalator**

**Coatroom Service**

**Office**

**Storage**

**MEN**

**WOMEN**

**Drinking Fountain**

**Stair DOWN**

**Stair UP**

**Frederick**

**Columbia**

**Annapolis**

**Baltimore**

**MARYLAND SUITE – SECOND FLOOR**

**HARBORVIEW ROOM**

**KOSHER KITCHEN**

**FOYER**

**ATRIUM LOBBY**

**Coffee Bar**

**CONSTELLATION BALLROOM**

**Mon., December 3**

- Time: 7-8 AM
  - Activity: Reg. / Pres. File Drop Off / Poster Setup

**Tuesday, December 4**

- Time: 10-12 PM
  - Activity: Forest Products Industry Status and Trends…

**Wednesday, December 5**

- Time: 10-12 PM
  - Activity: Social Dimensions of Forest Inventory

**Thursday, December 6**

- Time: 10-12 PM
  - Activity: Methods for Measuring and Assessing Landscape Change