# THE FOURTH FOREST VEGETATION SIMULATOR CONFERENCE

Fort Collins, CO

April 17th- 19th, 2012

All presentations will be held at the Fort Collins Hilton Hotel located at:

425 W. Prospect Road
970-482-2626
www.fortcollins.hilton.com

The Tuesday evening dinner and poster session will be held at the Fort Collins Brewery located at:

1020 E. Lincoln Ave
970-472-1499
http://www.fortcollinsbrewery.com/

All workshops will be held at the Natural Resource Research Center located at:

2150 E. Centre Ave, Building A
970-295-5020
http://www.fort.usgs.gov/about/nrrc.asp

The FVS Conference Committee:

Judy Adams, Tim Bottomley, Dave Cawrse, Nick Crookston, Gary Dixon, Chris Dahl, Lance David, Bob Havis, Chad Keyser, Leah Rathbun, Stephanie Rebain, Erin Smith-Mateja, Mike Van Dyck, and Dave Wilson

Conference Endorsements:

Society of American Foresters (SAF)
The International Union of Forestry Research Organization (IUFRO) Group:
    4.01.02 Growth models for tree and stand simulation
Conference Sponsors:
US Forest Service, National Headquarters Forest Management
US Forest Service, Rocky Mountain Research Station

# Tuesday, April 17th, 2012
## Salons IV and VI at the Hilton

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|---|---|
| 7:00 – 8:00 am | **Registration** |
| 8:00 – 8:15 am | **Welcome and Program Overview**<br>**Michael Van Dyck– Forest Vegetation Simulator (FVS) Group Program Leader**<br>**US Forest Service, Forest Management Service Center** |

## Keynote Address
### Moderated by Dave Cawrse

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| 8:15 – 9:15 am | **Keynote Address**<br>**Sam Foster – Station Director**<br>**US Forest Service, Rocky Mountain Research Station**<br>**Cal Joyner – Director of Forest Management**<br>**US Forest Service, National Forest Systems** |

## Session 1: Climate
### Moderated by Erin Smith-Mateja

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|---|---|
| 9:15 – 9:40 am | ***Climate-FVS: An Update***<br>**Nicholas L. Crookston – Operations Research Analyst**<br>**US Forest Service, Rocky Mountain Research Station** |
| 9:40 – 10:05 am | ***Incorporating Eastern Tree Species Responses to Climate Change into Climate-FVS***<br>**Melissa Shockey – Graduate Research Assistant**<br>**Virginia Tech** |
| 10:05 – 10:35 am | **Coffee Break** |

| | Session 2A: Insects<br>Moderated by Lance David<br>Salon IV | Session 2B: Carbon<br>Moderated by Morris Johnson<br>Salon VI |
|---|---|---|
| 10:35 – 11:00 am | ***Modeling the Effects of Emerald Ash Borer on Forest Composition in the Lake States***<br>**Ryan D. DeSantis – Postdoctoral Research Associate**<br>**University of Missouri**<br>**US Forest Service, Northern Research Station** | ***Application study of Forest Carbon Storage Estimation System in Larix olgensis plantations based on FFE-FVS***<br>**Ma Wei – Graduate Student**<br>**Beijing Forestry University** |
| 11:00 – 11:25 am | ***Study on the Risk and Dynamic Simulation of Pinus tabulaeformis Damaged by Dendroctonus valens in Shanxi Area of China***<br>**Juan Shi – Associate Professor**<br>**Beijing Forestry University** | ***Carbon Sequestration Estimation in Virginia Ecosystem Services Calculators***<br>**Christine E. Blinn – Research Scientist**<br>**Virginia Tech** |
| | Session 3A: Validation<br>Moderated by Chris Dahl<br>Salon IV | ***Evaluating Carbon Stock Estimates and Projections from the Forest Vegetation Simulator***<br>**Coeli M. Hoover – Research Ecologist**<br>**US Forest Service, Northern Research Station** |
| 11:25 – 11:50 am | ***Towards Unbiased Stand-Level Imputation from LiDAR-Derived Predictors***<br>**Andrew Hudak – Research Forester**<br>**US Forest Service, Rocky Mountain Research Station** | |

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|---|---|---|
| 11:50 – 1:00 pm | **Lunch Break** | |
| 1:00 – 1:25 pm | ***Model Validation of the Northeast Variant of the Forest Vegetation Simulator***<br>**Matthew Russell – Graduate Student**<br>**University of Maine** | ***Building a Database of Forest Carbon Functions Under Different Disturbance Scenarios: a Prelude to the Forest Carbon Management Framework (ForCaMF)***<br>**Alicia Peduzzi – Research Forester**<br>**US Forest Service, Rocky Mountain Research Station** |
| 1:25 – 1:50 pm | ***Reconciling Validation and Sensitivity Analysis Results of the Large Tree Diameter Growth Model in the Utah Variant of FVS***<br>**R. Justin DeRose – Research Ecologist**<br>**US Forest Service, Rocky Mountain Research Station** | ***Modelling Forest Landscape Carbon Considering Management, Bark Beetles, and Stochastic Wildfire***<br>**Andrew McMahan – Quantitative Ecologist**<br>**SOFTec Solutions, Inc.** |
| 1:50 – 2:15 pm | ***Comparison of Alternatives to Estimate Minnesota Statewide Changes in Aspen Forest Type Volumes***<br>**Curtis L. VanderSchaaf – Forest Modeler**<br>**Minnesota Department of Natural Resources** | ***Long-Term Effects of Fuel Treatments on Carbon Pools***<br>**Nicole M. Vaillant – Fire Ecologist**<br>**US Forest Service, Pacific Northwest Research Station** |
| 2:15 – 2:45 pm | **Afternoon Break** | |
| 2:45 – 3:10 pm | ***A framework for Validation and Model Improvement Using Forest Inventory Analysis Data***<br>**John D. Shaw – Lead Analyst**<br>**US Forest Service, Rocky Mountain Research Station** | Session 3B: Fire and Fuels<br>Moderated by Stephanie Rebain<br>Salon VI<br>***Developing a post-processor to link the Forest Vegetation Simulator (FVS) and the Fuel Characteristic Classification System (FCCS)***<br>**Morris Johnson – Research Fire Ecologist**<br>**US Forest Service, Pacific Northwest Research Station** |
| 3:10 – 3:35 pm | | ***Use of FFE-FVS for Fire Behavior Analysis in a Restoration Context***<br>**Tessa Nicolet – Regional Fire Ecologist**<br>**US Forest Service, Southwestern Region** |
| 3:35 – 4:00 pm | | ***BC Variant of the FFE – New Methods for Crowning, Spread, and Consumption***<br>**Sarah J. Beukema – Senior Systems Ecologist**<br>**ESSA Technologies Ltd.** |
| 4:00 – 4:25 pm | | ***The Efficacy and Limitations of Custom Fuel Modeling Using FFE-FVS***<br>**Erin Noonan-Wright – Fire Application Specialist**<br>**US Forest Service, Wildland Fire Management Research, Development, and Application** |

| Session 4: Poster Presentations<br>Moderated by Leah Rathbun<br>Fort Collins Brewery | |
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| 6:00 – 8:00 pm | **Poster Presentations and Welcome Reception held at the Fort Collins Brewery**<br><br>***Using FVS to Model Carbon and Species Composition Trajectory Changes Resulting from Disturbances***<br>**Megan K. Caldwell – Physical Scientist**<br>**US Geological Society**<br><br>***FVS Underestimates Growth of Small Trees in Uneven-Aged Black Hills Ponderosa Pine Stands***<br>**Seth Ex – Graduate Research Assistant**<br>**Colorado State University**<br><br>***Using the Forest Vegetation Simulator to Forecast Acorn Production at Bent Creek Experimental Forest, NC, USA***<br>**Chad Keyser – Forester**<br>**US Forest Service, Forest Management Service Center**<br><br>***Linking FVS Into Agent-Based Modeling of Coupled Social-Ecological Systems***<br>**Jessica Leahy – Associate Professor**<br>**University of Maine**<br><br>***Canopy Cover Estimates: Modifying FVS estimates to include different spatial patterns***<br>**Leah C. Rathbun – Forest Biometrician**<br>**US Forest Service, Forest Management Service Center**<br><br>***The Fire and Fuels Extension to the Forest Vegetation Simulator – Updates and Enhancements 2007-2012***<br>**Stephanie Rebain – Forester**<br>**US Forest Service, Forest Management Service Center**<br><br>***Estimated Timber Productivity and Financial Returns in a Natural Disturbance-Based System Using FVS-NE***<br>**Mike R. Saunders – Assistant Professor**<br>**Purdue University**<br><br>***Validating the Southern Variant Forest Vegetation Simulator (SN-FVS) Height Predictions on Southeastern Hardwoods in Kentucky and Tennessee***<br>**Steven C. Stedman – Forest Research Associate III**<br>**Colorado State University, Center for Environmental Management of Military Lands (CEMML)**<br><br>***Adaptive Management and Forest Vegetation Simulator Using the Event Monitor and the Role of Potential Natural Vegetation for Climate Adaptation***<br>**Melody A. Steele – Forester**<br>**Bureau of Indian Affairs**<br><br>***ArcFuels: an ArcGIS Interface for Fuel Treatment Planning and Wildfire Risk Assessment***<br>**Nicole Vaillant – Fire Ecologist**<br>**US Forest Service, Pacific Northwest Research Station** |

# Wednesday, April 18th, 2012
## Salons IV and VI at the Hilton

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|---|---|
| 8:00 - 8:15 am | **Housekeeping** |
| **Panel Discussion: Future of FVS<br>Moderated by Gary Dixon** | |
| 8:15 – 9:00 am | **Panelists: Nicholas Crookston, Donald Robinson, Michael Van Dyck, and Aaron Weiskittel** |
| **Session 5: Emerging Applications<br>Moderated by Tim Bottomley** | |
| 9:00 – 9:25 am | ***FVS as a Cooperator in Other Systems and Cooperation in FVS Development***<br>**Nicholas L. Crookston – Operations Research Analyst**<br>**US Forest Service Rocky Mountain Research Station** |
| 9:25 – 9:55 am | **Coffee Break** |
| 9:55 – 10:20 am | ***Development of an Application Program Interface (API) for the Forest Vegetation Simulator***<br>**Donald C.E. Robinson – Senior Systems Ecologist**<br>**ESSA Technologies, Ltd.** |
| 10:20 – 10:45 am | ***FVS-WRENSS: A Water Yield Postprocessor for FVS***<br>**Robert Havis - Information Technology Specialist**<br>**US Forest Service, Forest Management Service Center** |
| 10:45 – 11:10 am | ***Coupling FASST and FVS to Simulate Climate and Silvicultural Impacts on Seasonal Operability and Logging Equipment Terramechanics***<br>**Rob Keefe – Instructor**<br>**University of Idaho** |
| 11:10 – 11:35 am | ***Development and evaluation of the Acadian Variant of the Forest Vegetation Simulator***<br>**Aaron Weiskittel – Assistant Professor**<br>**University of Maine** |
| 11:35 – 12:00 pm | ***FVS-ORGANON: Plugging in a New Growth Engine***<br>**Jeff Hamann – President**<br>**Forest Informatics, Inc.** |
| 12:00 – 1:00 pm | **Lunch Break** |
| 1:00 – 1:25 pm | ***FSVeg Spatial Data Analyzer: A Spatial Interface to Integrate FVS, FSVeg and FSVeg Spatial technologies for Project and Landscape Analysis***<br>**Jonathan Marston – Systems Analyst**<br>**Cherokee Services Group** |
| 1:25 – 1:50 pm | ***NFS Regional Vegetation Classification Algorithms Embedded Within the Forest Vegetation Simulator***<br>**Don Vandendriesche – Forester / Program Manager**<br>**US Forest Service, Southwestern Region** |
| 1:50 – 2:15 pm | ***Local Weather Data Now Accessible and Usable in the Western Spruce Budworm Defoliator Model Extension of Forest Vegetation Simulator***<br>**Helen Maffei – Forest Pathologist**<br>**US Forest Service, Forest Health Protection** |

| Session 6: Restoration and Management<br>Moderated by Chad Keyser | |
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| 2:15 – 2:40 pm | ***Development of Alternative Growth Equations for the Lake State Variant of the Forest Vegetation Simulator (LS-FVS) to Capture the Increased Growth of Managed Stands***<br>**John M. Zobel – PhD student**<br>**University of Minnesota** |
| 2:40 – 3:10 pm | **Afternoon Break** |
| 3:10 – 3:35 pm | ***Predicting Growth and Development of Managed and Unmanaged Eastern White Pine Stands in Maine***<br>**Robert Seymour – Professor**<br>**University of Maine** |
| 3:35 – 4:00 pm | ***Applying FVS to Quantify the Effects of Management Activities for Land Management Planning***<br>**Don Vandendriesche – Forester / Program Manager**<br>**US Forest Service, Southwestern Region** |
| 4:00 – 4:25 pm | ***Estimating Growth Impacts of Interior Stand Edge in Gap-Based Silvicultural Treatments Using FVS-NE***<br>**Mike R. Saunders – Assistant Professor**<br>**Purdue University** |
| 4:25 – 4:50 pm | ***Investigating Combined Long-Term Effects of Variable Tree Regeneration and Timber Management on Forest Wildlife and Timber Production Using FVS***<br>**James D.A. Millington – Leverhulme Early Career Fellow**<br>**King's College London** |
| 4:50 – 5:15 pm | ***Simulating Aspen/Birch Dynamics in a Woodland Heath Community: FVS Applied to Ecosystem Restoration***<br>**Giorgio Vacchiano – Post Doctoral Researcher**<br>**University of Torino** |
| 5:15 – 5:30 pm | **Closing Remarks**<br>**Michael Van Dyck – Forest Vegetation Simulator (FVS) Group Program Leader**<br>**US Forest Service** |

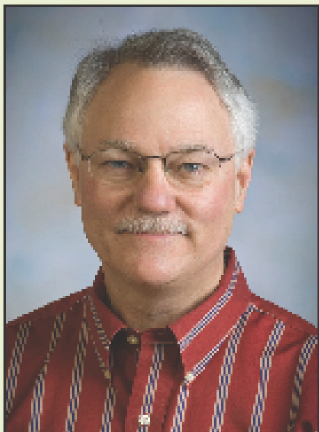
| **Thursday, April 19th, 2012**<br>**Natural Resource Research Center**<br>**Building A** | | | |
|---|---|---|---|
| 8:30 – 11:30 am | Refresher Workshop<br>Room 313<br>Organizers: Chris Dahl and Stacie Holmes | Advanced Topics Workshop<br>Rooms 122-124<br>Organizers: Leah Rathbun and Don Vandendriesche | Ask the Experts<br>Room 120<br>Organizers: Michael Van Dyck, Erin Smith-Mateja, Chad Keyser, Stephanie Rebain, Lance David, and Bob Havis |
| 11:30 – 12:30 pm | **Lunch** | | |
| 12:30 – 5:00 pm | Landscape-level Analysis Workshop<br>Rooms 122-124<br>Organizers: Chad Keyser, Jonathan Marston, Lynne Bridgford, and Eric Twombly, | Climate Workshop<br>Room 120<br>Organizers:<br>Erin Smith-Mateja and Nicholas L. Crookston | Carbon Workshop<br>Room 313<br>Organizers: Stephanie Rebain and Coeli M. Hoover<br>(This class ends at 3:00pm) |

# Tuesday April 17th, 2012

**Keynote Addresses**
**8:15– 9:15am**

## DR. GEORGE S. (SAM) FOSTER

DIRECTOR, ROCKY MOUNTAIN RESEARCH STATION
US FOREST SERVICE



Dr. George S. (Sam) Foster has served as Director of the U.S. Forest Service's Rocky Mountain Research Station since January 7, 2008. The Station is one of six regional units that make up the Forest Service Research and Development organization - the most extensive natural resources research organization in the world. Headquartered in Fort Collins, CO, the Station oversees 12 field laboratories throughout a 12-state territory that spans from Canada to Mexico, and from the Sierras to the Great Plains. Research programs produce and deliver knowledge and technology that helps land managers, planners and other specialists make wise decisions about our Nation's forests, rangelands, and grasslands.

"Our work has no boundaries; our scientists can collaborate in any corner of the world, and our research results are valued around the world," said Foster. "Climate change will play out first and most dramatically in the Interior West. Drought and invasive species are influencing insect and disease epidemics, and our snowpacks are melting earlier, resulting in less water during the hottest, driest part of the summer," he said. "Our region is known throughout the world for its spiritual, wilderness, and recreation values. The Station has a key role in helping to support those resources and values. Our research program is vital to the future of a healthy nation and world," said Foster.

Foster holds a BS degree in Forest Management and a MS in Forest Genetics and Silviculture from the University of Tennessee; and a PhD in Forest Genetics and Silviculture from Oregon State University.

In 1976, he went to work as a Quantitative Genetics Scientist with Weyerhaeuser Co. in Hot Springs, AR. He accepted a position as Research Forester with Crown Zellerbach Corp. in 1978 in Wilsonville, OR, transferring to their Research Division in Bogalusa, LA as R&D Manager in 1982. He served as Vice President of the International Forest Seed Company in Odenville, AL from 1986 to1988, then began work as a Supervisory Research Geneticist with the Forest Service's Southern Research Station in Huntsville, AL. He was promoted to Assistant Director of Research in 1992, relocating to Asheville, NC.

In 2001, Foster accepted the position of Dean, College of Forest Resources, and Director, Forest and Wildlife Research Center at Mississippi State University, later working as a Professor in the Department of Forestry.

He was selected as National Program Leader for Silviculture and Genetics Research, Forest Service headquarters, Washington, D.C. in 2003. Over the next two years, he served as Acting Director of the Wildlife, Fish, Water and Air Research Staff, and Acting Deputy Director of the Watershed, Fish, Wildlife, Air, and Rare Plants Staff in the National Forest System.

Prior to coming to the Rocky Mountain Research Station, Dr. Foster served four years in the Washington Office of the Forest Service. For the last two years of that term, he served as the Director of the Resource Use Sciences Staff, which oversees R&D at the national level for all labs working on issues related to people, including forest products, recreation, social science, and economics.

Foster is internationally known for his work in forest genetics and tree improvement. His work as a Research Geneticist and R&D Manager took him to 18 foreign countries. He completed international projects for the World Bank and Hilleshog AB in Sweden, providing seeds for planting new forests in China, India and the United States. He has authored over 75 research articles and book chapters, and is a Senior Executive Fellow with the Kennedy School of Government, Harvard University.

Learn more about the Rocky Mountain Research Station at

www.fs.fed.us/rmrs

# Cal Joyner
## Director of Forest Management
## US Forest Service

Cal Joyner is the Director of Forest Management, in the National Forest System, and has held the position since August, 2011. He was a Deputy Regional Forester in the Pacific Northwest Region, responsible for overseeing Natural Resources, Resource Planning and Monitoring, as well as State and Private Forestry, including Fire and Aviation Management, Cooperative Programs and Forest Health Protection from 2007 until August, 2011. From May, 2002 until March, 2007 he was the Region 6 Director of Natural Resources, responsible for programs of forest management, rangelands, soil, water, fish, wildlife and forest health protection.

Joyner was raised in California, graduated from Humboldt State University with a degree in watershed management, and completed the USDA Senior Executive Candidate Development program through American University. He began his Forest Service career in 1980, working as a hydrologist and environmental coordinator on the Siuslaw, Gifford Pinchot and Willamette National Forests, before becoming District Ranger in 1989 on the Bitterroot National Forest in Montana. From July, 1992 through June of 1995 Cal was in Region 3, working as both the Rural Development and State and Private Forestry Specialist for the Arizona half of the region. In 1995 he became the Associate Forest Supervisor of the San Juan-Rio Grande NFs and also the Area Manager of the San Juan Resource Area of BLM-Colorado. Joyner was named Forest Supervisor and Field Manager for the combined San Juan National Forest and San Juan BLM Field Office in Durango, CO from 1998 to 2002.

Learn more about the National Forest Systems at
http://www.fs.fed.us/forestmanagement

## Session 1: Climate
## 9:15– 10:05am
## Moderated by Erin Smith-Mateja

***Climate-FVS: An Update***

**Nicholas L. Crookston – Operations Research Analyst**
**US Forest Service, Rocky Mountain Research Station**
**Authors: Nicholas L. Crookston**

**Abstract.** Climate-FVS is a modification of the Forest Vegetation Simulator designed to account for effects expected climate change will have on forest species and size composition. It was built by: (1) adding functions that link mortality and regeneration of species to climate variables expressing climatic suitability, (2) constructing a function linking site index to climate and using it to modify growth rates, and (3) adding functions accounting for changing growth rates due to climate-induced genetic responses. Since its introduction in 2009 and publication in 2010, a provisional component has since been published and the model was updated to reflect the final version. In addition, the model's reliance on modeling climate-change-caused mortality solely on the bases of climates becoming inconsistent with species ranges was revisited. A new component is presented that increases tree mortality rates when the magnitude of climate change exceeds what would be expected if the trees were moved over 300 m (~1000 ft.) in elevation under contemporary climate at the site latitude and longitude. The formulation captures established information that reports poor survival when stock from a population of trees is move beyond its seed zone. The new component results high mortality rates by midcentury even in areas that remain viable for wide-spread species like Douglas-fir. An example is presented where Douglas-fir die as climate changes only to be regenerated with Douglas-fir assumed to be adapted to the new climate. The simulation outputs suggest that foresters will have relatively short time windows for growing trees from specific seed sources leading to shorter rotations. That climate change will create large-scale disruptions to forested ecosystems is also clearly displayed.

***Incorporating Eastern Tree Species Responses to Climate Change into Climate-FVS***

**Melissa Shockey – Graduate Research Assistant**
**Virginia Tech**
**Authors: Melissa Shockey, Huiquan Jiang, and Philip J. Radtke**

**Abstract.** Growing concerns over the possible effects of greenhouse-gas-related global warming on North American forests have led to increasing calls to address climate change effects on forest vegetation in management and planning applications. This work aims to extend the Climate-FVS modeling approach to eastern forests using regional data sets and scientific knowledge of factors that may affect forest responses to climate change, such as, genetics, soils, and ecophysiology. Forest Inventory and Analysis (FIA) data linked to soils, climate, and geographic data serve as the primary information for analysis. Predictive and explanatory relationships are under development primarily using ensemble classification and regression methods including Random Forests™. Expected results include characterization of baseline accuracies, and the development and delivery of prediction models designed for compatibility with FVS modeling tools, following the implementation framework of Climate-FVS for western forests. Climate responses will be accounted for in vegetation responses including species viability and abundance, changes in site productivity, survival, growth, and composition.

## Session 2A: Insects
## 10:35– 11:25am
## Moderated by Lance David

***Modeling the Effects of Emerald Ash Borer on Forest Composition in the Lake States***

**Ryan D. DeSantis – Postdoctoral Research Associate**
**University of Missouri**
**US Forest Service, Northern Research Station**
**Authors: Ryan D. DeSantis, W. Keith Moser, Robert J. Huggett, Jr., Ruhong Li, David N. Wear, Patrick D. Miles, and Kathleen S. Knight**

**Abstract.** The non-native invasive emerald ash borer (*Agrilus planipennis* Fairmaire; EAB) has caused considerable damage to the ash (*Fraxinus* spp.) resource in North America. While there are methods to mitigate, contain, control, or even eradicate other non-native invasive insects, EAB continues to spread unimpeded across North America. Considering strong evidence suggesting >99% host tree mortality probability, the loss of the North American ash resource appears imminent. In order to project the effects of EAB on species composition, we modeled the future composition of forests using the Forest Vegetation Simulator (FVS). These projections utilized US Forest Service Forest Inventory and Analysis (FIA) data and incorporated EAB host mortality data. In addition, we analyzed potential effects of EAB on species composition using projections designed for the US Forest Service's Northern Forest Futures Project (NFFP). These projections utilized FIA data, and incorporated EAB current range, estimated spread rate, and host mortality, as well as human population distribution, global economic conditions, energy and technology use, population and economic growth, climate change models, timber harvesting, land use change, and natural succession. This study provides some insight into the intensity and trajectory of EAB impacts on species composition, and their consequences for future stand development. Specifically, we highlight some key differences between EAB and non-EAB model results and provide insight on reasons behind the differences.

***Study on the Risk and Dynamic Simulation of Pinus tabulaeformis Damaged by Dendroctonus valens in Shanxi Area of China***

**Juan Shi – Associate Professor**
**Beijing Forestry University**
**Authors: Shi Juan, Bao Tingfang, Xu Zhichun, Luo Youqing, Dave Cawrse, Don Vandendriesche, and Andrew McMahan**

**Abstract.** *Dendroctonus valens* LeConte (red turpentine beetle), an important invasive alien species of forests in China which has spread to Shanxi, Hebei, Henan, Shaanxi and Beijing *et al.*, has caused the enormous economic and ecological loss to pine forests in North part of China, especially to *Pinus tabulaeformis* forest. Based on the research objectives in this paper of 21 Chinese pine forest in different forest types after the invasion of red turpentine beetle in Lingkongshan forest farm, Qinyuan county, Shanxi province, given the survey of individual trees and investigation of bio-environmental factors, combined with Forest Vegetation Simulator (FVS) and West Wide Pine Beetle Model (WWPB), the risk impact of red turpentine beetle on the structure and function of Chinese pine forest ecosystem were evaluated. The result showed that for Chinese pine stands, damaged to different degrees by red turpentine beetle, the stand growth was clearly distinct several years later. The growth of pure Chinese pine stands, after damage infected by pests, is obviously less than that of mixed damaged pine stand. On the other hand, The "Beetle kill potential (BKP)" of red turpentine beetle also showed the difference in different forest type, as for pure pine forest, the trend curve is "first decreased then increased final declined" which has a recent climax year in 2013, but for mixed one, the trend curve is "reduced year by year", which also indicates that for the recovery ability, the mixed forest is greater than the pure one. Furthermore, FVS-WWPB has been linked to electronic forest type map in ArcGIS, the potential risk of red turpentine beetle in Lingkongshan forest farm was analyzed quantificationally, which is more concretely and detailed than the traditional risk analyzing ones with from large scale as province detailed to mesoscale as compartment, and provide a reference to forecast the pests in other area of China.

## Session 2B: Carbon
## 10:35– 2:15pm
## Moderated by Morris Johnson

***Application Study of Forest Carbon Storage Estimation System in Larix olgensis Plantations Based on FFE-FVS***

**Ma Wei – Graduate Student**
**Beijing Forestry University**
**Authors: Ma Wei and Sun Yujin**

**Abstract.** To make better use of FFE-FVS (a submodel of Fire and Fuels Extension in Forest Vegetation Simulator) for estimating carbon stock, we made adjustment and modification on it, and chose korean larch (*Larix olgensis* Herry.) plantations for study object to test it. C stocks in forest ecosystem can be divided into six distinct storage pools, live trees, understory vegetation, standing dead trees, down dead wood, forest floor and mineral soil. Twenty fixed-radius plots were designed as Forest Inventory and Analysis (FIA) program for forest field surveys in Lesser Khingan Mountains, in Northeastern China. The sample harvest and allometric regression methods were used to estimate biomass. Carbon concentrations were determined respectively for various organs or tissues. C stock was directly derived from estimates of stand biomass by multiplying by carbon concentration. Least-square regression models of C stocks along a complete growth range were then developed using several curve forms. All raw and statistic data were initially arranged, recognized and summed up to database. Then, a new FFE-FVS whereby Agent structure and algorithms was designed to estimate and compare C stocks. Additionally, scenarios (i.e., tending and thinning) were simulated on a user-defined cycle. Carbon pools showing on the final output report are mainly trees, understory vegetation, down woody materials, and soil, which reflect real C distribution pattern in korean larch plantation in China. Via FFE-FVS, we obtain better play in C stock estimation, so as to further strengthen the role of C assessment and monitoring.

***Carbon Sequestration Estimation in Virginia Ecosystem Services Calculators***

**Christine E. Blinn – Research Scientist**
**Virginia Tech**
**Authors: Christine E. Blinn, Randolph H. Wynne, and Buck Kline**

**Abstract.** An online carbon calculator has been developed as part of a larger ecosystem services project to aid forest landowners in estimating the amount of carbon that is currently sequestered in their forest stands as well as to project future carbon sequestration. The current approach uses Forest Vegetation Simulator (FVS) based look-up-tables for hardwood and mixed forest types. User input to the FVS carbon tool includes the forest group, either the average basal area or height, and the acreage of the stand. An estimate of the total $CO_2$ sequestered in metric tons (t) is returned. This estimate is based on the mean carbon content of stands with similar attributes and is not an exact measurement of the carbon within the specified stand. In addition to just obtaining the current carbon estimate for a stand, the user can also obtain future carbon estimates for growth periods up to 25 years in increments of five years. The FVS carbon look-up-tables were created using the USDA Forest Service's Forest Inventory and Analysis (FIA) plot data from all of Virginia and North Carolina. Carbon estimates were calculated for the three most frequently occurring forest groups, Oak-Hickory, Loblolly-Shortleaf Pine and Oak-Pine, which were further subdivided into either three basal area or three top height classes (low, medium and high). Future work will focus on developing methods to make real time FVS calls based on user supplied input.

*Evaluating Carbon Stock Estimates and Projections from the Forest Vegetation Simulator*

**Coeli M. Hoover – Research Ecologist**
**US Forest Service, Northern Research Station**
**Authors: Richard G MacLean, Mark J Ducey, and Coeli M. Hoover**

**Abstract.** The Forest Vegetation Simulator (FVS) is often used to model projections of carbon accumulation in US forests. The model uses two unique sets of equations to create those carbon estimates: a volume conversion factors in the Fire and Fuels Extension (FFE method), and the Jenkins et al. national-scale equations. Both of these differ from the component ratio method (CRM) currently used by FIA (US Forest Service Forest Inventory and Analysis Program). Using equivalence testing, we compared static projections of carbon yield using the three approaches, as well as projected and observed carbon growth, using all remeasured FIA plots from the current panel design in the states covered by the Northeast variant of FVS. In general, carbon stocks estimated by the national biomass equations were higher than those calculated by FIA using the CRM approach, while estimates produced using the FFE default method were generally lower. Estimates produced using the national biomass equations were also higher than those from the FFE default method, although the difference was not as great. Overall, a spatial trend apparently related to stand height was observed in the differences between the CRM and other methods. 5-year forward projections of carbon yields were reasonable, although correlation with observed growth on remeasured plots was very low, indicating that local calibration of FVS is essential for carbon management.

***Building a Database of Forest Carbon Functions Under Different Disturbance Scenarios: a Prelude to the Forest Carbon Management Framework (ForCaMF)***

**Alicia Peduzzi – Research Forester**
**US Forest Service, Rocky Mountain Research Station**
**Authors: Alicia Peduzzi and Sean Healey**

**Abstract.** The forest manager needs for understanding and quantifying the effects of their management strategies on carbon pools have increased over the years. Carbon estimations from traditional forest inventories can only provide managers with estimations that represent a single point in time, therefore, this information might not be sufficient to aid future forest planning and management decisions. The Forest Vegetation Simulator (FVS), as a growth and yield-based model, can supply the required projection through time of forest development, as well as carbon estimations, under a combination of different silviculture and/or disturbance conditions. The main goal of this work was to use FVS to provide with a database of forest carbon behavioral models for a number of combinations of forest types and volumes, in different disturbance scenarios for the Northern region of the US National Forest System. The resulted equations will be used as the basis to link forest carbon projections to a geo-spatial (map) source of forest types and volumes estimated using Landsat imagery (at a resolution of 30 m) for the same region. These products, part of the Forest Management Carbon Framework (ForCaMF) project, are intended to facilitate forest managers with a tool for decision support at regional and operational scales.

*Modelling Forest Landscape Carbon Considering Management, Bark Beetles, and Stochastic Wildfire*

**Andrew McMahan – Quantitative Ecologist**
**SOFTec Solutions, Inc.**
**Authors: Andrew McMahan. Eric L. Smith and Alan A. Ager**

**Abstract.** North American forests sequester significant amounts of carbon. The fluxes of carbon into and out of forest ecosystems are influenced by a variety of processes, including management, climate, and stochastic disturbances such as wildfire, severe weather events, and pest outbreaks. While there is a substantial body of literature addressing stand- and landscape-scale forest carbon accounting under various management scenarios, both with and without accounting for possible future climate change effects, relatively few studies consider the effects of stochastic disturbances such as fire and pests at landscape scales. In this study, we demonstrate the use of FVS-FFE, FLAMMAP, and ArcFuels to provide a *probabilistic* estimate of future expected carbon on a landscape scale. The Random Ignition (Randig) module of FLAMMAP was used to derive *probabilistic* estimates of fire intensity across the landscape given thousands of possible random ignitions. These RandIg estimates, combined with FFE's carbon estimates (from a series of simulations that vary wildfire intensity via the FFE's FLAMEADJ ("Flame adjust") keyword, were used to estimate post-wildfire carbon dynamics for a 240,000-hectare landscape in central Oregon. The modelling design includes the effects of mountain pine beetles, management and wildfire. Results from 8 scenarios in a 2 x 2 x 2 design—with and without management, with and without bark beetles, with and without wildfire—are presented and discussed.

*Long-Term Effects of Fuel Treatments on Carbon Pools*

**Nicole M. Vaillant – Fire Ecologist**
**US Forest Service, Pacific Northwest Research Station**
**Authors: Nicole M. Vaillant and Erin Noonan-Wright**

**Abstract.** Understanding how fuel treatments affect carbon pools is of great interest to managers. Both positive and negative impacts of fuel treatments on above- and belowground woody carbon pools have been reported with respect to predicted fire behavior. As part of a long-term fuel treatment effects monitoring project data was collected at 89 permanent plots representing 28 fuel treatment projects on 14 national forests in California from 2001 to 2011. Fuel treatments ranged from prescribed fire only, thinning only, mechanical understory treatments such as mastication, and a combination of thinning plus understory fuel reduction treatments. Forest and fuels inventory data was collected before treatments were applied and up to 10 years after treatment (1, 2, 5, 8, and 10 year post treatment intervals) for each plot. We used FFE-FVS to quantify above and belowground woody carbon pools for each treatment period as well as predicted carbon loss due to emissions from modeled fire behavior. We will present information over time for distinct forest and treatment types.

## Session 3A: Validation
## 11:25– 3:10pm
## Moderated by Chris Dahl

*Towards Unbiased Stand-Level Imputation from LiDAR-Derived Predictors*

**Andrew Hudak – Research Forester**
**US Forest Service, Rocky Mountain Research Station**
**Authors: Andrew Hudak, Nicholas L. Crookston, Tod Haren, Robert Liebermann, and John Byrne**

**Abstract.** LiDAR provides detailed canopy structure metrics that can be used to predict forest stand attributes with high accuracy and spatial precision for the benefit of forest management. In this case study, Oregon Department of Forestry (ODF) managers in Tillamook District have 2007, 2008, and 2009 LiDAR collections that combined cover ~75% of ~1000 $km^2$ of state ownership. The objective was to use remotely sensed data as predictor variables for imputing forest structure attributes summarized from traditional stand exams (n = ~1000) at the stand and subplot levels using FVS. The dependent (y) variables included TPA, BA, SDI, CCF, TopHt, QMD, and various volume measures. Multi-temporal Landsat-derived tasseled cap indices were used as the independent (x) predictor variables across all stands. In the ~750 stands where LiDAR was available, a parsimonious set of LiDAR-derived canopy metrics were used as predictor variables. We imputed stand-level summary attributes from reference stands to target stands, and we imputed subplot-level summary attributes from reference subplots to 30 m x 30 m target pixels. Based on earlier studies, we hypothesized that LiDAR alone would explain twice as much variation in the response variables as Landsat alone. We also hypothesized that the stand-level imputations would be more biased than pixel-level imputations aggregated to the same stand boundaries. We will test these hypotheses and present results in support of an improved forest inventory strategy that minimizes bias at the stand level by leveraging the spatial precision of LiDAR along with more efficient field plot sampling.

*Model Validation of the Northeast Variant of the Forest Vegetation Simulator*

**Matthew Russell – Graduate Student**
**University of Maine**
**Authors: Matthew Russell, Philip J. Radtke, and Aaron Weiskittel**

**Abstract.** The Northeast Variant of FVS (FVS-NE) is one of the model’s largest in geographic area, yet forest structure and composition varies widely across the region. Distance-independent tree growth models like FVS-NE are known to work well in the mixed-species, uneven-aged stands that comprise much of the Northeast. This analysis validates the current version of FVS-NE by comparing model predictions with observed inventory data. Annual remeasurement data from the Forest Inventory and Analysis (FIA) Database version 4.0 were obtained for locations across the region where FVS-NE is suggested for use. Equivalence testing procedures were used to test the null hypothesis of dissimilarities between observed growth from the remeasured FIA plots and simulated growth from FVS-NE. Plot-level basal area and number of trees per hectare were considered the two primary response variables. Results provide a benchmark in the development of new Acadian variant of FVS to be implemented in Maine and the Canadian Maritime Provinces.

***Reconciling Validation and Sensitivity Analysis Results of the Large Tree Diameter Growth Model in the Utah Variant of FVS***

**R. Justin DeRose – Research Ecologist**
**US Forest Service, Rocky Mountain Research Station**
**Authors: R. Justin DeRose, John D. Shaw, and James N. Long**

**Abstract.** The Forest Vegetation Simulator (FVS) is the most widely used growth model for simulating forest conditions in response to management activities. The extent to which FVS model output is accurate can be assessed using a number of techniques. Model evaluation considers the efficacy of growth predictions compared to well-established rules of forest stand dynamics. Model validation is concerned with the patterns of predictive bias. Sensitivity analysis, although less understood, is used for determining the most influential independent variables. The Utah Variant of FVS has received considerable testing in the form of evaluation, validation, and sensitivity analysis, which indicated relatively strong model predictions. This strong model performance makes the Utah Variant suitable to make comparisons between analysis methodologies. Using the large tree diameter increment submodel for conifers in Utah, we assessed the relationships between the results of model validation and sensitivity analysis. Patterns of large tree bias determined from model validation were regressed against the most influential independent variables indicated by the sensitivity analysis. In addition, we assessed the pattern of bias for each independent variable against its estimated sign of influence (positive or negative). Results suggest general agreement between estimates of large tree bias and the strength of variable importance. However, the relationship between bias pattern and the sign of influence was unclear. This study further elucidates the explanatory capability of sensitivity analysis. Furthermore, examining results from validation and sensitivity analysis provides unique, but not mutually exclusive, inference regarding model performance, suggesting consideration of both when assessing FVS.

***Comparison of Alternatives to Estimate Minnesota Statewide Changes in Aspen Forest Type Volumes***

**Curtis L. VanderSchaaf – Forest Modeler**
**Minnesota Department of Natural Resources**
**Authors: Curtis L. VanderSchaaf**

**Abstract.** Regional growth rate estimates are important for many natural resource analyses including silvicultural assessment, harvest scheduling, and resource planning. At regional/state levels, due to costs and time involved, it can be difficult to establish enough observational units (e.g. plots) to produce accurate and precise estimates. Within the state of Minnesota, several alternatives exist to estimate regional/statewide changes in standing volume. One alternative is to take current Forest Inventory and Analysis (FIA) plot data and project the plots forward in FVS. The purpose of this study is to compare the ability of the FVS alternative with other alternatives to estimate change in standing volume of aspen forest types.

***A Framework for Validation and Model Improvement Using Forest Inventory Analysis Data***

**John D. Shaw – Lead Analyst**
**US Forest Service, Rocky Mountain Research Station**
**Authors: John Shaw, Michael Van Dyck, and Chad Keyser**

**Abstract.** The Forest Vegetation Simulator (FVS) and the Forest Inventory and Analysis (FIA) programs are both designed to cover all ownerships and forest types of the United States. FVS and FIA are also important to a wide and growing community of users, some of whom are advanced users of data and products from both programs. However, both programs rely heavily on data and equations that are developed outside of either program. While both programs seek to use the "best available" science, the need to cover such a large geographic area and wide range of forest types results in the use of models that are not optimal for particular species or locations. This situation has resulted in a greater effort toward validation. Although the FVS program has developed standards and guidelines for consistent model validation, the data used to test and validate FVS models have been variable in format, vintage, and source. The FIA program moved to an annual inventory system in the late 1990s. Most states have now started or completed at least one remeasurement cycle, and the resulting data have proven valuable for a wide variety of modeling applications. Remeasurement data and other data collected by the FIA program represent a rich source of information that is suitable to fill many modeling and validation needs of the FVS program. In this paper we will present a framework that can be used to formally link these two programs, providing multiple benefits to both user communities well into the future.

## Session 3B: Fire and Fuels
## 2:45– 4:25pm
## Moderated by Stephanie Rebain

***Developing a Post-Processor to Link the Forest Vegetation Simulator (FVS) and the Fuel Characteristic Classification System (FCCS)***

**Morris Johnson – Research Fire Ecologist**
**US Forest Service, Pacific Northwest Research Station**
**Authors: Morris C. Johnson, Stephanie Rebain, Sarah Beukema, David L. Peterson, and Roger Ottmar**

**Abstract.** We are developing an FVS post-processor to integrate the Forest Vegetation Simulator and the Fuel Characteristics Classification System (FCCS). FCCS is a scientifically robust, peer-reviewed approach to quantifying the structural complexity and variability of fuelbeds across diverse landscapes. FCCS was designed to provide quantitative fuelbed data for fire effects models and to assist in building customized fuel models for national application in the United States. Fuelbeds are classified into six horizontal strata that represent unique combustion environments: (1) canopy, (2) shrubs, (3) nonwoody fuels, (4) woody fuels, (5) litter–lichen–moss, and (6) ground fuels. This post-processor will allow managers to perform treatments and simulations in FVS, but will give them the option to calculate fire hazard assessments with the best available science for documenting and quantifying complex fuelbeds parameters responsible for fire behavior and fire effects. FCCS output consists of estimates of reaction potential (energy release per unit area per unit time), spread potential (rate of spread), and flame length potential (fireline intensity). Fire behavior estimates are based on a reformulated Rothermel spread equation which allows the direct use of inventoried fuel properties instead of stylized fuel models as inputs to a surface fire behavior model.

### *Use of FFE-FVS for Fire Behavior Analysis in a Restoration Context*

**Tessa Nicolet – Regional Fire Ecologist**
**US Forest Service, Southwestern Region**
**Authors: Tessa Nicolet and Don Vandendriesche**

**Abstract.** The Southwestern Region of the U.S. Forest Service is actively implementing restoration based projects and as such is looking for ways to explain to the public and our constituents why this is important. One assumed outcome of these projects is that the potential for active crown fire is lessened as the system is returned to its natural fire regime. Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator (FVS) is used extensively as a tool to help managers analyze effects of such treatments. Due to the inherent non-spatial nature of FFE-FVS, challenges arise in how this model can be used to assess fire behavior in spatially complex silvicultural prescriptions. Stand data from the Rim Lakes area located along the Mogollon Rim in east-central Arizona was processed through FFE-FVS. Output values were then used as input to educate the FlamMap model. As a result, spatial fire behavior predictions were developed for each proposed management alternative. Challenges in using FFE-FVS in spatially complex situations and how Fuel Models are assigned are highlighted as well as methods to depict spatial heterogeneity in FlamMap using FFE-FVS outputs.

### *BC Variant of the FFE – New Methods for Crowning, Spread, and Consumption*

**Sarah J. Beukema – Senior Systems Ecologist**
**ESSA Technologies Ltd.**
**Authors: Sarah J. Beukema, Steve Taylor, and Donald C.E. Robinson**

**Abstract.** The Fire and Fuels Extension (FFE) is a well-used extension of the Forest Vegetation Simulator (FVS) model, and allows the simulation of actual or potential impacts of fires of different intensities on stands. Users of FVS-FFE can examine the role of growth, mortality and fuels management upon stand structure as they combine to modify fire intensity and impact. Fire effect calculations are based upon nationally adopted equations that are in common use among numerous other fire models in the US. While the FFE has been linked to the British Columbia variant of FVS (also called Prognosis$^{BC}$), the cover type categories used nationally across Canada for fire suppression planning and fire management, are different from those used in the US. To improve the FFE's usefulness for strategic fire planning in BC, we have introduced new methods to the BC variant for calculating: (a) crowning probability (based on Cruz et al. 2006); (b) crown fire spread (based on Cruz et al. 2005), and (c) surface fire spread and fuel consumption (based on the Canadian Forest Fire Behavior Prediction System database). Users have the option of deciding which set of equations to use. Examples of outputs and behavior will be presented at the conference. The new variant is currently being tested in BC, and will be released shortly.

*The Efficacy and Limitations of Custom Fuel Modeling Using FFE-FVS*

**Erin Noonan-Wright – Fire Application Specialist**
**US Forest Service, Wildland Fire Management Research, Development, and Application**
**Authors: Erin Noonan-Wright and Nicole Vaillant**

**Abstract.** Managers measure both surface and canopy fuels pre- and post-treatment to evaluate fuel treatment effectiveness. Fuel loading is often computed for downed woody fuels using Brown's transects and subsequent calculations (Brown 1974). Other than comparing loading pre- and post- treatment, it is uncertain how best to use calculated values of fuel loading to model fire behavior. Traditionally, one of the 53 fuel models (Anderson 1982, Scott and Burgan 2005) is chosen to represent the fuel complex without using any of the fuel loading information to model fire behavior. Using a dataset encompassing 356 plots across 14 National Forests in California, we compared predicted fire behavior output (rate of spread, flame length) using two new methods in FFE-FVS that utilize fuel loading information. The first uses modeled fuel loads to create custom fuel models; the second applies modeled loads to choose one of the 53 fuel models. Predicted fire behavior is compared using the standard versus custom fuel models. Furthermore, the assumptions inherent with custom fuel modeling using the FFE-FVS methodology and the limitation of omitting measured values of live fuels and their contribution to bulk density (and fuel bed depth) is also discussed.

## Session 4: Poster Presentations
## 6:00– 8:00pm
## Moderated by Leah Rathbun
## Held at the Fort Collins Brewery

*Using FVS to Model Carbon and Species Composition Trajectory Changes Resulting from Disturbances*

**Megan K. Caldwell – Physical Scientist**
**US Geological Society**
**Authors: Megan K.Caldwell, Todd J. Hawbaker, and Jennifer Briggs**

**Abstract.** Forests play an important role in storing and sequestering carbon, where conifer forests in particular, store more than 33% within the terrestrial carbon pool. Disturbances, such as fire and insects, impact the amount of carbon that can be stored over time in conifer forests. Stand composition and structure, which plays an important role in carbon storage over time, may be altered by these large disturbances. A mountain pine beetle (MPB) epidemic has impacted forests along the Rocky Mountains, and has potentially altered carbon storage and stand composition trajectories in the short and long-term. This research used the Forest Vegetation Simulator (FVS) to quantify the scope and magnitude of the impacts of MPB on carbon storage and stand composition in a 200 year simulation. FVS was initialized with forest inventory tree, advanced regeneration and fuels data collected in 2010 in Grand County, Colorado, where Grand County was the epicenter of the MPB outbreak in the Southern Rocky Mountains. This FVS simulation carbon and stand composition results were compared to a "control" FVS simulation, where all trees killed by MPB were recoded as live to represent the conditions before the major mortality years of the MPB epidemic. The "MPB" simulation and "control" simulation trajectories were also compared to the trajectories of a "Fire" simulation in FVS, to compare MPB disturbance to fire disturbance. Carbon and stand trajectories were altered between the three simulations, showing MPB has altered forest carbon storage and stand structure, which is different from how fire disturbances affect carbon and species composition.

*FVS Underestimates Growth of Small Trees in Uneven-Aged Black Hills Ponderosa Pine Stands*
**Seth Ex – Graduate Research Assistant**
**Colorado State University**
**Authors: Seth Ex and Frederick W. Smith**

**Abstract.** The diameter growth equation used by FVS for Black Hills ponderosa pine is based on the GENGYM model developed by C.B. Edminster. FVS equation developers anticipated the GENGYM model would over-estimate diameter growth of small trees in uneven-aged stands. To compensate, developers had FVS reduce diameter growth of small trees in uneven-aged stands by applying either a version of the GENGYM model parameterized for southwestern ponderosa pine, or a blend of the Black Hills and southwest equations, depending on certain tree and stand-level criteria. We evaluated the Black Hills equation for size-related bias using measured increment growth from over 1,800 trees in 21 uneven-aged, and 10 even-aged pure ponderosa pine stands. In even-aged stands, model predictions were accurate, and unbiased with respect to tree size. In uneven-aged stands, the Black Hills equation under-estimated growth in general, and was biased with respect to tree size. Negative error was greater for small trees than for large trees. Consequently, adjustments applied by FVS actually worsened size-related bias in uneven-aged stands. However, adjustments were rarely applied. Criteria required for application of the southwest model were met by less than a fifth of trees, and no trees met the requirements for application of the blended model.

*Using the Forest Vegetation Simulator to Forecast Acorn Production at Bent Creek Experimental Forest, NC, USA*
**Chad Keyser – Forester**
**US Forest Service, Forest Management Service Center**
**Authors: Chad Keyser, Cathryn Greenberg, Leah Rathbun, Anita Rose, Todd Fearer, and Henry McNab**

**Abstract.** Acorn availability strongly influences wildlife populations and forest ecology, but production is highly erratic among years, species, locations, and individual trees. Forest managers need models that can predict average acorn production capability, with the capacity to tailor yield estimates to individual stands and test forest management scenarios that include adjustments for forest maturation over time. Our study examined how published acorn prediction models could be implemented into the Forest Vegetation Simulator (FVS) and how these models could be used to estimate acorn production in project analyses. FVS simulations showed that acorn production for the Bent Creek Experimental Forest in North Carolina declined slightly over the next 50 years when oak decline events were included in the simulations.

*Linking FVS into Agent-Based Modeling of Coupled Social-Ecological Systems*
**Jessica Leahy – Associate Professor**
**University of Maine**
**Authors: Jessica Leahy, Aaron Weiskittel, Jeremy Wilson, Robert Seymour, and Erika Gorcyzca**

**Abstract.** FVS is commonly used by forest biometricians, silviculturists, and other forest scientists to model growth and yield. In this poster, the emerging role for FVS in coupled social-ecological system modeling, particularly agent-based modeling (ABM), will be explored. Agent-based models are "…computationally intensive dynamic simulation model[s] of how individual agents (typically using simple behavioral rules) interact with their environment and each other, giving rise to system-wide macro patterns or emergent properties which cannot be deduced from the individual agent's rules" (Loomis, Bond, and Harpman, 2009, p.39). ABM allows for a more integrated approach, providing new insight into landowner decisions and responses to policy and environmental changes by linking social and biophysical interactions. We will highlight the use of FVS in our ABM developed to model family forest landowner harvest decisions in Maine. Landowner profiles are maintained in Microsoft Access, and trees are populated and grown on their landscape using FVS, linked by the programming languages of Python and SQL. In addition to a baseline scenario, a social system shock in the form of property tax increases and a biophysical system shock in the form of widespread tree mortality were tested. We will share lessons learned in using FVS in an ABM, and make suggestions for how to improve FVS modeling technology so that it can be used in future applications of forest-based, coupled social-ecological systems modeling.

*Canopy Cover Estimates: Modifying FVS estimates to Include Different Spatial Patterns*

**Leah C. Rathbun – Forest Biometrician**
**US Forest Service, Forest Management Service Center**
**Authors: Leah C. Rathbun and Andrew Sánchez Meador**

**Abstract.** The purpose of this research was to assess the accuracy of predictions of percent canopy cover produced by the Central Rockies Variant of FVS using stem plot data from Colorado and provide a recommendation for correcting the FVS estimates based on tree spatial distribution. Our hypotheses were: 1) the Beer-Lambert Law correction factor for crown overlap in FVS would produce accurate estimates for percent canopy cover when spatial distributions were random; 2) when spatial patterns were clumpier, the correction factor in FVS would overestimate percent canopy cover; and 3) using an estimate of spatial distribution (such as Nearest Neighbor Index or Pielou's Index of Non-randomness) a correction factor could be developed to obtain better estimates of percent canopy cover in FVS.

*The Fire and Fuels Extension to the Forest Vegetation Simulator – Updates and Enhancements 2007-2012*

**Stephanie Rebain – Forester**
**US Forest Service, Forest Management Service Center**
**Authors: Stephanie Rebain**

**Abstract.** The Fire and Fuels Extension (FFE) to the Forest Vegetation Simulator (FVS) is a software tool for natural resource managers that has been used extensively to assess fire hazard and examine fuel treatment effects in forested ecosystems. With the FFE-FVS system, users can input their own forest inventory data, simulate how these forests will grow over time, and simulate a wide variety of management activities, such as thinning and prescribed burning. FFE was first developed in the mid 1990's, but has been continually updated since that time. Three major features added in the last five years include down wood volume and cover reports, the ability to use a new fuel model selection logic that incorporates the Scott and Burgan (2005) fuel models, and the ability to predict fire behavior using modeled fuel loads directly rather than selecting a fuel model for that purpose. This poster reviews these three new features.

*Estimated Timber Productivity and Financial Returns in a Natural Disturbance-Based System Using FVS-NE*

**Mike R. Saunders – Assistant Professor**
**Purdue University**
**Authors: Mike R. Saunders and Justin E. Arseneault**

**Abstract.** Concerns over biodiversity have spurred interest in silvicultural systems based on patterns of natural disturbances in forest ecosystems. Common to many of these systems is an increase in spatial variability produced (e.g., creation of large interior gaps or variable density thinning) that can be quite difficult to model in some FVS variants. Without the capability to use FVS to forecast stand development and resulting financial returns, many land managers are hesitant to apply these systems. We compare the stand development, timber productivity, and financial returns of the gap-based Acadian Forest Ecosystem Research Program (AFERP) treatments to those of a two-stage shelterwood system and a single-tree selection system. The AFERP systems produced the widest ranges in diameter distribution at the end of the harvest rotation and were more effective in recruiting large trees (> 60 cm) relative to conventional silviculture systems. Standing value at the end of the rotation was inversely related to projected production rates and financial returns, which were greatest under the single-tree selection system ($3200 $ha^{-1}$), followed by the small-gap ($2900 $ha^{-1}$), large-gap ($1900 $ha^{-1}$), and shelterwood ($1450 $ha^{-1}$) systems. Our analysis suggests that, within the Acadian Forest Region, natural disturbance-based systems are capable of sustaining a greater diversity in forest structure and composition while producing volume yields and financial returns that are competitive with conventional even- and uneven-aged silvicultural systems.

*Validating the Southern Variant Forest Vegetation Simulator (SN-FVS) Height Predictions on Southeastern Hardwoods in Kentucky and Tennessee*

**Steven C. Stedman – Forest Research Associate III**
**Colorado State University, Center for Environmental Management of Military Lands (CEMML)**
**Authors: Steven C. Stedman and Bernard R. Parresol**

**Abstract.** The Forest Vegetation Simulator (FVS) height prediction equations are cornerstones of the model. The objective of this study was to test the Southern Variant of the Forest Vegetation Simulator (SN-FVS) prediction accuracy of the species height-diameter functions on a large independent hardwood dataset in southwestern Kentucky and northwestern Tennessee. Accuracy is the composite of both bias (i.e., average error) and precision. Validation was run on total height measurements taken on 9,236 trees from 301 fixed-area plots across the Fort Campbell forested landscape. There were 36 species with sufficient numbers (>30) to compute test statistics. Along with percent bias, statistics for the mean square error and prediction accuracy at ±25 percent were calculated with the combined effect yielding a unified estimate of prediction accuracy. For all species combined, the results are reasonable given the high variability normally associated with estimation of tree height. On an individual tree species basis, the results are less than desirable; 42 percent of the species failed to meet the acceptable precision standard while 50 percent of the species were not within the accepted standard of ±5 percent for accuracy. With this data, the SN-FVS also tended to underestimate actual tree heights 3-times more often than it overestimated heights. Inconsistencies with precision, accuracy and variability statistics (or combination thereof) indicate that species such as northern red oak (*Quercus rubra*), scarlet oak (*Quercus coccinea*) and black oak (*Quercus velutina*) may need additional work to more accurately predict tree heights.

*Adaptive Management and Forest Vegetation Simulator Using the Event Monitor and the Role of Potential Natural Vegetation for Climate Adaptation*

**Melody A. Steele – Forester**
**Bureau of Indian Affairs**
**Authors: Melody A. Steele**

**Abstract.** The adaptive management approach for Federal and Tribal forested lands have been evolving over the decades. The Forest Vegetation Simulator aka Suppose model has been the most effective prognosis software for forest site specific environmental analysis. It provides forest landscape ecological and economical alternatives for short-term timber harvest plans or long-term natural resource sustainability. Ultimately it achieves an objective means for disclosure of alternatives. There is enough precision for silvicultural prescriptions and wildlife habitat recommendations for implementation using adaptive management. The heart of the Forest Vegetation Simulator is pumped by the Event Monitor which allows for uncertainty blended with known cause and effects. The model uses several potential natural vegetation citations which contain a treasure of forestry, wildlife and natural fire descriptions and supporting data in each publication. These publications are identified for each variant - geographical area which adds ecological finesse. The ultra fast processing allows for hundreds of field inventory data or surrogate data on thousands of acres to be analyzed simultaneously while applying these ecological findings. By recognizing the potential natural vegetation research based on temperature and moisture, we can better meet today’s challenges of climate adaptation strategy and other environmental anomalies. The combination of input of current forest vegetation field inventory with site potential using potential natural vegetation using the Event Monitor and randomness for uncertainties presents optimal results. With professional management input and review, we achieve objectively comparable ecological and economical alternatives.

*ArcFuels: an ArcGIS Interface for Fuel Treatment Planning and Wildfire Risk Assessment*

**Nicole Vaillant – Fire Ecologist**
**US Forest Service, Pacific Northwest Research Station**
**Authors: Nicole M. Vaillant and Alan A. Ager**

**Abstract.** Wildland fire risk assessment and fuel management planning on federal lands in the U.S. is a complex problem that often requires advanced fire behavior modeling and intensive spatial data analyses. Both the benefits and potential impacts of proposed fuel treatments must be clearly demonstrated in the context of land management goals and public expectations. Potential fire behavior metrics, including fire spread, intensity, likelihood, and ecological risk need to be analyzed for proposed fuel treatment alternatives. ArcFuels was built to streamline the fuel management planning process, and provide tools for quantitative wildfire risk assessment. ArcFuels integrated a number of forest growth and fire behavior models and corporate spatial data within a ArcGIS framework. ArcFuels is available for both ArcGIS 9.x and 10.0 as well as within the Citrix environment. The system vastly simplifies spatial data manipulations and wildfire behavior analyses for design and testing fuel treatment alternatives. ArcFuels is used by forest and fire mangers and planners as well as researchers. ArcFuels has been utilized in a number of NEPA projects at the national forest district planning level and has been used in peer-reviewed published research. The program along with demonstration data and a user's guide and tutorial are available for download at www.arcfuels.org.

# Wednesday April 18th, 2012

**Panel Discussion**
**8:15– 9:00am**
**Moderated by Gary Dixon**
**Panelists: Nicholas Crookston, Donald Robinson, Michael Van Dyck, and Aaron Weiskittel**

The panel will discuss their vision of the future of FVS, including their ideas on how FVS can maintain relevancy and how its functionality should change to better meet user needs and requests. They will discuss needs and future enhancements in both the short term and the longer term. Each of the panel members will briefly describe their work with respect to future enhancements to the model. The panel will then answer questions submitted by the conference attendees. Everyone in attendance will have the opportunity to submit written questions regarding the future of FVS, and a moderator will read selected questions to the panel. Everyone is encouraged to participate.

## Session 5: Emerging Applications
## 9:00– 2:15pm
## Moderated by Tim Bottomley

***FVS as a Cooperator in Other Systems and Cooperation in FVS Development***
**Nicholas L. Crookston – Operations Research Analyst**
**US Forest Service Rocky Mountain Research Station**
**Authors: Nicholas L. Crookston**

**Abstract.** There is a need for FVS to serve as a component in forest simulation systems in addition to serving its traditional role as a powerful stand-alone growth model. Work is underway that is guided by functional requirements that are divided into two groups; those related to stand-level interaction and those related to landscape-level interactions. At the stand-level, a shared library version of FVS provides the ability to use independently-built growth and mortality functions, add submodels that represent other ecosystem components, incorporate new regeneration establishment models, run externally built harvesting logic, and include the creation of special outputs, including graphics, all without modifying FVS and without recompilation of the source code. At the landscape-level, FVS needs to work cooperatively with models that run over large areas representing disparate components of a modeled system and interacting with each other at every time step and over all stands in the spatial domain. Creation of these capabilities is requiring surprisingly few changes to FVS source code centered on the upper level routines that are otherwise rarely modified and are the same for all variants. The changes have been accomplished as part of the Open-FVS project that has as a major goal making participation in FVS development more opportune for people outside the Forest Service thereby fostering collaboration on FVS development. A few infrequently used features of FVS (such as the Parallel Processing Extension) are not supported but can be added if not soon retired. Existing keyword files still will run and programmers with knowledge of the source code will have little new to absorb. A greatly simplified build process, replacement of the windows-only and now obsolete data base connectivity, switching to free and modern compilers, and adding support for Linux and Unix (including MAC OSX) are products of the effort.

*Development of an Application Program Interface (API) for the Forest Vegetation Simulator*

**Donald C.E. Robinson – Senior Systems Ecologist**
**ESSA Technologies, Ltd.**
**Authors: Donald C.E. Robinson, Sarah J. Beukema, and Colin J. Daniel**

**Abstract.** FVS is being adapted so that it is better able to co-operate with other software systems while simulations are actually under way. To this end, we have developed an Application Program Interface (API) that allows other software systems and models to run FVS programmatically, passing inventory and site information through the API, running FVS and then returning output directly to the calling application. This functionality is currently implemented in a simplified and experimental run/stop/run fashion which has a very small memory footprint. We anticipate that this experimental approach will be soon be enhanced to allow run/pause/continue simulations which will better account for between-cycle calculations and provide better program flexibility. The API is implemented through C++ language functions which call a Dynamic Link Library (DLL) version of the main FVS model. Two applications are currently being developed using this API. The first of these links FVS to the TELSA model for simulations that will we expect will eventually grow to a geographic scale of 500,000 stands. The FVS-TELSA linkage is written in the VB.Net language, and code samples will be presented at the conference. The second application creates a plug-in to Microsoft Office. An example of an Excel plug-in will be demonstrated and code samples will be presented.

*FVS-WRENSS: A Water Yield Postprocessor for FVS*

**Robert Havis – Information Technology Specialist**
**US Forest Service, Forest Management Service Center**
**Authors: Robert Havis**

**Abstract.** The FVS-WRENSS Postprocessor is a tool to estimate water yield changes based on growth predictions from the Forest Vegetation Simulator (FVS) model. The Water Resources Evaluation of Non-point Silvicultural Sources (WRENSS) model was developed in the 1970s, about the same time as FVS, and simulates water yield from forested systems by taking the difference between seasonal precipitation and predicted evapotranspiration rates. Both the FVS and WRENSS models have been calibrated to data throughout most of the United States. The WRENSS model has been adapted to postprocess site data and results from FVS simulations (stand area, aspect, elevation, and basal area and tree height) to estimate the effects of silvicultural treatments and disturbance on forest water yield. The purpose is to describe the FVS-WRENSS Postprocessor assumptions, limitations, and capabilities for evaluation by potential users. Examples of the FVS-WRENSS Postprocessor output show changes in water yield on a per-acre basis for individual stands, and on an area-weighted, per-acre basis for groups of stands in an FVS serial run. Water yield changes are illustrated for thinning treatments, and fire and mountain pine beetle disturbance events. A sensitivity analysis of WRENSS input variables shows that water yield predictions are most sensitive to input precipitation and thinning intensity, and not very sensitive to model parameters.

***Coupling FASST and FVS to Simulate Climate and Silvicultural Impacts on Seasonal Operability and Logging Equipment Terramechanics***

**Rob Keefe – Instructor**
**University of Idaho**
**Authors: Rob Keefe, Zack Holden, and Anthony Davis**

**Abstract.** The US Army Corps of Engineers Fast All Season Soil STrength (FASST) model (Frankenstein, 2004) simulates the state of the ground as a function of local climate data for battlespace intelligence. Frankenstein's addition of vegetation models to FASST make it possible to simulate the effects of understory vegetation and multi-layer forest canopies on below canopy snow accumulation and ablation, soil moisture content, and the effects of freeze-thaw dynamics on soil load bearing capacities. A simple methodology can be used to translate FVS stand structure into the LAI layer thickness and height inputs required for FASST in order to simulate silvicultural effects on the within-year, below canopy micro-climate by running FASST and FVS jointly with multi-scale temporal representation. This approach has been used successfully by the author to simulate climate and canopy impacts on within-year, hourly conifer regeneration phenology within FVS's 10 year projection cycle by post-processing with R scripts that translate and pass data between the models. In this study, we used the Army Corps. model's soil strength calculations to forecast climate and silvicultural impacts on logging equipment physical terramechanics and mobility on the University of Idaho Experimental Forest. Gridded temperature loggers at variable-radius plot locations on a 200 acre parcel on the UIEF and a second grid on the Bitterroot National Forest, in an area with LIDAR-derived stand variables, were used to validate the ability of the coupled model system to predict below-canopy soil conditions and their potential impact on equipment mobility.

***Development and evaluation of the Acadian Variant of the Forest Vegetation Simulator***

**Aaron Weiskittel – Assistant Professor**
**University of Maine**
**Authors: Aaron Weiskittel1, John Kershaw, and Matthew Russell**

**Abstract.** The goal of this project was to develop a new variant for the Forest Vegetation Simulator (FVS) that is applicable to the Acadian region of Maine and New Brunswick and flexible enough to account for a range of potential future conditions. Specific objectives were to: (1) compile the regional growth and yield data; (2) develop an index of potential productivity; (3) fit total height and height to crown base static equations by species; (4) develop diameter and height increment equations by species; and (5) estimate growth modifiers for management activities. Since the start of the project in 2008, several significant developments have been made. First, an extensive database of nearly 3 million observations spanning over 50 years of observation and a large geographic area has been compiled. This database has been used to develop equations for maximum and stand-grown crown width as well as height and height to crown base have been estimated for the primary species in the Acadian Region. These equations give drastically different predictions when compared to the existing equations currently used by FVS-NE. Currently, diameter and height increment equations are being developed and some interesting trends are starting to emerge. Some key trends are predicting diameter rather than basal area increment significantly reduces long-term bias, a maximum multiplied by a modifier approach is more stable than unified equations, and treating species as a random effect allows for improvements in predictions for most species. These results as well as the future direction of the project will be discussed.

### *FVS-ORGANON: Plugging in a New Growth Engine*

**Jeff Hamann – President**
**Forest Informatics, Inc.**
**Authors: Jeff Hamann, Erin Smith-Mateja, and Nicholas L. Crookston**

**Abstract.** The Forest Vegetation Simulator (FVS) has practically everything users need to estimate current and predict future forest conditions. The simulator is extremely flexible, and users can modify most predictions with the existing features. For example, without recompiling the source code, users can create user defined output variables, modify growth predictions, change volume equations, and produce carbon accounting estimates using the extensive KEYWORD system. For users who need more control over the predictions, or want to completely replace the prediction models, or simply wish to take advantage of the decision support system features of FVS and SUPPOSE (e.g. SVS and SQL) with other forest growth models (e.g. CONIFERS, ORGANON or CACTOS), extensive source code modifications and testing is required. One possible solution is to provide a generic growth model interface for third-party growth models like those mentioned previously. To examine the feasibility of extending FVS to use the predictions from another growth model, we created FVS-ORGANON, which replaces the internal growth model predictions from FVS with those from the ORGANON Dynamic Link Library (DLL) project. While the application programming interface (API) for the ORGANON DLL project is not standardized, our results show that: 1) interfacing FVS with other forest growth models is feasible and advantageous for several user-groups, and 2) further refinements to a common forest growth model API would reduce simulator development costs and extend usability.

### *FSVeg Spatial Data Analyzer: A Spatial Interface to Integrate FVS, FSVeg and FSVeg Spatial technologies for Project and Landscape Analysis*

**Jonathan Marston – Systems Analyst**
**Cherokee Services Group**
**Authors: Jonathan Marston, Stephen Williams, and Lynne Bridgford**

**Abstract.** Stand exam data collected by the Forest Service has been stored in the FSVeg database for more than a decade. More recently an ArcGIS solution called FSVeg Spatial was built that provides a spatial front-end to maintain the related vegetation polygons and linkages to exam data. Over 150 million acres of vegetation polygons are managed by FSVeg Spatial, and roughly 500,000 stand exams are tied to a subset of these polygons. The FSVeg Spatial Data Analyzer (DA) is the most recent addition to the FSVeg suite of products. The DA provides a user-friendly interface to easily extract FSVeg spatial data and associated stand exam data into FVS-ready format in addition to running FVS behind the scenes to grow exam data to the current time. The DA provides a GIS front-end for running FVS and displaying the results spatially. A user can click on a polygon and run Suppose. A user can click on a drop down list of FVS output items (e.g. Basal Area) and create a symbolized map automatically. The alternative building function allows point and click assignment of activities like “prescribed burning”, “thin to BA 40”, etc. and then the user can run FVS to model future conditions for each alternative. The powerful Nearest Neighbor Imputation function within the DA can impute exam data to all polygons providing wall to wall data for the project area for use with FVS. The Natural Resource Manager (NRM) staff provides full support to the DA, along with other FSVeg products, including documentation, training, and helpdesk support.

***NFS Regional Vegetation Classification Algorithms Embedded Within the Forest Vegetation Simulator***

**Don Vandendriesche – Forester / Program Manager**
**US Forest Service, Southwestern Region**
**Authors: Don Vandendriesche**

**Abstract.** Mid-scale planning projects require that a vegetation classification system be in-place prior to any modeling effort. Map polygons and inventory data are needed to define the basic vegetation units. Fundamentally, a classification system that describes existing vegetation conditions is hierarchically based using components of forest type, size class, stocking density, and vertical stories. U.S. Forest Service Regions have developed unique vegetation classification systems that capture floristic attributes native to their local geographic area. The computational algorithms have been gathered and coded within the Forest Vegetation Simulator. A case example from the Southwestern Region will be presented that demonstrates the utility of the regional algorithms.

***Local Weather Data Now Accessible and Usable in the Western Spruce Budworm Defoliator Model Extension of Forest Vegetation Simulator***

**Helen Maffei – Forest Pathologist**
**US Forest Service, Forest Health Protection**
**Authors: Helen Maffei, Lance David, Leo Yanez, and Kathy Sheehan**

**Abstract.** A feature has been added to the General Defoliation Model (formerly known as the Western Spruce Budworm Model) which allows the use of actual weather station data to drive larval and foliage development. Prior to this update, simulated weather was the only weather option available and weather related parameters were generated by the model from historical averages and variation. As a result projections never replicated actual weather events; making real world validation of predictions highly problematic. The new option uses actual daily weather station data to calculate weather related parameters needed to predict larvae and host foliage development. The timing of specific events and length of stays in stages of development for both larvae and foliage are then used by the population dynamics component of the model. Larvae and host foliage synchrony is a general description of what is determined from the parameters derived from the daily weather data. The weather related driving variables now have a concrete and verifiable basis since they are tied to physical weather data. As a result, entomologists will now have the ability to compare predicted with actual outbreaks under real weather scenarios. This ability to validate and refine the underlying population model will confer more confidence when applying the model results and vegetation layers to risk map landscapes as well as evaluation of how risk might change under various climate change scenarios.

## Session 6: Restoration and Management
## 2:15– 5:10pm
## Moderated by Chad Keyser

***Development of Alternative Growth Equations for the Lake State Variant of the Forest Vegetation Simulator (lS-FVS) to Capture the Increased Growth of Managed Stands***

**John M. Zobel – PhD student**
**University of Minnesota**
**Authors: John M. Zobel and Alan R. Ek**

**Abstract.** The original Lake States variant of the Forest Vegetation Simulator (LS-FVS) became available in 1993 and used a regional growth model (LS-TWIGS). In developing and validating the original model, the development team utilized permanent research and inventory plots from across the upper Midwest. This data contained a wide variety of management histories, with a continuum of natural stands to plantations. The resulting growth projections are appropriate for stands or forests with similar backgrounds, but lack sensitivity for purely managed stands, especially intensively managed stands that have undergone combinations of treatments. With an ever increasing emphasis on ecological sustainability (while improving economic productivity), the need for an LS-FVS growth model alternative that accurately depicts the behavior and gains from intensive forms of management has become a high priority. In this study, we developed procedures for defining surrogate managed stand data from the USDA Forest Service Forest Inventory and Analysis (FIA) database for the Lake States region. Following the pattern from other FVS variants, we will add a dummy variable to the existing LS-FVS growth equation and fit the new model form to the FIA managed stand data. The coefficient on this new variable will represent the increased growth expected for managed stands. The final version of the managed stand growth model will be programmed into the FVS framework and made available to LS-FVS users via the existing keyword "MANAGED".

***Predicting Growth and Development of Managed and Unmanaged Eastern White Pine Stands in Maine***

**Robert Seymour – Professor**
**University of Maine**
**Authors: Robert S. Seymour, Justin Waskiewicz, and Emma Schultz**

**Abstract.** Eastern white pine (*Pinus strobus* L.) is arguably the most widespread and valuable commercial species in the northeastern United States, occurring in both monocultures of old-field origin and in many natural mixed-species associations of both central hardwoods and northern conifers. White pine is typically managed on long sawtimber rotations, including several commercial thinnings, which culminate in an extended shelterwood regeneration sequence. Our data come from four separate studies: remeasured plots from an unmanaged chronosequence ranging from ages 10 to 200; 20-year results from a commercial thinning study contrasting B-line and low-density treatments; reconstructions of sapling height development under variable overstory densities; and a reconstruction study of white pine growth in mixture with central hardwoods and eastern hemlock. We will (1) contrast actual stand performance against the current Northeast Variant in terms of diameter growth, height development, mortality (remeasured plots only), maximum stocking, small-tree model performance, and volume estimation; (2) suggest model calibrations and other modifications to improve performance where possible; and (3) apply the calibrated model to compare two contrasting silvicultural systems with radically different density management regimes.

### *Quantifying the FVS Effects of Management Activities for Land Management Planning*

**Don Vandendriesche – Forester / Program Manager**
**US Forest Service, Southwestern Region**
**Authors: Reuben Weisz, Don Vandendriesche, and Melinda Moeur**

**Abstract.** Previously, the Forest Vegetation Simulator (FVS) was used to report outcomes from natural growth modeling runs. Mean residence times, transition probabilities, and associated vegetation characteristics were computed. These successional attributes were used to parameterize the deterministic pathways in State and Transition Models (STM) used for land management planning in Arizona and New Mexico. A continuation of this work has led to the application of the FVS model to quantify the effects of management activities. A standard set of silvicultural and fire treatments were evaluated. Forest Inventory and Analysis (FIA) plots were stratified by each model state within designated Potential Natural Vegetation Types (PNVT). A range of activity outputs from FVS (resultant destination states, harvest volumes, fire hazard indices, and carbon metrics) were captured and linked to probabilistic pathways through the modeling framework.

### *Estimating Growth Impacts of Interior Stand Edge in Gap-Based Silvicultural Treatments Using FVS-NE*

**Mike R. Saunders – Assistant Professor**
**Purdue University**
**Authors: Justin E. Arseneault and Mike R. Saunders**

**Abstract.** Concerns over biodiversity have spurred interest in silvicultural systems based on patterns of natural disturbances in forest ecosystems. Common to many of these systems is an increase in spatial variability produced (e.g., creation of large interior gaps or variable density thinning) that can be quite difficult to model in some FVS variants. Without the capability to forecast stand development and resulting financial returns, many land managers are hesitant to apply these systems. Modeling stand development with FVS typically requires the inherent assumption that intra-stand variability has negligible effects on stand responses. We investigate this assumption by modeling patterns of edge creation and longevity using a discrete space model with the two canopy gap-based silvicultural systems of the Acadian Forest Ecosystem Research Program of central Maine. Results suggest, across both treatments, up to 52.4% of the stand area can be within one mature tree height of a gap edge, and that the edge area could persist for multiple cutting cycles (>10 years).

***Investigating Combined Long-Term Effects of Variable Tree Regeneration and Timber Management on Forest Wildlife and Timber Production Using FVS***

**James D.A. Millington – Leverhulme Early Career Fellow**
**King's College London**
**Authors: James Millington, Megan Matonis, and Michael Walters**

**Abstract.** Tree regeneration success and composition in northern hardwood forests of the Great Lakes region are variable and influenced by multiple factors. To examine the potential long-term impacts of variable regeneration, combined with uneven-aged timber harvest silviculture, we have developed a forest stand regeneration, growth and harvest simulation model. This model couples FVS (Ontario variant) with a forest-gap tree regeneration sub-model developed from field data collected in northern hardwood forests of Michigan's Upper Peninsula. The development and coupling of our regeneration sub-model with FVS is required because the multiple factors influencing regeneration in the study region cannot be represented internally within FVS. Here, we present our regeneration sub-model, describe its coupling with FVS, and illustrate the use of the resulting integrated simulation model to investigate potential long-term impacts on stand structure, songbird occupancy probabilities, and timber production. When simulated over a century, we find that higher overall tree regeneration densities and greater proportions of commercially high value, deer browse-preferred, canopy tree *Acer saccharum* (sugar maple) than low-value, browse-avoided subcanopy tree *Ostrya virginiana* (ironwood) ensure conditions allowing larger harvests of merchantable timber, and had greater impacts on songbird occupancy probability change. We also find that harvest prescriptions can be tailored to affect both timber removal volumes and bird occupancy probability simultaneously, but only when regeneration is adequate. Our results show how the use of FVS coupled with forest-specific models of tree regeneration and habitat suitability can help forest and wildlife managers work together to identify appropriate timber harvest regimes for long-term sustainability.

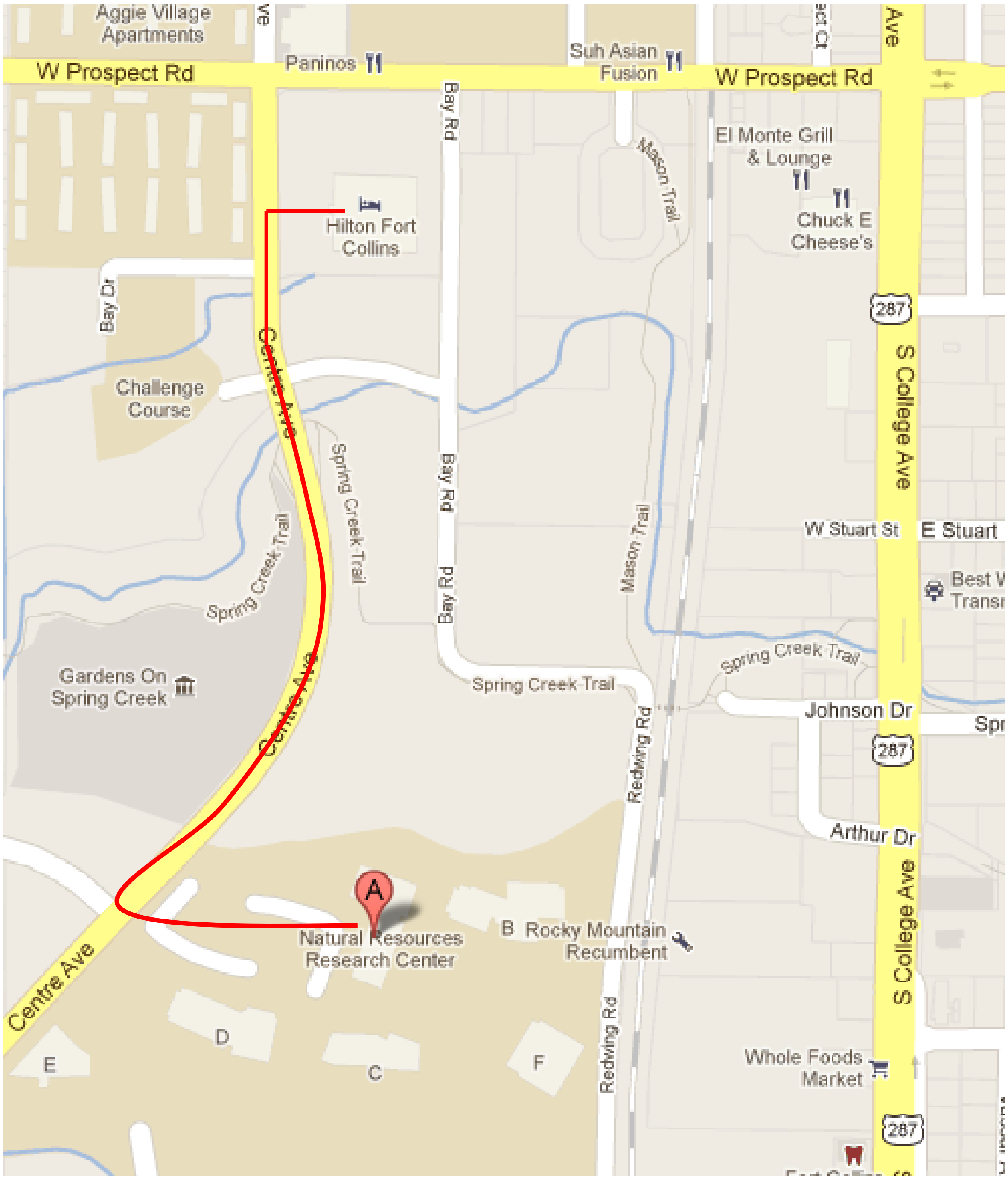
***Simulating Aspen/Birch Dynamics in a Woodland Heath Community: FVS Applied to Ecosystem Restoration***

**Giorgio Vacchiano – Post Doctoral Researcher**
**University of Torino**
**Authors: Giorgio Vacchiano and Davide Ascoli**

**Abstract.** The research aims at simulating the effect of fire and domestic grazing on the dynamics of *Populus tremula* L. and *Betula pendula* Roth. mixed stands in a continental heathland in Southern Europe. FVS and FFE needed calibration to the species and sites under analysis. As a basis for calibration, we chose an FVS variant based on ecological similarity (soil type, fire regime, common genera) and data available for the different submodels. We collected inventory data from the larger NW Italy region and integrated them with a field survey where we measured stand structure, tree size and growth by means of increment cores. We validated FVS "out of the box" against observations in order to identify relevant biases. Where applicable, we calibrated FVS submodels by means of the self-calibration feature and keywords. Calibration of FFE was achieved by fuel models customization, Rothermel's fire spread model adjustment, and comparing tree mortality probability curves vs. fire behavior descriptors (i.e. fireline intensity) using mortality and fire behavior data measured in fire experiments. The impact of grazing (not a native FVS component) was simulated by either (1) customizing the harvesting schedule, or (2) calibrating for a "grazed" version of the focus tree species, using data measured in grazing vs. control experiments. We simulated the outcome of several management + disturbance regimes, i.e., undisturbed, recurrent wildfires, recurrent grazing, low-frequency prescribed burning followed by grazing. Model output served as a basis for management recommendations (i.e., Rx prescriptions) aimed at the conservation of the heathland cultural landscape.

# Thursday April 19th, 2012
# Workshops

All workshops will be held in the Natural Resources Research Center, Building A, located west of the Hilton Hotel on Centre Ave. The distance from the hotel to the Natural Resources Research Center is approximately 2.5 blocks.



***Refresher***
**8:30– 11:30am**
**Organized by Chris Dahl and Stacie Holmes**
**Room 313**

This course is designed as a refresher workshop on how to use the Suppose Interface to make FVS growth projections. By the end of the workshop you will be able to perform basic management actions, adjust FVS runs to local conditions by using model modifiers, and obtain various FVS output reports.

***Advanced Topics***
**8:30– 11:30am**
**Organized by Leah Rathbun and Don Vandendriesche**
**Room 122-124**

This workshop will provide hands on modules designed to expand your knowledge on creating custom output variables and simulating advanced management activities.

***Ask the Experts***
**8:30– 11:30am**
**Organized by Michael Van Dyck, Erin Smith-Mateja, Chad Keyser, Stephanie Rebain, Lance David, and Bob Havis**
**Room 120**

You've probably seen books with titles containing the phrase, "everything you wanted to know but were afraid to ask." Well this is the place to actually ask the questions you've been afraid to ask. This "workshop" is actually an open discussion forum designed to answer any questions the attendees may have. Most of the FVS staff will be on hand, as will several other "experts" knowledgeable in aspects of the FVS model. Questions could potentially refer to actual problems or theoretical issues. They could range from specific procedural techniques to general practices; from underlying models to overall model concepts; from simulation to interpretation; from commonplace to obscure. Questions could be in the form of "how do I ..." or "why does the model ..." or "is there a better way to ..." or any other form.

***Carbon***
**12:30– 3:00pm**
**Organized by Stephanie Rebain and Coeli M. Hoover**
**Room 313**

This hands-on workshop will cover the basics of the FVS carbon reports. Topics include an overview, using Suppose to request the reports, reviewing the output, and practicing with some example data.

***Climate***
**12:30– 5:00pm**
**Organized by Erin Smith-Mateja and Nicholas L. Crookston**
**Room 120**

Nick Crookston (RMRS) with the FVS staff will provide a hands-on workshop covering the Climate-FVS model for the western FVS variants (excluding Alaska). The workshop will provide background and instruction on how to use the FVS-Climate Extension.

***Landscape-level Analysis***
**12:30– 5:00pm**
**Organized by Chad Keyser, Jonathan Marston, Lynne Bridgford, and Eric Twombly**
**Room 122-124**

The FSVeg Spatial Data Analyzer support team in conjunction with FVS staff will provide a workshop that will examine landscape analysis with FVS using the Forest Service product FSVeg Spatial Data Analyzer. The majority of the workshop will consist of discussion and demonstration of the applications capabilities. Topics will include: Acquisition of project data, visualization of FVS data, application of FVS activities to a landscape, alternative management, treating only portions of an area and imputing data across a landscape. There will be a few opportunities during the workshop to participate in hands-on exercises. It is important to note that the Data Analyzer currently runs in the Forest Service environment. For outside agency participants, options will be provided to participate in the hands-on work.