16th Biennial Southern Silvicultural Research Conference

February 14-17, 2011
DoubleTree Hotel
Charleston, South Carolina

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February 8, 2011

Dear Participants,

Welcome to Charleston and the 16th Biennial Southern Silvicultural Research Conference! This year's conference will feature two plenary talks on Tuesday morning. Dr. Dave Wear, Southern Research Station, and Dr. Al Lucier, NCASI, will discuss the myriad of driving forces, e.g. climate change, urbanization, ownership change, invasive species, influencing southern forests today, and the management implications for the future. Tuesday afternoon, evening and Wednesday will feature over 170 oral and poster presentations covering a broad array of topics: pine and hardwood silviculture, soil and water, growth and yield, economics, physiology, genetics, restoration, and bioenergy.

In addition to the General Sessions, we are excited to have a Special Session focusing on the theme "Southern Forest Science in Support of a Low Carbon Economy". Invited and selected speakers were asked to address the state-of-science in forest carbon cycle research, political and technical barriers in developing carbon accounting systems, bioenergy systems, economics of carbon sequestration, and co-benefits and costs as the southern region moves towards a low carbon economy. We are also pleased that *Forest Science* has agreed to publish papers from the session in a special issue.

On Thursday, two full-day field trips will explore some of the most productive and ecologically and economically important forests in the lower Coastal Plain of South Carolina. Dr. Phillip Dougherty, ArborGen Inc., will highlight state-of-the-art intensive management of loblolly pine and Dr. Carl Trettin, Southern Research Station, will present silvicultural research on the Francis Marion National Forest and the Santee Experimental Forest.

As in the past, proceedings of the 16th BSSRC will be published as a SRS General Technical Report, however, this year presenters of oral presentations are given the option of submitting a full conference paper or a shorter extended abstract. Proceedings instructions for full manuscripts and extended abstracts are located on the BSSRC web page.

The 16th BSSRC would not have been possible without the service of the planning and selection committees. We gratefully acknowledge student scholarship chairs Mike Kane, Zakiya Leggett, and Geoff Wang, student presentation awards chair Brian Lockhart, field tour organizers and guides Carl Trettin and Phillip Dougherty, and all of the session moderators.

Thanks to our many program sponsors. Special thanks to thank Susan Moore and Kelley McCarter with the Forestry and Environmental Outreach Program (FEOP) at North Carolina State University for handling just about all of the meeting administrative activities including logistics, lodging, and food at the Double Tree Hotel, registration, and field trip lunches and transportation. ArborGen, Inc. provided support for and assisted with our field trips.

We hope that this meeting will be both informative and enjoyable for the participants, and that everyone has a pleasant stay in Charleston.

Chris A. Maier
Kurt H. Johnsen

16th Biennial Southern Silvicultural Research Conference Organizing Committee

Chris Maier (co-chair)
USDA Forest Service, Southern Research Station, Forest Genetics and Ecosystem Biology

Dana Nelson (co-chair)
USDA Forest Service, Southern Research Station, Forest Genetics and Ecosystem Biology

Kurt Johnsen (co-chair)
USDA Forest Service, Southern Research Station, Forest Genetics and Ecosystem Biology

Felipe Sanchez (co-chair)
USDA Forest Service, Southern Research Station, Forest Genetics and Ecosystem Biology

Tim Albaugh
North Carolina State University, Forest Nutrition Cooperative

Susan Cohen
Marine Corps Base Camp Lejeune, Defense Coastal/Estuarine Research Program

Tom Dean
Louisiana State University, School of Renewable Natural Resources

Phil Dougherty
Arborgen, Inc.

Andy Edzell
Mississippi State University, Department of Forestry

Tom Fox
Virginia Tech, Department of Forest Resources and Environmental Conservation

Jim Guldin
USDA Forest Service, Southern Research Station, Southern Pine Ecology and Management

Eric Jokela
University of Florida, School of Forest Resources and Conservation

Mike Kane
University of Georgia, Warnell School of Forestry and Natural Resources

Tara Keyser
USDA Forest Service, Southern Research Station, Upland Hardwood Ecology and Management

Karen Kuers
The University of the South, Department of Forestry and Geology

Zakiya Leggett
Weyerhaeuser Company

Ted Leininger
USDA Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research

Brian Lockhart
USDA Forest Service, Southern Research Station, Center for Bottomland Hardwoods Research

Tim Martin
University of Florida, School of Forest Resources and Conservation

Steve McKeand
North Carolina State University, College of Natural Resources

Evan Mercer
USDA Forest Service, Southern Research Station, Forest Economics and Policy

Robert Mitchell
Joseph W. Jones Ecological Research Center

Susan Moore
North Carolina State University, Forestry & Environmental Outreach Program

Lisa Samuelson
Auburn University, School of Forestry and Wildlife Sciences

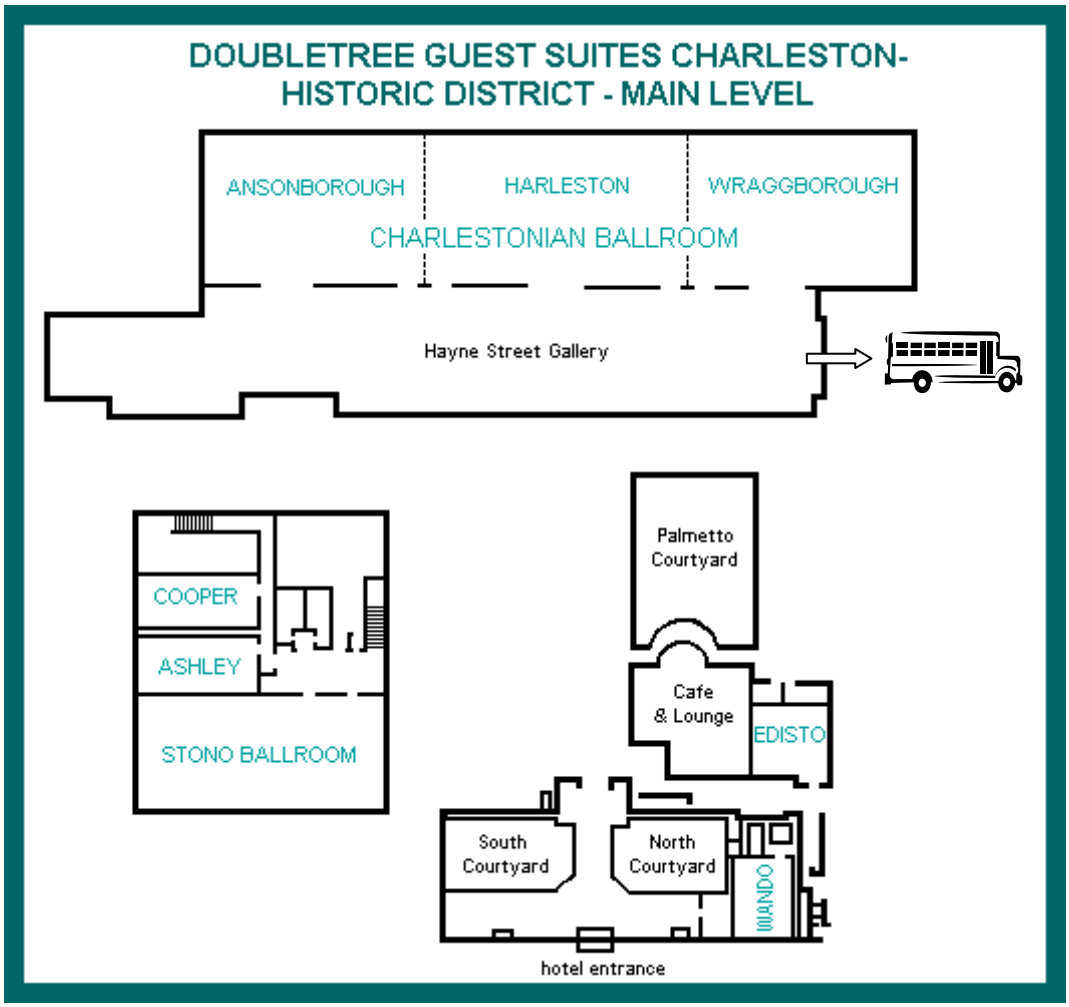
John Stanturf
USDA Forest Service, Southern Research Station, Center for Forest Disturbance Science

Carl Trettin
USDA Forest Service, Southern Research Station, Center for Forested Wetlands

Eric Vance
National Council for Air and Stream Improvement, Inc.

Geoff Wang
Clemson University, Department of Forestry and Natural Resources

Hotel Diagram with Meeting Rooms and Courtyard



Key locations and events:

Meals and refreshments throughout the conference will be provided buffet style in the Courtyard or Café & Lounge areas shown above. The social in association with the poster session will be held in the Stono Ballroom on the second floor.

Field tours will depart from the exit gate that is located at the far right side of the “Hayne Street Gallery” as illustrated above.

Concurrent Session Locations:

SS1 & 2 - Special Session - Harleston Room
1A & B - Pine Silviculture - Cooper Room
2A & B - Hardwood Silviculture - Ansonborough Room
3A - Soil and Water - Ashley Room
4A - Physiology and Genetics - Wraggborough Room
5A - Quantitative Silviculture and Economics - Ansonborough Room
6A - Fire and Fuels - Ashley Room
7A - Forest Health / Restoration - Wraggborough Room
8A – Carbon and Bioenergy - Wraggborough Room

Conference Overview Agenda

Sunday, February 13, 2011	
Starting 3:00pm	**Special lodging rates for BSSRC participants begin at 3pm today.**
Monday, February 14, 2011	
Noon to 6:00pm	**Early arrivers' registration desk opens in Edisto Room**
6:00pm to 10:00pm	**Poster set up period in Stono Ballroom**
7:00pm to 7:30pm	**Student Scholarship Recipient's Meeting in Edisto Room**
Tuesday, February 15, 2011	
7:00am to 8:00am	**Continental Breakfast in Courtyard, registration desk open in Hayne Street Gallery**
8:00am to 10:10am	**Plenary Session in Charleston Ballroom** ***Welcome and Announcements*** • Christopher Maier, USDA FS Southern Research Station and 16th BSSRC Chair • Dr. Robert Doudrich, USDA FS, Director Southern Research Station ***Contemplating the Future of the South's Forest Sector*** David N. Wear, Ph.D., Project Leader, Forest Economics and Policy Research at the USDA Forest Service Southern Research Station ***Southern Forest Science is Support of a Low Carbon Economy*** Alan A. Lucier, Ph.D., Senior Vice President of the National Council for Air and Stream Improvement, Inc.
10:10 am to 5:00pm	**Poster Visitation in Stono Ballroom**
10:10am to 10:30am	**Refreshment Break (provided) in Courtyard**
10:30am to 12:10pm	**Concurrent Sessions** 1A - Pine Silviculture – Cooper Room 2A - Hardwood Silviculture – Ansonborough Room 3A - Soil and Water – Ashley Room 4A - Physiology and Genetics – Wraggborough Room SS1 - Special Session 1 – Harleston Room

Noon to 1:00pm	**Luncheon (provided) in Courtyard and Café**
1:40pm to 2:55pm	**Concurrent Sessions**
	1A - Pine Silviculture – Cooper Room
	2A - Hardwood Silviculture – Ansonborough Room
	3A - Soil and Water – Ashley Room
	4A - Physiology and Genetics – Wraggborough Room
	SS1 - Special Session 1 – Harleston Room
3:20pm to 3:50pm	**Refreshment Break - Courtyard**
3:50pm to 5:30pm	**Concurrent Sessions**
	1A - Pine Silviculture (cont'd) – Cooper Room
	2A - Hardwood Silviculture (cont'd) – Ansonborough Room
	3A - Soil and Water (cont'd) - Ashley Room
	4A - Physiology and Genetics (cont'd) – Wraggborough Room
	SS1 - Special Session 1 (cont'd) – Harleston Room
6:00pm to 8:00pm	**Evening Social and Poster Session – Stono Ballroom**
Wednesday, February 16, 2011	
7:00am to 8:00am	**Continental Breakfast in Courtyard, registration desk open in Hayne Street Gallery**
8:00am to 5:00pm	**Poster Visitation in Stono Ballroom**
8:00am to 9:40am	**Concurrent Sessions**
	2B - Hardwood Silviculture / Quantitative Silviculture – Ansonborough Room
	6A - Fire and Fuels – Ashley Room
	7A - Forest Health / Restoration – Wraggborough Room
	SS2 - Special Session 2 – Harleston Room
9:40am to 10:10am	**Refreshment Break (provided) in Courtyard**
10:10am to 12:15pm	**Concurrent Sessions**
	1B - Pine Silviculture (cont'd) – Cooper Room

	5A - Quantitative Silviculture (cont'd) – Ansonborough Room
	6A - Fire and Fuels (cont'd) – Ashley Room
	7A - Forest Health / Restoration (cont'd) – Wraggborough Room
	SS2 - Special Session 2 (cont'd) - Harleston Room
12:15pm to 1:45pm	**Luncheon (provided) in Courtyard**
1:45pm to 3:25pm	Concurrent Sessions
	1B - Pine Silviculture (cont'd) – Cooper Room
	5A - Quantitative Silviculture (cont'd) – Ansonborough Room
	6A - Fire and Fuels (cont'd) – Ashley Room
	7A - Forest Health / Restoration / Carbon and Bioenergy - Wraggborough
	SS2 - Special Session 2 (cont'd) – Harleston Room
3:25pm to 3:55pm	**Student Awards and Refreshment Break in Courtyard**
3:55pm to 5:35pm	Concurrent Sessions
	5A - Quantitative Silviculture (cont'd) – Ansonborough Room
	8A - Carbon and Bioenergy (cont'd) – Wraggborough Room
	SS2 - Special Session 2 (cont'd) – Harleston Room
6:00pm to 7:00pm	**BSSRC Business Meeting in Harleston Room**

Thursday, February 17, 2011 Field Trip Day (pre-registration required)

7:30am	**Breakfast-to-Go (provided for field tour participants only) - Courtyard**
8:00am	**Depart for Field Tours (bag lunch provided) – buses on Hayne Street**
5:00pm	**Return from Field Tours**
	Conference Adjourns
	Final night for special lodging rates in Charleston for BSSRC participants

Tuesday, February 15 10:30 AM to 5:55 PM	Special Session 1 – Southern Forest Science in Support of a Low Carbon Economy Room: Harleston Moderator: Kurt Johnson

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:30:00 AM	GENETIC VARIATION IN PINES INFLUENCING ECTOMYCORRHIZAL SYMBIOSIS: POTENTIAL IMPLICATIONS FOR GENOTYPE SELECTION AND SOIL CARBON SEQUESTRATION Jason Hoeksema, University of Mississippi	332
10:55:00 AM	ESTIMATING SOIL CARBON CONTENTS ACROSS THE LANDSCAPE: A COMPARISON OF THREE SAMPLING METHODS Daniel Markewitz, University of Georgia	331
11:20:00 AM	SHORT ROTATION WOODY CROP BIOMASS ENERGY FEEDSTOCK PRODUCTION SYSTEMS Mark Coleman, University of Idaho	162
11:45:00 AM	LOBLOLLY PINE AND SWITCHGRASS INTERCROPPING BIOENERGY PRODUCTION SYSTEMS IN THE SOUTHEAST U.S.: IMPACTS ON PLANT-SOIL CARBON AND ENVIRONMENTAL SERVICES Michael Blazier, Louisiana State University	148
1:40:00 PM	THE ROLE OF VARIOUS FOREST BASED FEEDSTOCKS PRODUCTION SYSTEMS ON C-CYCLING: WEYERHAEUSER'S INTEGRATED APPROACH FOR SUSTAINABILY MANAGING OUR FORESTS FOR BIOMASS, WOOD PRODUCTS AND C-SEQUESTRATION Eric Sucre, Weyerhaeuser Company	264
2:05:00 PM	TECHNOLOGY FOR BIOMASS FEEDSTOCK PRODUCTION IN SOUTHERN FORESTS AND GHG IMPLICATIONS Bob Rummer, USDA Forest Service	336
2:30:00 PM	FIELD PERFORMANCE AND BIOENERGY CHARACTERISTICS OF FOUR COMMERCIAL EUCALYPTUS GRANDIS CULTIVARS IN FLORIDA Donald Rockwood, University of Florida	193
2:55:00 PM	RESOURCE AVAILABILITY EFFECTS ON GROWTH EFFICIENCY, LEAF AREA DISPLAY, AND GENOTYPE PHYSIOLOGICAL RESPONSES OF EUCALYPTUS CLONES AND HYBRIDS Tom Fox, Virginia Tech	249
3:50:00 PM	ZONING EUCALYPTUS SPECIES ADAPTATION AND BIOMASS PRODUCTION IN THE SOUTHEASTERN US Jose Stape, NC State University	334
4:15:00 PM	TIMBER MARKET, INVENTORY AND CARBON OUTCOMES FROM NEW BIOENERGY MARKETS Karen Abt, USDA Forest Service	140
4:40:00 PM	THE EVALUATION AND MANAGEMENT OF FOREST OFFSET REVERSAL RISK Christopher Galik, Duke University	312
5:05:00 PM	WHAT MAKES CARBON WORK? A SENSITIVITY ANALYSIS OF FACTORS AFFECTING FOREST OFFSET VIABILITY Christopher Galik, Duke University	313
5:30:00 PM	COMPARATIVE ECONOMICS OF FOREST CARBON SEQUESTRATION Evan Mercer, USDA Forest Service	293

Tuesday, February 15 **10:30 AM to 5:00 PM**	**Concurrent Session 1A – Pine Silviculture** Room: Cooper Moderator: Tim Albaugh

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:30:00 AM	LONGLEAF PINE WOOD AND STRAW YIELDS FROM TWO OLD-FIELD PLANTED SITES IN GEORGIA - RESULTS THROUGH AGE 21-YEARS David Dickens, University of Georgia	168
10:55:00 AM	ARE WE OVER-MANAGING LONGLEAF PINE? John Kush, Auburn University	215
11:20:00 AM	IS ROOT SYSTEM ARCHITECTURE THE MAIN FACTOR CAUSING LONGLEAF PINE SAPLINGS TO LEAN OR TOPPLE AFTER STRONG WIND EVENTS? Shi-Jean Sung, USDA Forest Service	265
11:45:00 AM	SPATIAL ANALYSIS OF LONGLEAF PINE STAND DYNAMICS AFTER 60 YEARS OF MANAGEMENT John Gilbert, Auburn University	316
1:40:00 PM	EFFECT OF HERBICIDES AND TIMING ON LONGLEAF SEEDLING SURVIVAL AND PERCENTAGE OUT OF THE GRASS STAGE ON OLD-FIELD PLANTED SITES – TWO YEAR RESULTS David Dickens, University of Georgia	310
2:05:00 PM	USE OF AMINOCYCLOPYRACHLOR FOR FORESTRY SITE PREPARATION IN THE SOUTHEASTERN U.S. Andrew Ezell, Mississippi State University	175
2:30:00 PM	EFFICACY OF TREATMENTS USING MAT-28 FOR PINE SITE PREPARATION Andrew Ezell, Mississippi State University	176
2:55:00 PM	A COMPARISON OF HERBICIDE TANK MIXTURES FOR MID-ROTATION GALLBERRY COMPETITION RELEASE IN SLASH PINE Luke Petre, Rayonier	184
3:50:00 PM	LOW-COST REGENERATION TECHNIQUES FOR MIXED-SPECIES MANAGEMENT – 20 YEARS LATER Thomas Waldorp, USDA Forest Service	322
4:15:00 PM	PINE STRAW PRODUCTION: FROM FOREST TO FRONT YARD Janice Dyer, Auburn University	172
4:40:00 PM	PLANTING DENSITY AND SILVICULTURAL INTENSITY IMPACTS ON LOBLOLLY PINE STAND DEVELOPMENT IN THE WESTERN GULF COASTAL PLAIN THROUGH AGE 8 Michael Kane, University of Georgia	192

Tuesday, February 15 10:30 AM to 5:00 PM	Concurrent Session 2A – Hardwood Silviculture Room: Ansonborough Moderator: Jamie Schuler

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:30:00 AM	THE 3PS OF OAK REGENERATION: PLANNING, PERSISTENCE, AND PATIENCE Dale Weigel, USDA Forest Service	278
10:55:00 AM	FIRST YEAR RESPONSE OF OAK NATURAL REGENERATION TO A SHELTERWOOD HARVEST AND MIDSTORY COMPETITION CONTROL IN THE ARKANSAS OZARKS Kyle Cunningham, University of Arkansas	164
11:20:00 AM	EFFICACY OF MIDSTORY INJECTION AND NON-TARGET IMPACT IN BOTTOMLAND HARDWOODS Derek Alkire, Mississippi State University	179
11:45:00 AM	HERPETOFAUNAL AND SMALL MAMMAL RESPONSE TO OAK-REGENERATING SILVICULTURAL PRACTICES IN THE MID-CUMBERLAND PLATEAU OF SOUTHERN TENNESSEE Andrew Cantrell, Alabama A&M University	157
1:40:00 PM	SUSTAINING QUERCUS HUMBOLDTII AND COLOMBOBALANUS EXCELSA ON THE COLOMBIAN LANDSCAPE: PRESERVATION OR CONSERVATION – A RESEARCH PERSPECTIVE Daniel Dey, USDA Forest Service	167
2:05:00 PM	EFFECTS OF CHEMICAL SITE PREPARATION ON HERBACEOUS VEGETATION PRIOR TO HARDWOOD PLANTATION ESTABLISHMENT Andrew Self, Mississippi State University	2
2:30:00 PM	EVALUATING DIFFERENT PLANTING STOCKS FOR OAK REGENERATION ON HURRICANE KATRINA DISTURBED LANDS Damon Hollis, Mississippi State University	208
2:55:00 PM	CONTROL OF EASTERN BACCHARIS IN RECENTLY ESTABLISHED BOTTOMLAND HARDWOOD PLANTATIONS Jamie Schuler, University of Arkansas	251
3:50:00 PM	PRELIMINARY RESULTS OF APICAL BUD STRENGTH TESTS AND TREE SWAY MOVEMENTS TO EXAMINE CROWN ABRASION Tyler Brannon, University of Tennessee	152
4:15:00 PM	STAND AND INDIVIDUAL TREE GROWTH RESPONSE TO TREATMENTS IN YOUNG NATURAL HARDWOODS Dan Robison, NC State University	240
4:40:00 PM	EVALUATION OF SITE PREPARATION AND PLANTING STOCK ON NUTTALL OAK AND CHERRYBARK OAK GROWTH ON A FORMER AGRICULTURE AREA Andrew Self, Mississippi State University	338

Tuesday, February 15 **10:30 AM to 5:00 PM**	**Concurrent Session 3A – Soil and Water** Room: Ashley Moderator: Eric Vance

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:30:00 AM	A WATERSHED-BASED ENVIROMENTAL AND REGULATORY DATA ANALYSIS SYSTEM FOR THE FOREST PRODUCTS INDUSTRY John Beebe, Western Michigan University	300
10:55:00 AM	LONG-TERM MONITORING OF THE EFFECTIVENESS OF FORESTRY BEST MANAGEMENT PRACTICES IN THE FLAT CREEK WATERSHED, LOUISIANA Abram DaSilva, Louisiana State University Agricultural Center	297
11:20:00 AM	SEDIMENT YIELD ALONG AN ACTIVELY MANAGED RIPARIAN BUFFER Ferhat Kara, Auburn University	211
11:45:00 AM	CHARACTERIZING BENTHIC MACROINVERTEBRATE COMMUNITIES IN LOW-GRADIENT, OXYGEN-DEPLETED STREAMS OF FORESTED HEADWATERS IN CENTRAL LOUISIANA Derrick Klimesh, Louisiana State University	299
1:40:00 PM	EFFECTS OF SILVICULTURAL MANAGEMENT ON LOW GRADIENT STREAM WATER QUALITY IN LOUISIANA John Beebe, Western Michigan University	294
2:05:00 PM	SPATIAL AND TEMPORAL DYNAMICS OF DISSOLVED OXYGEN, NITROGEN, AND PHOSPHORUS IN A LOW-GRADIENT WATERSHED, LOUISIANA Abram DaSilva, Louisiana State University Agricultural Center	298
2:30:00 PM	FERTILIZATION EFFECTS ON LONG-TERM NUTRIENT AVAILABILITY IN SOUTHEASTERN US PINE AND HARDWOOD PLANTATIONS Chris Kiser, Virginia Tech	213
2:55:00 PM	SOIL DISTURBANCE AND SITE IMPACTS RELATED TO A THINNING OPERATION IN KENTUCKY Emily Carter, USDA Forest Service	285
3:50:00 PM	EFFECTIVENESS AND COSTS OF FIVE SKID TRAIL CLOSURE TECHNIQUES IN THE VIRGINIA PIEDMONT W. Michael Aust, Virginia Tech	250
4:15:00 PM	ASSESSING SOIL IMPACTS RELATED TO FOREST HARVEST OPERATIONS Emily Carter, USDA Forest Service	286
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Tuesday, February 15 10:30 AM to 5:05 PM	Concurrent Session 4A – Physiology and Genetics Room: Wraggborough Moderator: John Seiler

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:30:00 AM	ARE GENETICALLY IMPROVED SEEDELINGS WORTH IT? Randall Rousseau, Mississippi State University	248
10:55:00 AM	CHARACTERIZATION OF YIELD AND GROWTH EFFICIENCY OF HALF-SIB, FULL-SIB, AND VARIETAL PINUS TAEDA GENOTYPES GROWN AT TWO ESTABLISHMENT DENSITIES Derek Dougherty, University of Georgia	171
11:20:00 AM	ADAPTING THE 3-PG+ MODEL TO ESTIMATE GROWTH, CARBON SEQUESTRATION, AND WATER USE OF HIGH PRODUCTIVITY LOBLOLLY PINE CLONES UNDER SHORT ROTATION SILVICUTURE Chris Bryars, University of Georgia	154
11:45:00 AM	WHOLE-CANOPY GAS EXCHANGE AMONG FOUR ELITE LOBLOLLY PINE SEED SOURCES PLANTED IN THE WESTERN GULF REGION Bradley Osbon, Louisiana State University	245
1:40:00 PM	SHORT-TERM CARBON PARTITIONING FERTILIZER RESPONSES VARY AMONG TWO FULL-SIB LOBLOLLY PINE CLONES Jeremy Stovall, Virginia Tech	302
2:05:00 PM	MANAGEMENT INTENSITY AND GENETICS AFFECT LOBLOLLY PINE SEEDLING PERFORMANCE Scott Roberts, Mississippi State University	205
2:30:00 PM	MANAGEMENT INTENSITY AND GENETICS AFFECT LOBLOLLY PINE CROWN CHARACTERISTICS Landis Herrin, Mississippi State University	204
2:55:00 PM	SILVICULTURE OF VARIETAL LOBLOLLY PINE PLANTATIONS: SECOND YEAR IMPACTS OF SPACING AND SILVICULTURAL TREATMENTS ON VARIETIES WITH DIFFERING CROWN IDEOTYPES Lance Vickers, Virginia Tech	273
3:50:00 PM	GENETIC INFLUENCES ON SURVIVAL IN A 21-YEAR-OLD LOBLOLLY PINE SPACING TRIAL Scott Roberts, Mississippi State University	206
4:15:00 PM	DIFFERENCE AMONG SHORTLEAF PINE SEED SOURCES ON THE OUACHITA AND OZARK NATIONAL FORESTS AT AGE TEN Charly Studyvin, USDA Forest Service	189
4:40:00 PM	GENETIC EFFECTS ON STAND-LEVEL UNIFORMITY, AND ABOVE- AND BELOW-GROUND BIOMASS PRODUCTION IN JUVENILE LOBLOLLY PINE Mike Aspinwall, NC State University	307

Wednesday, February 16 8:00 AM to 6:00 PM	Special Session 2 – Southern Forest Science in Support of a Low Carbon Economy Room: Harleston Moderator: Dana Nelson & Zakiya Leggett

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
8:00:00 AM	POTENTIAL EFFECTS OF CLIMATE CHANGE ON SPECIES DISTRIBUTIONS IN THE SOUTHERN US – IMPLICATIONS FOR CARBON SEQUESTRATION Robert Teskey, University of Georgia	269
8:25:00 AM	MANAGEMENT APPROACHES FOR FOREST CARBON SEQUESTRATION IN LONGLEAF PINE Lisa Samuelson, Auburn University	187
8:50:00 AM	FOREST RESIDUE MANAGEMENT EFFECTS ON SITE CARBON POOLS AND PRODUCTIVITY IN CLONAL LOBLOLLY PINE PLANTATIONS Christopher Maier, USDA Forest Service	335
9:15:00 AM	CARBON EMISSIONS AND SEQUESTRATION FROM FOREST FERTILIZATION OF PINUS TAEDA Tim Albaugh, NC State University	328
10:10:00 AM	THE END OF ROTATION EFFECTS OF WEED CONTROL AND FERTILIZATION ON THE CARBON AND NITROGEN DYNAMICS OF A SLASH AND LOBLOLLY PINE FOREST IN NORTH CENTRAL FLORIDA Jason Vogel, Texas A&M University	274
10:35:00 AM	CARBON STORAGE IN DECAYING ROOT SYSTEMS OF HARVESTED TREES Geoff Wang, Clemson University	277
11:00:00 AM	CARBON SEQUESTRATION POTENTIAL OF SE COASTAL PLAIN FORESTS Asko Noormets, North Carolina State University	239
11:25:00 AM	A FLEXIBLE HYBRID MODEL OF LIFE CYCLE CARBON BALANCE OF LOBLOLLY PINE PLANTATION MANAGEMENT SYSTEMS Carlos Gonzalez, University of Florida	196
11:50:00 AM	DROUGHT EFFECTS ON THE ENERGY AND WATER BALANCES ON TWO NORTH CAROLINA LOWER COASTAL PLAIN LOBLOLLY PINE PLANTATIONS Ge Sun, USDA Forest Service	306
1:45:00 PM	FUTURE CLIMATIC AND ENVIRONMENTAL CONDITIONS WILL LIMIT HYDRAULIC REDISTRIBUTION BY DEEP ROOTS AND WILL AFFECT NEGATIVELY WATER AND CARBON CYCLING OF SOUTHERN FORESTS Jean-Christophe Domec, North Carolina State University	170
2:10:00 PM	IMPACTS OF CARBON MANAGEMENT ON ECOSYSTEM SERVICES: A STRUCTURAL AND FUNCTIONAL APPROACH TO EXAMINING ECOLOGICAL TRADE-OFFS James Vose, USDA Forest Service	327
2:35:00 PM	TOWARD ECOLOGICAL GENOMICS IN POPULUS Stephen DiFazio, West Virginia University	330
3:00:00 PM	GENETICALLY IMPROVED LOBLOLLY PINE AND CARBON SEQUESTRATION Steve McKeand, North Carolina State University	292
3:55:00 PM	INFLUENCE OF GENETICS AND SPACING ON BIOMASS YIELDS IN LOBLOLLY PINE PLANTATIONS David Barker, North Carolina State University	144

Wednesday, February 16 8:00 AM to 6:00 PM	Special Session 2 – Southern Forest Science in Support of a Low Carbon Economy, cont'd. Room: Harleston Moderator: Dana Nelson & Zakiya Leggett

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
4:20:00 PM	CARBON SEQUESTRATION OPPORTUNITIES IN NATURALLY-REGENERATED SOUTHERN PINE STANDS MANAGED USING EVEN-AGED AND UNEVEN-AGED SILVICULTURAL SYSTEMS James Guldin, USDA Forest Service	321
4:45:00 PM	THE EFFECTS OF THINNING AND STAND CHARACTERISTICS ON ABOVEGROUND CARBON STOCKS IN MIXED-HARDWOOD FORESTS OF THE SOUTHERN APPALACHIANS Tara Keyser, USDA Forest Service	318
5:10:00 PM	CARBON ASSESSMENT FOR SEQUESTRATION PROJECTS: VARIATION IN ASSESSMENT PROCEDURES AND GROWTH ESTIMATES – AN OZARK MOUNTAINS CASE STUDY James McCarter, University of Washington	227
5:35:00 PM	CARBON EMISSIONS FROM WILDLAND FIRES IN THE SOUTHERN U.S. UNDER A CHANGING CLIMATE John Stanturf, USDA Forest Service	257

Wednesday, February 16 10:10 AM to 4:20 PM	Concurrent Session 1B – Pine Silviculture, cont'd Room: Cooper Moderator: Tom Fox

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:10:00 AM	AGE STRUCTURE OF A SOUTHERN PINE STAND FOLLOWING 72 YEARS OF UNEVEN-AGED SILVICULTURE Don Bragg, USDA Forest Service	4
10:35:00 AM	THE EFFECTS OF PLANTING DENSITY AND CULTURAL INTENSITY ON LOBLOLLY PINE CROWN CHARACTERISTICS AT AGE TWELVE Madison Akers, University of Georgia	139
11:00:00 AM	LONGITUDINAL VARIATION IN WOOD SPECIFIC GRAVITY OF PLANTED LOBLOLLY PINE IN THE SOUTHERN UNITED STATES Finto Antony, University of Georgia	194
11:25:00 AM	ABOVEGROUND BIOMASS ALLOCATION FOR LOBLOLLY PINE MANAGED UNDER DIFFERENT CULTURAL REGIME AND PLANTING DENSITY Santosh Subedi, University of Georgia	263
11:50:00 AM	INFLUENCE OF LIGHT AND MOISTURE ON LONGLEAF PINE SEEDLING RECRUITMENT IN SELECTION SILVICULTURE David Dyson, USDA Forest Service	173
1:45:00 PM	CHANGES NON-PINE WOODY SPECIES DENSITY, COMPOSITION, AND DIVERSITY FOLLOWING HERBICIDE AND FERTILIZATION APPLICATION TO MID-ROTATION LOBLOLLY PINE STANDS Hal Liechty, University of Arkansas	219
2:10:00 PM	ROBUST DATA ACQUISITION SYSTEM FOR MEASURING SIZE AND SPATIAL DISTRIBUTION OF FIBER AND OTHER CELL TYPES WITHIN WOOD: FLATECH Bogdan Strimbu, Louisiana Tech University	260
2:35:00 PM	GLYPHOSATE FORMULATIONS WITH AND WITHOUT LI 700 FOR CONTROL OF ROADSIDE NONCROP PINE IN SE OKLAHOMA Jason Grogan, Stephen F. Austin State University	326
3:00:00 PM	CLONAL LOBLOLLY PINE GROWTH EXPLAINED BY MULTIPLE REGRESSION ANALYSIS OF SOIL PROPERTIES IN THE PIEDMONT PHYSIOGRAPHIC REGION OF VIRGINIA Nicholas Bonzey, Virginia Tech	340
3:55:00 PM	CUT STUMP CONTROL OF YAUPON, SWEETGUM, AND CHINESE TALLOWTREE WITH AMINOCYCLOPYRACHLOR Jason Grogan, Stephen F. Austin State University	325

Wednesday, February 16 8:00 AM to 9:40 AM	Concurrent Session 2B – Hardwood Silviculture, cont'd Room: Ansonborough Moderator: Tom Fox

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
8:00:00 AM	TWENTY-EIGHT YEARS OF DEVELOPMENT IN PLANTED CHERRYBARK OAK-SWEETGUM MIXTURES: IMPLICATIONS FOR FUTURE MIXED-SPECIES HARDWOOD PLANTATIONS Brian Lockhart, USDA Forest Service	223
8:25:00 AM	GROWTH AND BOLE QUALITY RESPONSES TO THINNING IN A RED OAK-SWEETGUM STAND IN SOUTHEASTERN ARKANSAS: NINE-YEAR RESULTS Steve Meadows, USDA Forest Service	230
8:50:00 AM	THE APPLICATION OF SINGLE-TREE SELECTION COMPARED TO DIAMETER-LIMIT CUTTING IN AN UPLAND OAK-HICKORY FOREST ON THE CUMBERLAND PLATEAU IN JACKSON COUNTY, ALABAMA Callie Schweitzer, USDA Forest Service	253
9:15:00 AM	STAND QUALITY MANAGEMENT IN A LATE-ROTATION, RED OAK-SWEETGUM STAND IN EAST MISSISSIPPI: PRELIMINARY RESULTS FOLLOWING THINNING Steve Meadows, USDA Forest Service	231

Wednesday, February 16 10:10 AM to 3:25 PM	Concurrent Session 5A – Quantitative Silviculture and Economics Room: Ansonborough Moderator: Mike Kane

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
10:10:00 AM	FINANCIAL RETURNS AND LANDOWNER CHOICES IN LOBLOLLY PINE MANAGEMENT UNDER CARBON MARKETS Umesh Chaudhari, University of Arkansas	159
10:35:00 AM	PRESCRIBED BURNING COST ANALYSIS OF SITE PREPARATION AND SILVICULTURAL BURNING FOR NIPF LANDOWNERS IN NORTH CAROLINA Ron Myers, NC Division of Forest Resources	237
11:00:00 AM	A COMPARISON OF THE FINANCIAL IMPACTS OF COST SHARE PROGRAMS ON SECOND GENERATION AND GENETICALLY IMPROVED LOBLOLLY AND LONGLEAF PINE PLANTATIONS Tamara Cushing, Clemson University	165
11:25:00 AM	INTEGRATING FOREST STAND PROJECTIONS WITH WILDLIFE OCCUPANCY MODELS TO DEVELOP A DECISION SUPPORT TOOL Michelle Tacconelli, Auburn University	267
11:50:00 AM	IMPACT OF THE SAMPLING DESIGN AND STAND STRUCTURE ON THE ESTIMATES Bogdan Strimbu, Louisiana Tech University	259
1:45:00 PM	USE OF THE WEIBULL FUNCTION TO PREDICT FUTURE DIAMETER DISTRIBUTIONS FROM CURRENT PLOT DATA Quang Cao, Louisiana State University	158
2:10:00 PM	A GROWTH AND YIELD SYSTEM FOR CLONAL LOBLOLLY PINE PLANTATIONS Bruce Borders, University of Georgia	183
2:35:00 PM	LONG AND SHORT TERM CHANGES IN THE FORESTS OF THE CUMBERLAND PLATEAU AND MOUNTAINS USING LARGE SCALE FOREST INVENTORY DATA Christopher Oswalt, USDA Forest Service	244
3:00:00 PM	EXTENDING THE CAPABILITIES OF AN INDIVIDUAL TREE GROWTH SIMULATOR TO MODEL NON-TRADITIONAL LOBLOLLY PINE PLANTATION SYSTEMS FOR MULTIPLE PRODUCTS Ralph Amateis, Virginia Tech	142

Wednesday, February 16 8:00 AM to 2:35 PM	Concurrent Session 6A – Fire and Fuels Room: Ashley Moderator: Jim Guldin

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
8:00:00 AM	FUEL CONSUMPTION AND SMOKE EMISSIONS RESULTING FROM PRESCRIBED FIRES IN THE OUACHITA MOUNTAINS OF ARKANSAS Virginia McDaniel, USDA Forest Service	197
8:25:00 AM	SELECTED THERMAL PROPERTIES OF SEVERAL GRASSES (NATIVE AND EXOTIC) ASSOCIATED WITH LONGLEAF PINE ECOSYSTEMS Thomas Elder, USDA Forest Service	174
8:50:00 AM	DOES FREQUENT BURNING AFFECT LONGLEAF PINE (PINUS PALUSTRIS) BARK THICKNESS? Geoff Wang, Clemson University	315
9:15:00 AM	BEETLE-KILLED STANDS IN THE SOUTH CAROLINA PIEDMONT: FROM FUEL HAZARD TO REGENERATING OAK FORESTS Aaron Stettlemyer, Pennsylvania State University	258
10:10:00 AM	SURFACE SOIL ROOT RESPONSE TO SEASON OF REPEATED FIRE IN A YOUNG LONGLEAF PINE PLANTATION Mary Anne Sword Sayer, USDA Forest Service	266
10:35:00 AM	EFFECTS OF FIRE REGIME ON LONGLEAF PINE GROWTH Sharon Hermann, Auburn University	203
11:00:00 AM	FUEL REDUCTION TREATMENTS IN THE SOUTHERN APPALACHIAN MOUNTAINS: ARE THEY EFFECTIVE AND FOR HOW LONG? Helen Mohr, USDA Forest Service	190
11:25:00 AM	FREQUENCY AND SEASON OF PRESCRIBED FIRE AFFECT UNDERSTORY PLANT COMMUNITIES IN LONGLEAF PINE STANDS James Haywood, USDA Forest Service	1
11:50:00 AM	SPATIAL AND TEMPORAL PATTERNS OF WILDFIRE OCCURRENCES IN MISSISSIPPI Weiming Yu, Mississippi State University	295
1:45:00 PM	DID DOMINANT TABLE MOUNTAIN PINES START LIFE IN FULL SUNLIGHT OR PARTIAL SHADE? Patrick Brose, USDA Forest Service	153
2:10:00 PM	USING COMPUTER VISUALIZATION FOR PUBLIC OUTREACH AND DISCUSSION OF MANAGEMENT CONCERNS: CEDAR POINT PRESERVE CASE STUDY James McCarter, University of Washington and NC State University	143

Wednesday, February 16 8:00 AM to 3:00 PM	Concurrent Session 7A – Forest Health and Restoration Room: Wraggborough Moderator: Barbara Crane

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
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8:25:00 AM	FIRST YEAR RESULTS OF A CHESTNUT PLANTING ON THE CUMBERLAND PLATEAU OF EASTERN KENTUCKY ILLUSTRATE CHALLENGES FACING REINTRODUCTION Cornelia Pinchot, University of Tennessee	333
8:50:00 AM	EFFECTS OF ECOLOGICAL AND SOCIOECONOMIC DETERMINANTS ON TALLOW TREES IN SOUTHERN COASTAL FOREST LANDS Zhaofei Fan, Mississippi State University	288
9:15:00 AM	THREATS OF MAJOR NONNATIVE INVASIVE PLANTS IN THE SOUTHERN FOREST LAND: CONDITION, EXTENT AND POTENTIAL DRIVING FACTORS Zhaofei Fan, Mississippi State University	289
10:10:00 AM	WILL AFFORESTATION IN TEMPERATE ZONES WARM THE EARTH? David South, Auburn University	256
10:35:00 AM	SILVICULTURE AND THE ASSESSMENT OF CLIMATE CHANGE GENETIC RISK FOR SOUTHERN APPALACHIAN FOREST TREE SPECIES Barbara Crane, USDA Forest Service	308
11:00:00 AM	GEOSPATIAL RELATIONSHIPS OF TREE SPECIES DAMAGE CAUSED BY HURRICANE KATRINA IN SOUTH MISSISSIPPI USING MIFI DATA AND GIS Mark Garrigues, Mississippi State University	314
11:25:00 AM	EVALUATION OF SHORT-ROTATION WOODY CROPS TO STABILIZE A DECOMISSIONED SWINE LAGOON Dipesh K.C., Oklahoma State University	210
11:50:00 AM	DISTRIBUTION OF SMALL DIAMETER TREE BIOMASS IN MISSISSIPPI Zhaofei Fan, Mississippi State University	287
1:45:00 PM	DEVELOPING SILVICULTURAL PROTOCOLS FOR LONGLEAF PINE ECOSYSTEM RESTORATION IN LOBLOLLY PINE STANDS AT FORT BENNING, GA Benjamin Knapp, Clemson University	214
2:10:00 PM	EFFECTS OF ABOVE- AND BELOW-GROUND COMPETITION ON WIREGRASS ESTABLISHMENT IN A XERIC SANDHILLS LONGLEAF PINE FOREST Evelyn Wenk, USDA Forest Service	279
2:35:00 PM	LESSONS FROM THE FIELD: THE FIRST TESTS OF RESTORATION AMERICAN CHESTNUT (CASTANEA DENTATA) SEEDLINGS PLANTED IN THE SOUTHERN REGION Stacy Clark, USDA Forest Service	160

Wednesday, February 16 3:00 PM to 6:00 PM	Concurrent Session 8A – Carbon and Bioenergy Room: Wraggborough Moderator: Tim Martin

Start time	ABSTRACT TITLE Presenter, Affiliation	Abstract number
3:00:00 PM	LONG-TERM EFFECTS OF TIMBER HARVESTING DISTURBANCE ON ABOVE-GROUND PRODUCTIVITY AND CARBON CYCLING IN BOTTOMLAND HARDWOOD FORESTS Scott McKee, Virginia Tech	228
3:55:00 PM	DEVELOPMENT OF DORMANT BLACK WILLOW UNROOTED PLANTING STOCK FOR SHORT ROTATION BIOENERGY PLANTATIONS Jake Camp, Mississippi State University	156
4:20:00 PM	HERBICIDE SITE PREPARATION AND RELEASE OPTIONS FOR EUCALYPTUS PLANTATION ESTABLISHMENT IN THE WESTERN GULF Michael Blazier, Louisiana State University	145
4:45:00 PM	INITIAL RESULTS OF A BIOMASS PRODUCTION SYSTEM USING BLACK WILLOW, COTTONWOOD AND AMERICAN SYCAMORE GROWN WITH AND WITHOUT FERTILIZATION Jamie Schuler, University of Arkansas	252
5:10:00 PM	DEVELOPMENT OF AN APPLIED BLACK WILLOW TREE IMPROVEMENT PROGRAM FOR THE BIOMASS PRODUCTION IN THE SOUTH Randall Rousseau, Mississippi State University	247
5:35:00 PM	CHANGES IN CARBON EMISSIONS FROM PRESCRIBED BURNING IN THE SOUTHEAST DUE TO CLIMATE CHANGE INDUCED FUEL DISTURBANCES Yongqia Liu, USDA Forest Service	222

Abstract Number	Oral Presentation Abstracts Abstracts are listed in numerical order.

001 **FREQUENCY AND SEASON OF PRESCRIBED FIRE AFFECT UNDERSTORY PLANT COMMUNITIES IN LONGLEAF PINE STANDS**

James D. Haywood*, USDA Forest Service, Southern Research Station, Pineville, LA

Prescribed fire research on the Kisatchie National Forest, Louisiana spanned the last seven decades and led to a greater understanding of fire behavior and the importance of fire in longleaf pine (*Pinus palustris* Mill.) forests in the bluestem (*Andropogon* spp. and *Schizachyrium* spp.) range. Early research focused on management of the range for livestock forage. Because of its tolerance to fire, range burning favored longleaf pine over other woody plants making the establishment of pure longleaf pine stands possible. Through its continued application, fire greatly influenced the nature of the understory and midstory plant communities, and both the frequency and season of prescribed burning further affected herbaceous plant productivity. The importance of frequency and season of prescribed burning is discussed using both past and recent research results.

002 **EFFECTS OF CHEMICAL SITE PREPARATION ON HERBACEOUS VEGETATION PRIOR TO HARDWOOD PLANTATION ESTABLISHMENT**

Andrew B. Self*, Andrew W. Ezell, College of Forest Resources, Mississippi State University, Starkville, MS

Chemical site preparation is sometimes prescribed when attempting hardwood afforestation in the South. However, adequate research has not been performed regarding the efficacy of various herbicide treatments often recommended prior to plantation establishment. For practical purposes, the question of whether chemical site preparation provides residual control of herbaceous vegetation in retired agricultural fields has not been established. This study was performed near Port Barre, Louisiana in St. Landry Parish. Four commonly used chemical site preparation treatments were applied during July 2004. Percent herbaceous coverage was estimated occularly May 2005 - August 2005. Herbaceous components were separated into grass/sedge or broadleaf categories and then further delineated into major species. Means separation was used to determine changes in herbaceous coverage percentages as the growing season progressed. Significant differences were found among average herbaceous coverage percentages among treatments and within individual treatments on a monthly basis. As the growing season progressed, an inverse relationship between grass/sedge and broadleaf categories was noted. Grass/sedge coverage decreased while broadleaf coverage increased in the treated areas.

004 **AGE STRUCTURE OF A SOUTHERN PINE STAND FOLLOWING 72 YEARS OF UNEVEN-AGED SILVICULTURE**

Don C. Bragg*, USDA Forest Service, Monticello, AR

For all of the long history of the Crossett Experimental Forest (CEF), we have not systematically aged the loblolly (*Pinus taeda*) pine-dominated Farm Forestry Forties, an uneven-aged demonstration established in 1937. Rather, we have accepted decades of continuous sawtimber production as *de facto* evidence of this age structure. This paper quantifies the age structure of the Poor Forty, a parcel designated "poor" because of its low initial pine stocking (not site quality). Five pines were randomly selected (4 overstory and 1 seedling/sapling) for ring counts on each of 25 plots systematically established in this stand. Not surprisingly, the Poor Forty has a diffuse age distribution, reflecting 30 annual harvests from 1938 to 1968 and 7 periodic harvests since 1969. Of the 125 pine ring counts from this sample, only 7 trees (5.6%) were at least 73 years old (maximum estimated age = 86 years). The prescribed upper diameter regulation controls the number of pines > 20 inches d.b.h., and therefore also limits the abundance of old trees. In addition to old pines, two other deficiencies in the Poor Forty age class data are notable—the first arises from the lack of pines 30-40 years old, a consequence of harvesting alterations during the closure of the CEF in the 1970s. The second is apparent over the last 5 years, attributable to the lack of recruitment following the initial pulse after the 2002 harvest. Similar to uneven-aged forests dominated by shade-tolerant species, there was only a moderate relationship between d.b.h. and age.

005 **CONTEMPLATING THE FUTURE OF THE SOUTH'S FOREST SECTOR**

David N. Wear, USDA Forest Service, Southern Research Station, Project Leader, Forest Economics and Policy Research
Southern Research Station, Research Triangle Park, North Carolina

Today's southern forests are the product of a long history of use, abuse, recovery, and conservation. The future forests of the region will similarly be shaped by a combination of driving forces including a strong urbanization dynamic, climate changes, ownership change, public policy, and demands for fiber. Given its long run nature, forest management decisions need to be evaluated in the context of these broader dynamics, and the implications they hold for forest conditions and timber scarcity in the future. Using a combination of technical models and science synthesis, we examine a number of alternative futures for southern forests based on demographic, economic, and climate forecasts. This provides a framework for considering the possible demands for and challenges to forest management in the future.

006 **Southern Forest Science in Support of a Low Carbon Economy**

Alan A. Lucier, Ph.D. , Senior Vice President, NCASI , Research Triangle Park, NC

Fossil fuel combustion and other human activities are causing increases in atmospheric concentrations of carbon dioxide. Higher CO2 concentrations tend to increase photosynthesis, plant growth, and water use efficiency. Effects of CO2 on plants are greater in some species than in others and therefore will alter competition among plant species.

Reliable forecasts of climate change are not yet available at spatial scales relevant to forest management decisions. Directionally, climate "forcing" by human influences on Earth's radiation balance is toward warming. Some experts believe that climate cooling is the greatest risk related to natural climate variability. Climate science is making good progress on many important topics but it is not clear when reliable forecasts will be available.

Uncertainty about climate forecasts translates into uncertainty about future effects of climate change on forests. Climate warming per se would be unlikely to cause forest dieback because most tree species can tolerate temperatures warmer than they normally experience. Warming could damage forests if it co-occurs with drought or has indirect impacts mediated by insects, diseases, or wildfire. Climate cooling could cause forest dieback directly because inadequate cold tolerance is fatal to trees.

There does not appear to be a scientific basis for changing forestry practices now in anticipation of any particular scenario of climate change. For example, planting southern tree species in northern climates in anticipation of climate warming is not advisable. However, it is reasonable to assume that well-managed stands will be more responsive to higher CO2 concentrations and more resistant to climate-related stress than stands that are overstocked, deficient in nutrients, or otherwise in poor condition. It is also reasonable to assume that changes in silvicultural practices may be necessary and / or desirable at some point in the future and that long-term investments in forest genetics and silvicultural research programs are the best approach to ensuring that future foresters have the germplasm and silvicultural options they need to sustain healthy and productive forests.

Climate policies are evolving rapidly and could have significant effects on forest ecosystems and forest-based industries. Policies to limit greenhouse gas emissions could affect economic growth, demand for wood, and incentives for forest stewardship. Climate policies that target biomass energy and carbon sequestration have special and complex implications for the forest sector. There is an urgent need for research on the near-term and longer-term implications of such policies for wood demand and forest management.

139 **THE EFFECTS OF PLANTING DENSITY AND CULTURAL INTENSITY ON LOBLOLLY PINE CROWN CHARACTERISTICS AT AGE TWELVE**

Madison Akers*, Michael Kane, Robert Teskey, Richard Daniels, Dehai Zhao, Santosh Subedi, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA

Twelve-year old loblolly pine stands were analyzed for the effects of planting density and cultural intensity on tree and crown attributes. Four study installations were located in the Piedmont and Upper Coastal Plain regions of the U.S. South. The treatments included six planting densities (300, 600, 900, 1200, 1500, 1800 trees per acre) and two levels of culture (intensive and operational). The intensive cultural treatment included frequent fertilization and complete sustained competition control. The operational cultural treatment included less frequent fertilization and early competition control. Density and cultural treatments were combined to make a total of twelve plots per installation. Destructive sampling methods were used to obtain detailed tree and crown measurements. We hypothesize that larger crowns will be associated with stands with lower planting densities and higher levels of culture. Similarly, we hypothesize that leaf area index (LAI) and foliar nitrogen content will be greater for trees with larger crowns. Our final hypothesis is that higher densities and the intensive level of culture will lead to greater crown variability individually and even more so when combined. These crown observations at age twelve will be useful when determining how the trees will respond to mid-rotation management practices, such as thinning.

140 **TIMBER MARKET, INVENTORY AND CARBON OUTCOMES FROM NEW BIOENERGY MARKETS**

Karen L. Abt*, USFS Southern Research Station, Research Triangle Park, NC; **Robert C. Abt**, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC; **Christopher Galik**, Climate Change Partnership, Duke University, Durham, NC

An increase in the demand for wood to be used for energy, including cellulosic ethanol, bioelectricity, and pellets, has the potential to affect traditional wood users, forest land uses, management intensities, and ultimately, carbon sequestration and release. Of particular concern is the rate of carbon storage and release under different policy designs. Recent studies have shown that increases in bioenergy markets will likely lead to some displacement of traditional wood-using industries in the short run and intensive management, land use change and sawtimber market impacts in the long-run. We simulate market outcomes for in prices, inventory, planting, and land use as well as harvest for traditional and bioenergy wood use. Bioenergy demands are from FoRisk and traditional demands are downscaled from Bureau of Economic Analysis forecasts. This paper examines the carbon trade-offs from these market reactions in the South by evaluating four subregions in the South using forecasts of bioenergy demands as well as traditional wood product demands. We use life cycle analysis to examine the carbon tradeoffs resulting from emerging bioenergy markets and southern timber markets, addressing issues such as carbon release in residue decay, displacement of traditional pulpwood use, and management intensification.

142 **EXTENDING THE CAPABILITIES OF AN INDIVIDUAL TREE GROWTH SIMULATOR TO MODEL NON-TRADITIONAL LOBLOLLY PINE PLANTATION SYSTEMS FOR MULTIPLE PRODUCTS**

Ralph L. Amateis*, Harold E. Burkhart, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA

Demand for pulp and solid wood products from southern forests continues to increase even as demand for woody biomass for uses such as biofuels is on the rise. How to manage the plantation resource to meet demand for multiple products from a shrinking land base is of critical importance. Non-traditional plantation systems comprised of two populations planted on the same site and managed for multiple products may be an economical and environmentally attractive alternative. In order to examine the feasibility and profitability of these systems, growth and yield models flexible enough for such regimes will be needed. In this paper we describe how an individual tree growth and yield simulator (PTAEDA) can be altered to accommodate two populations planted at different densities and spacings on the same site and managed for alternative product objectives. Preliminary evaluations suggest that the individual tree growth model architecture is a suitable platform for modeling such stands.

143 **USING COMPUTER VISUALIZATION FOR PUBLIC OUTREACH AND DISCUSSION OF MANAGEMENT CONCERNS: CEDAR POINT PRESERVE CASE STUDY**

Michael G. Andreu, School of Forest Resources and Conservation, University of Florida, Gainesville, FL; **James B. McCarter***, School of Forest Resources, College of the Environment, University of Washington, Seattle, WA and Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh NC

Increasingly public land managers are facing the issues concerning the treatment or restoration of lands situated in an urban landscape. Lands that were purchased to provide habitat for wildlife, conserve ecological function and provide recreational opportunities to the public often become entwined in public debate and controversy when mangers attempt to use silvicultural techniques to manage the structure and composition of the forest. In Charlotte County Florida neighbors and dedicated users of the Cedar Point Preserve recently came out to oppose a series of mechanical fuel treatments to reduce risk of fire in the 60 year old fire excluded pine flatwoods system. In an attempt to reach out to the concerned citizens a public meeting was held to share the results of modeled runs using a combination of Forest Vegetation Simulator (FVS), Fire and Fuels Extension (FFE-FVS), and Stand Visualization System (SVS). By being able to discuss and visualize silvicultural treatments Extension Specialists were better able to communicate the tradeoffs associated with the various treatment options to help explain two major concepts; 1) that forest systems are dynamic and will continue to change regardless if the area is treated or not and 2) that without treatment the risk of devastating wildfire was very high and would continue to increase over time. Finding ways to extend silvicultural tools to front line land managers will be critical for the sustainable management of lands as landscape of urbanization expands in Florida and throughout the US.

144 **INFLUENCE OF GENETICS AND SPACING ON BIOMASS YIELDS IN LOBLOLLY PINE PLANTATIONS**

David K. Barker*, Steven E. McKeand, Robert C. Abt, Fikret Isik, Ross W. Whetten, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC

Maximizing biomass growth is essential to biofuel production. Loblolly pine (*Pinus taeda* L.) is the most important species to meet wood biomass demand in the South. The use of genetically superior varieties for feedstock will be critical for future biomass silvicultural systems. Combining planting spacing data with the growth data collected at various ages from a large number of field trials, we can characterize the relationship between trees per acre planted and future biomass yield for different loblolly pine families. It may also be possible to detect how spacing affects the dynamics of biomass accumulation in young stands versus older stands. Preliminary assessment of the data at age eight indicates that site and family have a big impact on biomass production: across all tests, the best 5% of families produced 96% more volume than average families. Additionally, the best site had over twice the mean annual increment than an average site (9.6 vs. 4.5 green tons ac^{-1} $year^{-1}$). Spacing also has a significant impact on volume production. Regression analysis of volume at age eight shows that per-acre volume production peaks around 700 tpa and then declines as decreasing individual tree volumes are no longer offset by increased tpa. The results suggest that spacing and genetics should be taken into account for woody biomass prediction, inventory and modeling.

145 **HERBICIDE SITE PREPARATION AND RELEASE OPTIONS FOR EUCALYPTUS PLANTATION ESTABLISHMENT IN THE WESTERN GULF**

Michael A. Blazier*, Louisiana State University AgCenter, Homer, LA; **John Johnson**, MeadWestvaco, Summerville, SC; **Eric L. Taylor**, Texas AgriLife Extension Service, Overton, TX; **Bradley Osbon**, Louisiana State University AgCenter, Homer, LA

Cold-tolerant species of eucalyptus (*Eucalyptus* spp.) are increasingly grown in the Western Gulf region as short-rotation pulpwood feedstock. Operational chemical suppression of competing vegetation has been relatively costly and inefficient because it consists of frequent applications of glyphosate applied via backpack sprayers. A series of studies were conducted in eucalyptus plantations in southwest Louisiana to identify herbicides that can be broadcast-applied by aircraft, providing effective competition suppression without damaging eucalyptus. A trial of 12 herbicide treatments in 2008 indicated that sulfometuron methyl applied to newly planted eucalyptus at 1.25 oz. per acre was a viable herbicide for promoting eucalyptus growth without damaging seedlings. A trial of 8 herbicide treatments in 2008 revealed that imazapyr applied at 32 oz. per acre provided effective pre-plant competition suppression with no significant eucalyptus damage. Further testing with post-plant applications of sulfometuron methyl to one- and two-year-old eucalyptus plantations found that application rates exceeding 2.0 oz. per acre significantly damaged and reduced growth rates of eucalyptus.

148 **LOBLOLLY PINE AND SWITCHGRASS INTERCROPPING BIOENERGY PRODUCTION SYSTEMS IN THE SOUTHEAST U.S.: IMPACTS ON PLANT-SOIL CARBON AND ENVIRONMENTAL SERVICES**

Michael A. Blazier*, Louisiana State University AgCenter, Homer, LA; **Eric B. Sucre, Zakiya H. Leggett, Darren Miller**, Weyerhaeuser Company, Vanceboro, NC; **Eric D. Vance**, National Council of Air and Stream Improvement Inc., Research Triangle Park, NC; **T. Bently Wigley**, National Council of Air and Stream Improvement Inc., Clemson, SC; **Terry Clason**, USDA Natural Resource Conservation Service, Alexandria, LA; **Scott Roberts, Randall Rousseau, Jeff Hatten**, Mississippi State University, Starkville, MS; **Lewis Gaston**, Louisiana State University AgCenter, Baton Rouge, LA**; Michael Tyree, A. Gordon Holley**, Louisiana Tech University, Ruston, LA; **Eric L. Taylor**, Texas AgriLife Extension Service, Overton, TX

Switchgrass (*Panicum virgatum*) has several favorable characteristics as a bioenergy feedstock (high growth potential, low nutrient demand, and high heat energy yields), and it grows well in moderate shading. Due to these attributes, bioenergy production systems could be developed for growing switchgrass as an annually harvested bioenergy feedstock between rows of loblolly pine (*Pinus taeda* L.) managed for traditional forest products. A series of trials have been established in Louisiana, North Carolina, and Mississippi to determine the potential yield and environmental impacts of loblolly pine-switchgrass intercropping systems. In Louisiana, switchgrass was established in juvenile, mid-rotation, and late-rotation loblolly pine, with diverse densities of pine in each age class. In a late-rotation loblolly pine-switchgrass intercropped stand in Louisiana, organic and inorganic sources of fertilizer were applied to switchgrass. In North Carolina, switchgrass and loblolly pine were established in the presence and absence of logging debris. In Mississippi, switchgrass was established within diverse clonal and open-pollinated genotypes of loblolly pine. Similar clonal and open-pollinated loblolly pine genotypes were established in Louisiana as well. This series of trials thus explores several loblolly pine management practices and their potential influences on switchgrass growth and development. Plant and soil carbon, soil respiration, potential nitrogen mineralization, pine and switchgrass nutrient uptake efficiency, soil nutrient concentrations, and loblolly pine carbon allocation patterns are being assessed in these trials. Treatment effects on these variables will be discussed.

152 **PRELIMINARY RESULTS OF APICAL BUD STRENGTH TESTS AND TREE SWAY MOVEMENTS TO EXAMINE CROWN ABRASION**

Tyler Brannon*, Wayne Clatterbuck, Department of Forestry, University of Tennessee, Knoxville, TN

Apical bud strength differences are examined for several species to determine if crown abrasion affects shoot growth of determinate and indeterminate species during stand development. Determinate buds will set and harden, while the indeterminate shoots form leaves from the apical meristem continuously based on the resources that are available at the time of growth. These growth differences can influence which species' buds are abraded or broken upon impact with adjoining crowns affecting crown growth. Several standardized tests of shoot and bud strength by species and shoot growth form are evaluated. Crown movement is assessed by using 3-axial accelerometers in outer most extreme points of crowns and on various points of a single branch. Accelerometers automatically log the movement of the tree crown over a period of time and are evaluated with local wind data. By using both the crown sway information and associated bud and branch strength models, evidence is provided to suggest that crown friction and abrasion are contributors to crown and stand development patterns in mixed species stands, often allowing species with determinate shoot growth to stratify above trees with indeterminate growth.

153 **DID DOMINANT TABLE MOUNTAIN PINES START LIFE IN FULL SUNLIGHT OR PARTIAL SHADE?**

Patrick H. Brose*, USDA Forest Service, Irvine, PA; **Ross J. Phillips, Thomas A. Waldrop,** USDA Forest Service, Clemson, SC

Table Mountain pine (*Pinus pungens*) is an endemic species of the Appalachian Mountains where it is found on dry south-facing ridges that burned periodically. Because of this relationship with site and fire, Table Mountain pine is regarded as shade intolerant. However, recent research casts doubt on the validity of this shade intolerance assumption. We used radial growth analysis to test whether the current dominant pines originated and grew in full sunlight or partial shade. More than 400 Table Mountain pines in nine stands in northern Georgia, western South Carolina, and eastern Tennessee were cored to determine their ages and years of origin. We measured the increment cores using standard dendrochronological techniques to develop individual radial growth chronologies. The beginning of each individual chronology was then compared to a master chronology developed from 20-year-old Table Mountain pines known to have originated and grown in full sunlight. Results varied by location. Nearly all Table Mountain pines from Tennessee and one site in South Carolina had chronologies similar to the master chronology - rapid initial growth and little growth suppression - suggesting that they originated and grew in full sunlight. Conversely, Table Mountain pines from Georgia and two sites in South Carolina displayed markedly different growth patterns, slow initial growth and periods of growth suppression, indicating that they originated and grew in partial shade. These results support recent research that Table Mountain pine is intermediate in shade tolerance and can originate after periodic, low-intensity surface fires as well as high-intensity crown fires.

154 **ADAPTING THE 3-PG+ MODEL TO ESTIMATE GROWTH, CARBON SEQUESTRATION, AND WATER USE OF HIGH PRODUCTIVITY LOBLOLLY PINE CLONES UNDER SHORT ROTATION SILVICUTURE**

Charles Bryars*, Robert Teskey University of Georgia, Athens, GA; **Chris Maier**, USDA Forest Service, Research Triangle Park, NC; **Phil Dougherty**, ArborGen, Summerville, SC

Clonal loblolly pine planting stock is being used by land managers in plantation establishment more and more frequently. Some clones are suited for bioenergy production with growth rates approaching that of eastern cottonwood but with lower implementation costs. The loblolly pine clonal genotypes suitable for biomass production could become important sources of bioenergy feedstock in the Southeast. Despite the increasing planting of these clones, the effects of their use on plantation productivity, site carbon sequestration, and water use are for the most part undocumented. This project has attempted to refine the 3-PG+ model to accurately predict growth rates, productivity, belowground carbon partitioning and water use of short-rotation clonal loblolly pine plantations under a wide range of management intensities and environmental gradients. The model was calibrated using two fast growing loblolly pine clones that exhibit contrasting morphological and physiological characteristics. Data was collected from an established field study (Cross Carbon Study), which covers several soil types and incorporates a variety of silvicultural treatments. This observed data was then used to parameterize and modify the 3-PG+ model so that it accurately predicts growth rates and productivity. The model was then used to examine potential productivities of these clones across a wide range of environmental gradients. This makes the 3-PG+model a powerful tool for evaluating the feasibility of short rotation, high intensity clonal forestry across the Southeast. The parameterized model is also useful for evaluating water use efficiency of different genotypes, providing an additional assessment tool to aid in selection strategies of genetically improved planting stock.

156 **DEVELOPMENT OF DORMANT BLACK WILLOW UNROOTED PLANTING STOCK FOR SHORT ROTATION BIOENERGY PLANTATIONS**

Jake C. Camp* and Randall J. Rousseau, Department of Forestry, Forest & Wildlife Research Center, Mississippi State University, Mississippi State, MS

Black willow (*Salix nigra* Marsh.) has the potential to be a viable biomass crop for heavy clay soils throughout the southern United States. Regeneration using vegetative propagules allows the ability to develop genetically superior clones within a short timeframe. The use of dormant unrooted cuttings provides for the use of clonal stock and ease of planting. The objective of this study was to determine the optimal cutting size and planting depths that would enhance survival and growth of black willow. We examined four cutting diameters, three cutting lengths, and three planting depths. There were no significant age-one survival differences among the various factors. Significant age-one total height differences were shown for cutting length, depth of planting, and cutting diameter. Height was greater for those cuttings that were the longest but planted at a shallower depth. While cutting diameter was a significant factor for age-one height it followed no cutting size trend. The test will be measured at the end of the second growing season and compared with first year results.

157 **HERPETOFAUNAL AND SMALL MAMMAL RESPONSE TO OAK-REGENERATING SILVICULTURAL PRACTICES IN THE MID-CUMBERLAND PLATEAU OF SOUTHERN TENNESSEE**

Andrew Cantrell* and Yong Wang, Department of Natural Resources and Environmental Science, Alabama A&M University, Normal, AL; **Cathryn Greenberg**, USDA Forest Service, Southern Research Station, Asheville, NC; **Callie Schweitzer**, USDA Forest Service, Southern Research Station, Normal, AL

The USDA Forest Service Southern Research Station has implemented a Regional Oak Study (ROS), in which they are investigating the impact of oak-regenerating silvicultural treatments. Such treatments have the capability to alter landscapes, which in return can alter wildlife populations. My research has identified some of the mechanisms responsible for influencing herpetofaunal and small mammal diversity and population fluctuations in the oak-hickory hardwood forests ecosystems of the mid-Cumberland Plateau in Grundy County of Southern Tennessee. A completely randomized design with 5 replications was used to test three forest treatments consisting of: 1) shelterwood (30%-40% basal area (BA) retention), 2) oak shelterwood (partial removal of the mid-story by applying 3A Garlon), and 3) prescribed burn (pre-treatment for this portion of the study), along with a control resulting in 20 experiment units (~ 5 ha each). To sample herpetofaunal and small mammal communities drift fences with the aid of pitfall and box funnel traps and Sherman live traps (SLT) were used. The response of herpetofaunal and small mammal communities caused by silvicultural treatments are species specific. The findings of this research will provide forest resource managers and private forest land owners with better knowledge for conserving herpetofaunal and small mammal species when implementing management practices for oak forest regeneration in this region.

158 **USE OF THE WEIBULL FUNCTION TO PREDICT FUTURE DIAMETER DISTRIBUTIONS FROM CURRENT PLOT DATA**

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The Weibull function has been widely used to characterize diameter distributions in forest stands. The future diameter distribution of a forest stand can be predicted by use of a Weibull probability density function from current inventory data for that stand. The parameter recovery approach has been used to “recover” the Weibull parameters from diameter moments or percentiles. The Moment method involves arithmetic or quadratic mean diameter, and diameter variance, whereas the Percentile method includes diameter percentiles (e.g. 25^{th}, 50^{th}, 31^{st}, 63^{rd}, or 95^{th}). The Hybrid method is a combination of both methods, requiring both diameter moments and percentiles. Data from loblolly pine (*Pinus taeda* L.) plantations will be used to evaluate these different methods, based on Reynolds et al. (1988) error index.

159 **FINANCIAL RETURNS AND LANDOWNER CHOICES IN LOBLOLLY PINE MANAGEMENT UNDER CARBON MARKETS**

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Concerns related to global climate change are driving limits on carbon emissions globally. Forestry carbon offsets are one strategy for reducing a carbon emitting entity's "carbon footprint." These carbon offsets would be bought and sold on carbon markets or exchanges much like other commodities, and would be secured by forest growth that is retained during some specified carbon contract period. As the price of carbon increases, private landowners net returns from commodity wood products and carbon changes. Using long-term actual inventory data sampled from three management regimes of loblolly pine, commodity wood prices and carbon prices were simulated to determine financial returns and landowner preferences between even-aged plantation, even-aged natural pine, and uneven-aged pine. Sensitivity to carbon prices, and carbon trading rules, including the allowance for long-lived wood products, and total forest biomass are included.

160 **LESSONS FROM THE FIELD: THE FIRST TESTS OF RESTORATION AMERICAN CHESTNUT (*CASTANEA DENTATA*) SEEDLINGS PLANTED IN THE SOUTHERN REGION**

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An exotic fungus, the chestnut blight (*Cryphonectria parasitica* Murr. Barr) decimated the American chestnut tree (*Castanea dentata* Marsh. Borkh.) throughout eastern North America in the first half of the 20th century. The chestnut's demise had significant consequences on forest ecosystem processes and utilitarian values. The United States Department of Agriculture, Forest Service (FS), The University of Tennessee, and The American Chestnut Foundation (TACF) are collaborating on chestnut restoration research on National Forest System lands. In autumn 2007 and 2008, TACF used their back-cross breeding program to produce chestnuts that are predicted to be American chestnut in character with blight resistance from Chinese chestnut (*Castanea mollissima* Blume). Chestnut seedlings were grown as bare-root 1-0 seedlings and then out-planted on three southern National Forests in 2009 and 2010. To date, five test plantings have been established, and six more plantings are expected to be established in 2011. The FS will continue to receive chestnut material in subsequent years to continue field testing and eventually for reforestation purposes. We present early test results that indicate chestnuts are capable of fast-growth in the first two years after planting, but may be susceptible to animal, insect, and disease pressure. Early indications are that the putatively blight-resistant generation, commonly referred to as the BC_3F_3 generation, resembles pure American seedlings in growth and phenology. We discuss logistical, silvicultural, and administrative considerations for nursery and field tests as well as the partnerships that contributed to these activities.

162 **SHORT ROTATION WOODY CROP BIOMASS ENERGY FEEDSTOCK PRODUCTION SYSTEMS**

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Bioenergy feedstocks can be produced through a variety of agricultural and forestry applications. Woody feedstocks from forestry can be harvested year round and the resulting solid chips are easily handled, stored and converted to energy using well developed operations. Short rotation woody crops (SRWC) refer to intensive forest management practices that grow woody feedstock in short harvest rotations using fast growing varieties, herbicides, fertilizer and possibly irrigation. These approaches result in harvest cycles of three to twelve years at production rates up to 20 dry Mg ha^{-1} $year^{-1}$. Such SRWC approaches are appropriate for producing biomass for energy feedstocks as well as for pulp, paper, engineered and solid wood products. Bioenergy feedstocks can be produced with a variety of SRWC systems using numerous species. Dense plantings of willow, sycamore and eucalyptus that are capable of resprouting following cutting (i.e. coppice), will occupy the site rapidly, and have vigorous regrowth without replanting for multiple 3- to 5-year rotations. Specialized planting and harvesting equipment is available for coppice systems. Larger trees can also be produced in low-density plantings using the SRWC approach, which allows efficient use of conventional forest harvesting equipment. Numerous hardwood tree species have been used for low-density SRWC including poplar, sycamore, sweetgum and eucalyptus. Hardwood trees are selected for high productivity rates and converted to energy with thermochemical and biochemical approaches. Conifers, such as loblolly pine, are also considered opportune bioenergy feedstock species for theomochemical conversion. Economics favor rapid growth, but the most favorable trees for SRWC will have robust site requirements such as pine and sweetgum that can be planted on a range of marginal sites. Other tree species will be favored only if they can be bred or modified for water and nutrient use efficiency. SRWC plantations near bioenergy facilities provides consistent feedstock supply and quality standards.

164 **FIRST YEAR RESPONSE OF OAK NATURAL REGENERATION TO A SHELTERWOOD HARVEST AND MIDSTORY COMPETITION CONTROL IN THE ARKANSAS OZARKS**

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A study evaluating the response of oak natural regeneration to a shelterwood harvest and midstory competition control in an upland hardwood stand within the Ozark Highlands of Arkansas is being conducted. The study site is located in the dissected Springfield Plateau physiographic region, on the University of Arkansas – Division of Agriculture Livestock and Forestry Research Station near Batesville, AR. 5-acre treatment plots were established within a 140 acre shelterwood harvest on north-facing slopes (SI 70 - 75 for oaks) in a 110 year old upland hardwood stand. The overstory is dominated by white oak (*Quercus alba* L.), black oak (*Quercus velutina* Lam.), and northern red oak (*Quercus rubra* L.). Treatments include: 1) shelterwood harvest to BA 50; 2) shelterwood harvest to BA 50 plus injection of undesirable stems greater than 1" DBH; and 3) no stand modification. Initial measurements, midstory competition control, and a shelterwood harvest were conducted in 2009. Preharvest species composition of regeneration included 15% oak species, and 85% non-oak species. Approximately ninety percent of oak regeneration was less than 3 ft tall prior to harvest. First year results of regeneration and stump sprout response will be presented. Residual overstory conditions, including epicormic branching response, will also be presented.

165 **A COMPARISON OF THE FINANCIAL IMPACTS OF COST SHARE PROGRAMS ON SECOND GENERATION AND GENETICALLY IMPROVED LOBLOLLY AND LONGLEAF PINE PLANTATIONS**

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We examined the bare land value associated with using varietal seedlings compared to 2nd generation seedlings. The analysis was conducted with and without cost share programs for both loblolly and longleaf pine. For the longleaf analyses the first rotation was simulated assuming requirements were met to qualify for Farm Service Agency cost share programs, all future rotations were simulated assuming NRCS cost share program requirements were met. The analysis for loblolly pine indicated the bare land value for varietals in higher than the 2nd generation seedlings assuming a 6% discount rate and a 25 year rotation. The decision to favor varietals was the same with and without the use of cost share programs. The longleaf pine analysis showed similar results assuming a 30 year rotation. The analysis demonstrates the cash flows associated with genetically improved seedlings are positive and can be improved through the use of cost share programs

167 **SUSTAINING QUERCUS HUMBOLDTII AND COLOMBOBALANUS EXCELSA ON THE COLOMBIAN LANDSCAPE: PRESERVATION OR CONSERVATION – A RESEARCH PERSPECTIVE**

Daniel C. Dey*, Alejandro A. Royo, USDA Forest Service, Northern Research Station; **Emile S. Gardiner**, USDA Forest Service Southern Research Station; **Luis Mario Cardenas**, Fundacion Natura, Bogota, Colombia

In the coffee growing region of Colombia, conversion of forests to agriculture on steep mountain slopes has caused great concern and a desire to protect the remaining forests for wildlife, water yield and quality, and biodiversity conservation. *Quercus humboldtii* and *Colombobalanus excelsa* are important species throughout this region and they provide high quality timber and fuelwood to the people. Preservation of existing forests that precludes any type of management, laws prohibiting the cutting of *Quercus* spp., and reforestation are strategic directions being taken to reverse the loss of forest and reclaim marginal crop fields to forests. But the people live by subsistence and local economies based on farming, grazing and forestry. Alternative strategies for the sustainable management of these species and forests are needed that achieve conservation and ecological objectives while meeting the resource needs of the people. The incorporation of these species in agroforestry practices in farm and coffee plantation settings, or in reforestation land has the potential to meet both ecological and social needs of the forests across a large portion of the Colombian landscape.

Much is unknown of the biology and ecology of the *Quercus* and *Colombobalanus* species in these Colombian forests, and it is uncertain if their populations are sustainable in forest preserves. Research is needed to determine how best to sustainably manage these species in forest and agroforest ecosystems? This requires research in natural and artificial regeneration, including production of plant material, and silviculture to manage stand dynamics to promote *Quercus* and *Colombobalanus* in both natural and agroforest environments.

168 **LONGLEAF PINE WOOD AND STRAW YIELDS FROM TWO OLD-FIELD PLANTED SITES IN GEORGIA – RESULTS THROUGH AGE 21-YEARS**

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Little is known or published concerning longleaf pine's growth rate and wood and pine straw yields on old-field sites. The University of Georgia installed two study areas in December 1986 old-field planted, unthinned longleaf stands in Georgia in Screven and Tift Counties in 2003 to address the old-field pine growth and straw yields. Soil series were delineated and replicated plots with three levels of fertilization (control=zero NPK, a NPK single dose, and a NPK split dose) were imposed at each site. This paper will focus on longleaf pine stand growth and wood and pine straw yields through age 21-years. The results indicate that these two old-field longleaf pine stands are growing at a rate of 13.6 (control at Tift County site) to 16.6 (single NPK dose at Tift County site) cubic meters per hectare per year through age 21-years. Mean annual increments for all treatments at both sites were increasing from age 17- through age 21-years. Mean d.b.h. values ranged from 22.4 cm (control at Tift County site) to 24.2 cm (split NPK at the Screven County site). Mean heights through age 21-years ranged from 17.9 m (single NPK dose at the Screven County site) to 18.4 m (control and split NPK dose at the Tift County site). Pine straw yields averaged 200 (control at Tift County site) to 245 (split NPK at Screven County site) bales per acre per year from ages 17- through age 21-years.

170 **FUTURE CLIMATIC AND ENVIRONMENTAL CONDITIONS WILL LIMIT HYDRAULIC REDISTRIBUTION BY DEEP ROOTS AND WILL AFFECT NEGATIVELY WATER AND CARBON CYCLING OF SOUTHERN FORESTS**

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Plants do not only lose water from the canopy through transpiration, but lose a portion of water taken up at night from deep, moist soil layers through flux from roots to shallow, dry soil layers. This process is termed 'hydraulic redistribution' (HR). We investigated the temporal variability of soil moisture dynamic in three AmeriFlux sites and used data from the Duke Free-Air CO_2 Enrichment site to forecast future environmental impacts on HR and its effect on water cycling and carbon sequestration. Our results showed that HR played a critical role in delaying the drying of upper soil layers by replacing more than 25% of the water utilized during the day with water taken up by deep roots at night. Furthermore, HR mitigated the effects of soil drying on understory and stand evapotranspiration and had important implications for net primary productivity by maintaining pine plantations as a carbon sink. The warming climate is expected to bring along higher vapor pressure deficit, which will increase nighttime transpiration and reduce HR. We predicted that increases in temperature, vapor pressure deficit and CO_2 would reduce HR and limit shallow soil rewetting, thus affecting negatively net ecosystem exchange (NEE). Modeling carbon flux showed that in the absence of HR, gross ecosystem productivity (GEP) and NEE would be reduced by 750 g C m^{-2} yr^{-1} and 400 g C m^{-2} yr^{-1}, respectively. HR-induced decrease of GEP outweighed the decrease of soil respiration, thus contributing to a lower NEE.

171 CHARACTERIZATION OF YIELD AND GROWTH EFFICIENCY OF HALF-SIB, FULL-SIB, AND VARIETAL *PINUS TAEDA* GENOTYPES GROWN AT TWO ESTABLISHMENT DENSITIES

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Cumulative growth through six growing seasons and annual growth in the sixth growing season will be contrasted for block plantings of varying crown ideotypes of loblolly pine established at two planting densities (388 and 518 tpa). Genotypes to be compared include selections from three levels of genetic improvement, including open-pollinated, mass-control-pollinated, and varietal-level stock. Two replicated studies with the same genotypes will be reported on, including one site located in the Lower Coastal Plain of SC, near Summerville, SC, and a second site located in the Upper Coastal Plain of GA, near the town of Buena Vista. Growth efficiency will also be evaluated and discussed for the genotypes represented. Block level data will be scaled up to evaluate the growth and financial impacts of operational deployment of the selected genotypes.

172 **PINE STRAW PRODUCTION: FROM FOREST TO FRONT YARD**

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Southern forestry may be undergoing a paradigm shift in which timber production is not necessarily the major reason for owning forested land. However, there remains interest in generating income from the land and landowners are exploring alternatives, including agroforestry practices and production of non-timber forest products (NTFPs). There is renewed interest in one activity that goes back to the original settlement of the Southeast: silvopasture, or the grazing of livestock in the forest understory. Another alternative more recent to the Southeast is collecting and selling pine straw for use in urban landscapes. Common to both of these would be use of longleaf pine as the species of choice. The pre-settlement forest of the Southeast was dominated by longleaf pine and these forests were grazed by cattle and maintained by frequent fire. As for the newly developing pine straw market, it has been shown that longleaf pine straw will bring the landowner more money than straw from other southern pine species. The Regional Longleaf Growth Study will be utilized to provide information on the potential for forage and pine straw production based on overstory density, season of fire, age class, and site quality. This information will be combined with preliminary results of a survey of landowners and pine straw producers in Alabama will provide additional insight into pine straw markets in the state –from the forest to the front yard.

173 **INFLUENCE OF LIGHT AND MOISTURE ON LONGLEAF PINE SEEDLING RECRUITMENT IN SELECTION SILVICULTURE**

David S. Dyson*, Dale G. Brockway, USDA Forest Service, Southern Research Station; **Edward F. Loewenstein**, Auburn University, School of Forestry and Wildlife Sciences; **Steven B. Jack**, Joseph W. Jones Ecological Research Center at Ichauway

Selection silviculture has become increasingly common for longleaf pine management, yet questions remain regarding residual canopy effects on seedling survival and growth. To determine what levels of residual overstory promote adequate seedling recruitment, 600 containerized longleaf pine seedlings were planted on two sites during the 2007-2008 dormant season. To differentiate overstory from understory influences, half of the seedlings were randomly selected for understory removal (with herbicide). Canopy gap fraction was determined using hemispherical photography and average soil moisture was determined from four TDR measurements during the 2008 and 2009 growing seasons. Seedling groundline diameter (GLD) was measured at planting and in August, 2008 and 2009. First-year results showed weakly positive relationships between soil moisture and seedling growth, whereas generally negative but statistically non-significant relationships existed between gap fraction and seedling growth. Second-year results showed few significant relationships, but generally positive trends between gap fraction and GLD growth. No general trend was present between soil moisture and GLD growth. Data collected during this study support previous research suggesting that initial longleaf pine survival and growth are limited by moisture availability, but following establishment, light becomes the primary driver of longleaf pine seedling growth.

174 **SELECTED THERMAL PROPERTIES OF SEVERAL GRASSES (NATIVE AND EXOTIC) ASSOCIATED WITH LONGLEAF PINE ECOSYSTEMS**

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Prior to European settlement, fire was a ubiquitous and important process responsible for the persistence of longleaf pine forests. Fire-maintained longleaf pine ecosystems have been observed with over 40 species of plants per square meter. Grasses, especially bunch grasses, may make the largest contribution to maintaining structure and function of the forest because they, in conjunction with pine needles, often make up the bulk of the fine fuel. As such, there is a renewed interest in restoring longleaf pine ecosystems by planting native, warm season grasses which are observed in fire-maintained ecosystems, but the importance of various grass species to fire effectiveness is unknown.

Among the factors that control fire behavior are the combustion properties of the fuels, influencing fire initiation, establishment and propagation. The objectives of the current work are to evaluate the thermal properties of grasses common to longleaf pine ecosystems. These have been addressed by an examination of native understory grasses (broomsedge (*Andropogon virginicus*), arrow-feather three-awn and wiregrass (*Arisitida purpurescens* and *A. beyrichiana*), slender little bluestem (*Schizachyrum tenerum*), downy oatgrass (*Danthonia sericea*), pineywoods dropseed (*Sporobolus junceus*), and the exotics cogongrass (*Imperata cylindrical*) and lovegrass (*Eragrostis* spp.) using thermogravimetric analysis (TGA), oxygen bomb calorimetry, and differential scanning calorimetry (DSC). The temperatures associated with the degradation of cellulose, hemicellulose and lignin are reported along with the chemical kinetics of thermal degradation in both inert and oxidizing environments. These data will be related to observed fire behavior and the biology of the various species.

175 **USE OF AMINOCYCLOPYRACHLOR FOR FORESTRY SITE PREPARATION IN THE SOUTHEASTERN U.S.**

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It is not often that new chemistry is made available for use in forestry applications. Aminocyclopyrachlor is a new active ingredient which may have usefulness as a forestry herbicide. Research using this active ingredient began in 2005 and is continuing in university projects across the South. Both hardwood control efficacy and pine tolerance have been evaluated in these trials. A total of 60 different treatments have been evaluated for use in site preparation applications in Mississippi and Texas. This paper will provide a summary report of the findings from those research projects. Expected control for the major hardwood competitors encountered in pine site preparation will be presented by species. In addition, results from the work with *Baccharis* will be presented for those interested in control of this exotic species. Loblolly pine tolerance to the treatments will be presented and the potential use for the material in forestry applications will be discussed.

176 **EFFICACY OF TREATMENTS USING MAT-28 FOR PINE SITE PREPARATION**

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Site preparation for pine plantation establishment continues to be the principal use of herbicides in the South. Due to the timing of the work and the cost involved, these applications are critical in both biological and economic terms. In an effort to improve performance in both considerations, a study was undertaken to evaluate a numbered herbicide compound in site preparation applications. A total of 12 treatments were applied with three replications in a randomized complete block design. Applications were completed in mid-July using a total spray volume of 15 gpa. Treatments included MAT-28 applied alone at three rates and MAT-28 applied in combination with metsulfuron, imazapyr, glyphosate, or sulfometuron. An assessment of brownout was completed at 45 days after treatment and hardwood control was evaluated at one year after treatment. Results from all evaluations will be presented along with a discussion of the potential of this herbicide for use in operational applications.

179 **EFFICACY OF MIDSTORY INJECTION AND NON-TARGET IMPACT IN BOTTOMLAND HARDWOODS**

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The need for midstory control in bottomland hardwood regeneration work has been well documented. However, only a few research efforts have documented the efficacy of such efforts and the potential negative effects on non-target stems. This potential negative impact is extremely important in these stands where individual stem values are characteristically high. As part of an oak regeneration project, this study is designed to evaluate the efficacy of midstory control on target species as well as incidental damage to non-target stems. During this study, approximately 72,000 midstory stems were injected during August and September, 2009. These stems were located on 90 acres of bottomland hardwood stands within minor stream bottoms in northern Mississippi. All midstory stems except oaks which were ≥1" diameter at breast height (d.b.h.) received one hack per three inches d.b.h. and one ml of a 20 percent volume to volume Arsenal AC aqueous solution per hack. Ninety 0.025-acre plots will be evaluated in August 2010 to determine the effectiveness of the injection. Injected midstory stems within a plot will be recorded as dead or alive. All non-target stems on the plots will be evaluated for mortality or damage. In addition, any damage noted on non-target stems across the study areas outside the measurement plots will be recorded and reported. Results will be reported as percentages by species and diameter class. This information will be of great value to hardwood mangers using the wide spacing imazapyr injection method for control of undesirables.

183 **A GROWTH AND YIELD SYSTEM FOR CLONAL LOBLOLLY PINE PLANTATIONS**

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A new growth and yield system has been developed for clonal loblolly pine plantations for the southern U.S. The model is calibrated using a large regionwide database that has been compiled for clonal loblolly pine stands. Model structure and use will be discussed and demonstrated.

184 **A COMPARISON OF HERBICIDE TANK MIXTURES FOR MID-ROTATION GALLBERRY COMPETITION RELEASE IN SLASH PINE**

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Seventeen different herbicide combinations including Forestry Garlon® 4, Garlon® 4Ultra, Garlon® XRT, Chopper®, and MilestoneVM® were tested for gallberry (*Ilex glabra)* control. Treatments were applied to the understory of a 9-year-old slash pine (*Pinus elliottii* Engelm.) plantation in south Georgia. Herbicide tank mixtures were foliar applied at a total volume of 20 GPA and replicated three times in a randomized complete block design. One and two years after treatment plots were evaluated and ranked by gallberry control. Forestry Garlon®4 performed similar to newer formulations Garlon®4Ultra and Garlon®XRT. The most effective herbicide treatment for gallberry was achieved with 4 quarts of Garlon®4 or 3 quarts of Garlon®4 (or equivalent Garlon formulation) tank-mixed with 16oz of Arsenal® or 48 oz Chopper®.

187 **MANAGEMENT APPROACHES FOR FOREST CARBON SEQUESTRATION IN LONGLEAF PINE**

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To better understand carbon sequestration in longleaf pine (*Pinus palustris* Mill.) forests, our objective was to examine the influence of density and basal area management on stand carbon (C) stocks and soil respiration (R_S) in 50-year-old longleaf pine. The study is located in the Escambia Experimental Forest in southern Alabama and burned on three year intervals. Plots varied in density from 49 to 1334 trees ha^{-1} and ranged in basal area from 7 to 36 m^2 ha^{-1}. Total standing C stocks in longleaf pine biomass (foliage, stem, branch, tap root, coarse roots) ranged from 36 to 139 Mg C ha^{-1}. The majority of C was sequestered in tree biomass followed by soil C and C in the litter. Temperature explained the majority of variation in R_S followed by litter mass and depth. On an annual basis, R_S ranged from 11 to 18 Mg C ha^{-1} yr^{-1} and was only weakly related to basal area or density. Maximum net primary productivity was 5.2 Mg C ha^{-1} yr^{-1} in plots with the highest basal areas. Using literature based values for fine root turnover and shrub production in longleaf pine ecosystems and assuming heterotrophic respiration was 50% of R_S, the majority of plots were C sources with only the highest basal areas being a C sink. Critical gaps in understanding C dynamics in longleaf pine include belowground production, heterotrophic respiration and understory C sequestration.

189 **DIFFERENCE AMONG SHORTLEAF PINE SEED SOURCES ON THE OUACHITA AND OZARK NATIONAL FORESTS AT AGE TEN**

David Gwaze, Missouri Department of Conservation, Columbia, MO ; **Charly Studyvin***, Mark Twain National Forest, Rolla, MO

Progeny test planting of shortleaf pine (*Pinus echinata* Mill.) was started on the National Forests in Arkansas in 1978, and continued through 1990. A series of progeny tests established on the Ouachita and Ozark National Forests were analyzed to determine if significant differences exist between the three seed sources in Arkansas (the East Ouachita, the West Ouachita and the Ozarks) for height, diameter and survival at age 10. Sixteen tests were from the Ouachita National Forest and fourteen from the Ozark National Forest. Preliminary analyses indicate significant differences among seed sources for height and diameter, but not survival. Families within seed source were significant for all traits. Implications of these results will be discussed.

190 **FUEL REDUCTION TREATMENTS IN THE SOUTHERN APPALACHIAN MOUNTAINS: ARE THEY EFFECTIVE AND FOR HOW LONG?**

Helen H. Mohr*, Thomas A. Waldrop, Ross J. Phillips, USDA Forest Service, Clemson, SC

An often-stated objective of fuel reduction treatments in the southern Appalachian Mountains is to promote restoration of open woodland communities. However, this objective cannot be considered a success if treatments do not lower the risk or severity of wildfire. This study tested the success of four fuel reduction treatments for mitigating wildfire behavior over a period of 9 years. Three blocks of four treatments were installed in a mature hardwood forest in western North Carolina. Fuel reduction treatments included chainsaw felling of small trees and shrubs (mechanical treatment), two prescribed fires 3 years apart, a combination of mechanical and burning treatments, and an untreated control. Each active treatment impacted loading of litter and small woody fuels and changed several measures of BehavePlus4-simulated fire behavior (rate of spread, flame length, spread distance, and area burned). Ice storms, which occurred twice during the 9-year study, increased fuels in unburned plots but had no impact to burned plots. Prescribed burning in combination with the mechanical treatment was the most effective at reducing all measures of fire behavior. Each of the active treatments tested must be repeated to reduce fuels and lower wildfire behavior but prescribed burning must be repeated frequently.

192 **PLANTING DENSITY AND SILVICULTURAL INTENSITY IMPACTS ON LOBLOLLY PINE STAND DEVELOPMENT IN THE WESTERN GULF COASTAL PLAIN THROUGH AGE 8**

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We examined impacts of planting density and silvicultural intensity on loblolly pine stand and tree attributes through age eight on a regional field trial series in the Western Gulf Coastal Plain of Arkansas, Texas and Louisiana. Planting densities ranged from 200 to 1200 trees per acre and were tested in increments of 250 trees per acre. Each planting density was tested at two levels of culture: 1) Operational that included first growing season herbaceous weed control and fertilization at establishment; and 2) Intensive that included near total and sustained competition control and frequent fertilization. A total of 18 installations were established during the 2001 to 2003 planting years across four soil groups. Stand and individual tree development patterns through age 8 by soil group are described for a subset of nine installations with age 8 measurements. At age 8, planting density and silvicultural intensity each significantly affected per acre basal area, volume, and weight and mean values for d.b.h and height. Significant interaction effects of planting density and silvicultural intensity were not observed for most stand and tree attributes. However, there was a significant interaction of planting density and silvicultural intensity for mean height; height response to intensive culture tended to be greater at higher than lower planting densities. Height responses to intensive culture also tended to be greater on imperfectly drained soils than on well drained soils. Implications of results for plantation management with objectives ranging from biomass to sawtimber are discussed.

193 **FIELD PERFORMANCE AND BIOENERGY CHARACTERISTICS OF FOUR COMMERCIAL *EUCALYPTUS GRANDIS* CULTIVARS IN FLORIDA**

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Substantial genetic improvements in the growth, form, and freeze resilience of Florida *E. grandis* resulted in the release in 2009 of four commercial cultivars: *E*.nergy™ G1'^{PPAF}, G2'^{PPAF}, G3'^{PPAF}, and G4'^{PPAF}. While G1, G2, G3, and G4 have exceptional growth rate, stem form, freeze tolerance, and coppicing ability compared to 4th-generation *E. grandis* seedlings, the four cultivars have important differences in these characteristics, their genetics, and wood chemistry. Three cultivars planted at six locations throughout peninsular Florida in 2009 and another seven locations in 2010 survived well under often adverse weather conditions, were up to 6m tall in 8 months, and typically tolerated the exceptionally cold weather of January-February 2010. Commercial plantings, two in 2009 and two in 2010, further substantiated cultivar performance in the 13 studies. Responses to study treatments provide planting density, fertility, and rotation length guidelines for using the cultivars in bioenergy production systems in southern, central, and even northern Florida. Wood analyses have identified the bioenergy products for which each cultivar may be used. Overall, progress to date with *E. grandis*, and especially the future potential, illustrate how genetics and biotechnology can result in optimal tree populations for bioenergy production.

194 **LONGITUDINAL VARIATION IN WOOD SPECIFIC GRAVITY OF PLANTED LOBLOLLY PINE IN THE SOUTHERN UNITED STATES**

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Loblolly pine (*Pinus taeda* L.) is the most important plantation species grown in the southern United States, and is used for a multitude of uses including pulp and paper manufacture and lumber production. Specific gravity (SG) is an important measure of wood quality, and varies both with height within trees and regionally. To better understand the variability of SG that exists within a tree, disk SG at different heights was measured for 407 trees representing 135 plantations across the natural range of loblolly pine. A semiparametric model was proposed to explain the vertical and regional variation in disk SG. Based on the fitted model, a stem can divided into three segments with respect to the vertical variation in disk SG. The mean trend in disk SG of trees from the southern Atlantic and Gulf Coastal Plain was observed to be higher than other physiographical regions (Upper Coastal, Hilly Coastal, northern Atlantic Coastal Plain and Piedmont). The lowest disk SG was observed for trees from the northern Atlantic Coastal Plain.

196 **A FLEXIBLE HYBRID MODEL OF LIFE CYCLE CARBON BALANCE OF LOBLOLLY PINE PLANTATION MANAGEMENT SYSTEMS**

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The University of Florida's Carbon Resources Science Center has developed a flexible modeling system for even-aged pine forest carbon sequestration which combines growth and yield models with biometric equations to estimate fluxes and stocks of carbon for slash pine, loblolly pine, and longleaf pine plantations in the SE United States. For loblolly pine, we used growth and yield models reported in peer reviewed literature. These models account for multiple choices of silvicultural treatments (e.g., site preparation, weed control, fertilization and thinning). At each age, allometric equations were used to estimate above and below ground stand biomass from quadratic mean diameter and number of surviving trees simulated by the growth and yield model. Dynamics of litterfall biomass accumulation on forest floor was determined using a 25-year time-series of pine needle fall, LAI and inventory measured yearly on permanent plots that received different silvicultural treatments. Leaf area index was estimated as a function of Stand Density Index (SDI) and Site Index (that includes the effects of silvicultural treatments) and litterfall and understory biomass were estimated as a function of stand LAI. At the time of thinning, reductions in LAI were set to be proportional to changes in SDI due to thinning and therefore forest floor and understory biomass were affected due to their LAI-dependence. The modeling system also tracks the fate of harvested carbon removed from the site and processed into forest products. The model used current values of forest product conversion efficiencies and forest product decay rates to calculate *ex situ* C pool. The model was validated from a variety of sources, accurately simulating C estimates based on multiple measurement techniques and sites. For example, when simulated total stand biomass was compared with reported values on 14 stands ranging from age 3 to 48 years, the overall difference was less than 2.5% and the slope of the 1:1 relationship was not different from one.

197 **FUEL CONSUMPTION AND SMOKE EMISSIONS RESULTING FROM PRESCRIBED FIRES IN THE OUACHITA MOUNTAINS OF ARKANSAS**

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Prescribed fire is an important tool used to maintain many plant communities in landscapes dominated by southern pines. But fine particles produced as smoke during prescribed fires can impair human health and reduce visibility in scenic areas. As a result of these concerns about health and air quality, the State of Arkansas developed Voluntary Smoke Management Guidelines based upon standard fire behavior and fuel models developed elsewhere in the nation to set daily limits on smoke emissions from prescribed burning. However, there is some question whether the predicted tons per acre of fuels consumed and smoke emitted during prescribed burning from these models are accurate. In this study we established 54 modified Brown's transects in six burn units on the Mena, Oden, and Poteau Ranger Districts of the Ouachita National Forest in Arkansas to determine fuel loads before and after prescribed fires. In addition to the ordinary Brown's methodology of measuring litter and duff depth and tallying woody fuels we also collected supplemental samples of one- and ten-hour fuels to quantify these volatile fuel types commonly found in Arkansas ecosystems. We used FFI (Fire Ecology Assessment Tool-Firemon Integrated) software to quantify fuel consumption on six prescribed fires. Preliminary analyses show that the fuel consumption occurring in the Ouachita Mountains is consistent with expected based on standard fire behavior and fuel models.

200 **MISSISSIPPI'S COMPREHENSIVE SOUTHERN PINE BEETLE PREVENTION PROGRAM - IMPLEMENTATION AND ECONOMIC CONTRIBUTION**

James E. Henderson*, Andrew J. Londo, Department of Forestry, Mississippi State University, Mississippi State, MS

The southern pine beetle (SPB) has historically been one of the most damaging of all pests in southern pine forests. The USFS-Forest Health Protection, in collaboration with state forestry agencies initiated the SPB Prevention Program to reduce the threat of the SPB through education and thinning activities. Mississippi State University Extension Forestry became involved with the SPB Prevention Program in 2006. Initially, this program was primarily focused on educational outreach activities, but has since expanded to include a cost share program designed to assist landowners with pre-commercial and first commercial pine plantation thinning in areas rated medium to high hazard for SPB outbreak. Additionally funds obtained through the American Recovery and Reinvestment Act (ARRA) have been obtained. ARRA funds are being used to provide a cost share program for foresters and loggers, all in the effort to reduce the threat. The past four years have seen expansions in the program from an educational/outreach focus to an incentive based silvicultural program benefiting not only timber land owners but loggers and foresters as well. Outcomes of this project to date, including distribution of acres thinned, and the economic impacts (cost share funds dispersed, job creation, and overall economic contribution of the SPB prevention program) will be discussed.

203 **EFFECTS OF FIRE REGIME ON LONGLEAF PINE GROWTH**

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The effects of seasonality and frequency of fire on longleaf pine growth have been studied on the Escambia Experimental Forest near Brewton, AL for almost 40 years. Across the region, early results of various burn studies show a decrease in growth of young longleaf pine of burn treatments compared to unburned plots. This was seen in an Escambia study published in the mid-1980's that considered biennial burns (spring, summer, winter, and unburned). However, a subsequent examination of later data revealed a difference in the effects of fire on different time increments of longleaf pine growth. As a result of data indicating a volume loss due to fire, a study was established in 1984 to look at the effects of 2, 3, and 5-year, winter and spring burns. The 25th year data from the study were collected during the 2009-2010 dormant season. The effects of fire will be examined by seasonality and frequency. Of special interest is whether increments of growth have changed with different fire regimes over the 25 years of burn treatments.

204 **MANAGEMENT INTENSITY AND GENETICS AFFECT LOBLOLLY PINE CROWN CHARACTERISTICS**

B. Landis Herrin*. **Scott D. Roberts, Randall J. Rousseau**, Department of Forestry and Forest and Wildlife Research Center, Mississippi State University, Starkville, MS

The development of elite loblolly pine genotypes may lead to reduced planting densities as a means of reducing establishment costs. However, this can lead to undesirable crown and branch characteristics in some genotypes. Selecting appropriate genetic material, combined with appropriate silvicultural management, is essential to realizing potential genetic gains. A study was established in 2008 to examine the performance of two loblolly pine varieties, one selected as a sawtimber "crop tree" ideotype (Var A) and the other as a "competitor" ideotype (Var B), at different initial tree spacing and management intensities. After two growing seasons, genetics was already having an effect on crown morphology. Var A was, on average, taller, had longer and wider crowns, greater crown volume, and less acute branch angles. Management intensity had an even greater impact on crown characteristics. Compared with non-intensive management, intensive management resulted in trees that averaged over 1.1 ft (~24%) taller with wider crowns (0.7 ft, 30%), longer crowns (0.9 ft, 32%), and greater crown volume (5.5 ft^3, 133%). Differences due to management intensity were related to reduce crowding from competing vegetation and lower incidence of damage from pine tip moth and sawfly.

205 **MANAGEMENT INTENSITY AND GENETICS AFFECT LOBLOLLY PINE SEEDLING PERFORMANCE**

Scott D. Roberts*, Randall J. Rousseau, **B. Landis Herrin**, Department of Forestry and Forest and Wildlife Research Center, Mississippi State University, Starkville, MS

Capturing potential genetic gains from tree improvement programs requires selection of the appropriate genetic stock for a given site, incorporation of specific management strategies, and application of appropriate silvicultural management techniques. Limited information is available on how specific loblolly pine varietal genotypes perform under different growing space and management approaches. A study was established in 2008 to examine the performance of two selected loblolly pine varieties (Var A vs. Var B) at different initial planting spacings and management intensities. The selection of these two genotypes was based on their putative divergent crown architectures. After two growing seasons, survival of variety Var A (98.0%) was significantly greater than that of Var B (87.2%). Overall survival (92.6%) was not affected by management intensity. Much of the mortality was due to sawfly damage that occurred late in the second growing season. Growth of surviving seedlings was affected by both genetics and management intensity. Mean year-two height and ground-line diameter in the high intensity management plots exceeded that on the low intensity management plots by 1.1 ft and 0.2 in, respectively. Height and ground-line diameter of the Var A seedlings exceeded that of the Var B seedlings by 0.5 ft and 0.2 in, respectively. Results from year-three measurements will also be presented.

206 **GENETIC INFLUENCES ON SURVIVAL IN A 21-YEAR-OLD LOBLOLLY PINE SPACING TRIAL**

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Survival was analyzed in a 21-year-old loblolly pine genetics x spacing trial in east Mississippi. Eight open-pollinated half-sib families were planted at three spacings (5 x 5, 8 x 8, and 10 x 10 ft). Families were selected from a 12-year-old progeny test to represent combinations of fast vs. slow growth, and large vs. small crowns. Families were deployed in both pure and mixed family plots. Average survival across families ranged from approximately 43-44% at the 5 ft spacing to 68-69% at the 10 ft spacing. Individual family survival ranged from 28% for family 6 (5 ft spacing in mixed plots) to 86% for family 1 (10 ft spacing in mixed plots). Families selected for fast growth had greater survival than slow growth families. Differences in survival between fast and slow growth families were least in the pure family plots at 5 ft spacing (3.5%) and greatest in the mixed plots at 5 ft spacing (17.6%). There was little difference in average survival of fast and slow growth families relative to pure vs. mixed deployments at the 8 or 10 ft spacings. Selection for crown size, in general, had little effect on overall survival. Small crown families had slightly lower survival, ranging from 1-2% less in the 5 ft spacing to approximately 5% less in the 8 and 10 ft spacings. Proportional hazard regression analysis, however, suggests that the factor having the greatest influence on survival is crown length, indicating that actual crown size was indeed an important factor in survival in competitive environments.

208 **EVALUATING DIFFERENT PLANTING STOCKS FOR OAK REGENERATION ON HURRICANE KATRINA DISTURBED LANDS**

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Many nonindustrial private landowners are artificially regenerating oaks on their lands. Matching species to site and selection of planting stock type are critically important management decisions because each planting stock has advantages/disadvantages and site conditions determine which species are best suited to an area. There are four primary types of planting stock: seed, containerized stock, bareroot seedlings, and potted seedlings. This research was initiated because little comparative research has been performed regarding the growth and survival of various planting stocks of oaks. Planting stocks utilized in this study include, conventional containerized seedlings with a 240 cm^3 container, 1-0 bareroot seedlings, and Root Production Method (RPM™) seedlings with a 11.4 L container. Initially after outplanting, height and groundline diameter (GLD) were recorded. Height and GLD were again recorded at the conclusion of the first growing season. The study sites are located in Hancock and Pearl River Counties, Mississippi on Hurricane Katrina disturbed lands. Species planted in the study were: swamp chestnut oak (*Quercus michauxii* Nutt.) and Nuttall oak (*Q. texana* Buckl.). A total of 3600 seedlings (1800 seedlings per site) were planted in this study, 300 seedlings for each of the six planting stock/species treatments. Statistical comparisons of growth and survival among species and planting stock types were analyzed. RPM™ and bareroot planting stocks exhibited similar growth and survival, while the conventional container stock had significantly lower growth and survival. Results of this study will assist landowners in deciding which planting stock to utilize based on early growth and survival.

210 **EVALUATION OF SHORT-ROTATION WOODY CROPS TO STABILIZE A DECOMISSIONED SWINE LAGOON**

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Fast growing stands of trees represent a more environmentally friendly, less expensive method for stabilization of decommissioned animal production lagoons than excavation and transportation of lagoon solids. We are testing the feasibility of using short-rotation woody crops in central Oklahoma to close a decommissioned swine lagoon and are evaluating the growth performance of two candidate species. We are also measuring the rate of nutrient removal from the sludge by measuring nutrient capture by aboveground biomass. After backfilling a de-watered swine lagoon with soil, we planted stands of sycamore (*Platanus occidentalis*) in 2008 and cottonwood (*Populus deltoides*) in 2009 at 2240 trees ha^{-1}. After two years, the tallest sycamore trees were 4 m with an average of 2.7m and standard deviation of 0.5 m. After one year, the tallest cottonwood reached 3.9 m and averaged 2.1 m with standard deviation of 2.4 m. Foliar nitrogen concentrations measured in July 2009 were 2.1 and 2.4% for sycamore and cottonwood respectively. Foliar phosphorous concentrations were greater for cottonwood (0.33%) than for sycamore (0.20%). For two-year-old sycamore, aboveground biomass averaged 2,940 kg ha^{-1}. For the sycamore stands, the majority of the nitrogen was in foliage (26.0 kg ha^{-1}) with lesser amounts in branch (4.3 kg ha^{-1}) and stem (7.3 kg ha^{-1}). Similar patterns occurred for phosphorus with 2.27 kg ha^{-1} in leaves, 0.16 kg ha^{-1} in branches, and 0.20 kg ha^{-1} in stem. In addition to these results, biomass and nutrient capture of both species will be discussed for the 2010 growing season.

211 **SEDIMENT YIELD ALONG AN ACTIVELY MANAGED RIPARIAN BUFFER**

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High quality water is generally associated with forested watersheds. Although intensive forest management operations are necessary to increase timber production from the forest, these operations can adversely affect water quality. Silvicultural treatments such as timber harvesting, residue removal, and road construction may increase the amount of sediment leaving a forested watershed without well-designed logging roads and the implementation of mitigating measures such as buffer zones. Best management practices (BMPs) such as streamside management zones (SMZs) have appeared to be effective for mitigating the effects of forestry operations on water quality. Although SMZ's need not be excluded from silvicultural activities, these buffers should be carefully designed, and any silvicultural activity within them must be closely supervised and managed. In this study, we aim to regenerate a mature SMZ stand and create an uneven-aged forest with multiple canopy tiers using single tree selection based on Proportional-B method. During this process, the effects of partial cutting on sedimentation were observed by comparing the study watershed with an unharvested reference site. In addition to determining harvesting effects on sediment yield, we also evaluated the effects of different land uses and a recent clearcut on sedimentation, quantified the effect of forest cover on sediment, and determined the efficacy of the SMZ at reducing sediment yield from potential source areas.

213 **FERTILIZATION EFFECTS ON LONG-TERM NUTRIENT AVAILABILITY IN SOUTHEASTERN US PINE AND HARDWOOD PLANTATIONS**

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Management of forest plantations in the southeastern United States includes fertilization to increase volume production. Our objective was to determine the effect of fertilization on long-term nutrient availability at two sites with similar soils that differ in fertilizer regime, stand age, and species. Site one, SETRES, was planted with loblolly pine (*Pinus taeda*) in 1985 and has been fertilized annually since 1992. Site two, Mt. Pleasant, was planted with loblolly pine and sweetgum (*Liquidambar styraciflua*) in 1997 and was fertilized annually until 2006. Fertilization increased forest floor N and P at SETRES by 270 and 20 kg ha^{-1}, respectively. At Mt. Pleasant, fertilization increased loblolly pine forest floor N and P by 140 and 7 kg ha^{-1}, respectively. Also, sweetgum forest floor N and P were increased by 100 and 7 kg ha^{-1}, respectively. No fertilization effect was observed for mineral soil total-N at both sites while mineral soil P increased by 50 kg ha^{-1} (SETRES), 45 kg ha^{-1} (Mt. Pleasant, loblolly), and 18 kg ha^{-1} (Mt. Pleasant, sweetgum). Measurements of forest floor cumulative inorganic-N flux indicated a fertilization effect at SETRES (+30 kg ha^{-1}). This effect was much less at Mt. Pleasant (+0.50 kg ha^{-1}). Fertilization altered mineral soil cumulative NO_3-N flux only at SETRES (+12 kg ha^{-1}). Results suggest that fertilization will increase long-term availability of P but not N by increasing the mineral soil pool. Furthermore, differences in the N response among sites suggest fertilization effects on N are short-lived and decline rapidly when nutrient additions cease.

214 **DEVELOPING SILVICULTURAL PROTOCOLS FOR LONGLEAF PINE ECOSYSTEM RESTORATION IN LOBLOLLY PINE STANDS AT FORT BENNING, GA**

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Restoration of the longleaf pine (*Pinus palustris* Mill.) ecosystem to upland loblolly pine (*Pinus taeda* L.) stands that currently support the federally endangered red-cockaded woodpecker (RCW; *Picoides borealis*) presents a unique challenge to many land managers in the southeastern US. We established an experiment with a randomized, complete block, split-plot design to evaluate the effects of management on planted longleaf pine seedling response. Seven main plot treatments were used to manipulate the canopy, including four treatments that resulted in uniform distribution but varying density of canopy trees (Control ~ 15 m^2 ha^{-1} basal area, MedBA ~ 9 m^2 ha^{-1} basal area, LowBA ~ 5 m^2 ha^{-1} basal area, Clearcut) and three treatments as gaps of different sizes (Small ~ 1256 m^2, Medium ~ 2826 m^2, Large ~ 5024 m^2). Additional split-plot treatments were designed to improve growing conditions for planted seedlings (herbicide release, herbicide release plus fertilizer, check treatment). First-year mortality was significantly affected by main plot treatment ($p < 0.0001$), with mortality lowest on the uncut Control plots (9%) and highest on the Clearcut plots (48%). Within gaps, mortality increased from forest edge to gap center, with mortality higher in the northern half than the southern half of gaps ($p = 0.0c$). Seedling size was significantly affected by main plot treatment after the first ($p = 0.0034$) and second ($p < 0.0001$) growing seasons, with the largest seedlings on Clearcut plots. Early results suggest that retaining canopy trees for RCW habitat may increase seedling survival at the cost of reduced seedling growth.

215 **ARE WE OVER-MANAGING LONGLEAF PINE?**

John S. Kush*, Rebecca J. Barlow, John C. Gilbert, Longleaf Pine Stand Dynamics Laboratory School of Forestry & Wildlife Sciences, Auburn University

Longleaf pine (*Pinus palustris* Mill.) is not loblolly or slash pine. There is the need for a paradigmatic shift in our thinking about longleaf pine. All too often we think of longleaf as an intolerant species, slow-grower, difficult to regenerate and yet it dominated the pre-settlement Southeastern forest; how can that be? Wahlenberg, in his 1946 book about longleaf, wrote that mismanagement of longleaf pine has been the rule rather than the exception, due to the ignorance of the unique life history and incomplete knowledge of factors determining the life and death of seedlings and hence the succession of forest types. Using data from the Regional Longleaf Growth Study and what had been a virgin stand of longleaf pine, the Flomaton Natural Area, this presentation will focus on examining data from areas that have been/were allowed to grow "unmanaged", i.e. no timber cutting. How did longleaf stay on the landscape before we almost managed it out of existence?

219 **CHANGES NON-PINE WOODY SPECIES DENSITY, COMPOSITION, AND DIVERSITY FOLLOWING HERBICIDE AND FERTILIZATION APPLICATION TO MID-ROTATION LOBLOLLY PINE STANDS**

Hal O. Liechty*, School of Forest Resources, University of Arkansas, Monticello, AR; **Conner Fristoe**, Plum Creek Timber Company, Crossett, AR

Fertilization and herbicide application are common practices used to increase productivity of loblolly pine (*Pinus taeda* L) in mid-rotation stands. Although a number of studies have reported the impacts of these treatments on growth of pine crop trees, few studies have specifically documented the effect of these silvicultural treatments on the composition, density, and diversity of non-pine woody vegetation. We monitored woody vegetation (d.b.h$\geq$2.54 cm) response for up to six years following a herbicide (1.17 L imazapyr ha^{-1}), a fertilizer (409 kg urea and 196 kg diammonium phosphate ha^{-1}) and a combined fertilizer and herbicide application in four loblolly pine stands located within the Upper Gulf Coastal Plain. Approximately 60-80% of the original non-pine vegetation died within three years following herbicide application. Herbicide mortality was greater with than without fertilizer application. Differences in mortality among non-pine species were observed. Significant recruitment of additional woody vegetation occurred following all treatment applications but herbicide reduced recruitment for up to six years. Differences in diversity and composition of the non-pine vegetation among treatments will be summarized for information collected five to six years following the initial treatment applications.

222 **CHANGES IN CARBON EMISSIONS FROM PRESCRIBED BURNING IN THE SOUTHEAST DUE TO CLIMATE CHANGE INDUCED FUEL DISTURBANCES**

Yongqiang Liu*, John A. Stanturf, Scott L. Goodrick, US Forest Service, Athens, GA; **Hanqin Tian, Chi Zhang**, Auburn University, Auburn, AL; **Yuhang Wang, Tao Zeng**, Georgia Institute of Technology, Atlanta, GA

Prescribed burning has been widely used in the southeastern United States, treating millions of acres of forest and agricultural land each year. This leads to a large amount of carbon emissions into the atmosphere. Carbon emissions from wildland fires depend on fuel properties, including fuel loading and moisture. A recent study using a global dynamic vegetation model driven by projected climate change indicated significant changes in future fuel loading in the Southeast. Meanwhile, fuel moisture, which is closely related to atmospheric conditions, will see large disturbances under the changing climate. As a result, carbon emissions from prescribed burning are expected to change in the future in this region. This study will evaluate the potential impacts on carbon emissions from prescribed burning in the Southeast resulting from disturbances in fuel properties.

223 **TWENTY-EIGHT YEARS OF DEVELOPMENT IN PLANTED CHERRYBARK OAK-SWEETGUM MIXTURES: IMPLICATIONS FOR FUTURE MIXED-SPECIES HARDWOOD PLANTATIONS**

Brian Roy Lockhart*, USDA Forest Service, Stoneville, MS; **Andrew W. Ezell**, **John D. Hodges**, Mississippi State University, Mississippi State, MS, **Wayne K. Clatterbuck**, University of Tennessee, Knoxville, TN

Results from a long-term planted mixture of cherrybark oak (*Quercus pagoda* Raf.) and sweetgum (*Liquidambar styraciflua* L.) showed sweetgum taller in height and larger in diameter than cherrybark oak early in plantation development. By age 17 years, cherrybark oak was similar in height and diameter with sweetgum and by age 21 years was taller in height and larger in diameter than sweetgum depending on the spacing arrangement. The ascendance of cherrybark oak above sweetgum in an intimate plantation mixture confirms results from a stand reconstruction study of cherrybark oak and sweetgum in natural stands. We will present results following 28 years of development. Field observations indicate that cherrybark oak in considerably taller than sweetgum, with cherrybark oak crowns competing with other cherrybark oak crowns above the sweetgum. We will discuss how results from this study and other published information on mixed-species hardwood development can be used in planning mixed-species hardwood plantations to meet specific landowner objectives.

227 **CARBON ASSESSMENT FOR SEQUESTRATION PROJECTS: VARIATION IN ASSESSMENT PROCEDURES AND GROWTH ESTIMATES – AN OZARK MOUNTAINS CASE STUDY**

James B. McCarter*, School of Forestry, College of the Environment, University of Washington, Seattle, WA and Department of Forestry and Environmental Resources, College of Natural Resources, North Carolina State University, Raleigh, NC; **Gordon Smith**, Ecofor LLC, Seattle, WA

Carbon sequestration projects require estimates of current and future carbon for evaluation of potential benefits to landowners and interested stakeholders. There are a variety of carbon estimation techniques available, each resulting in different estimates of the amounts of carbon sequestered. We compare three carbon quantification processes by applying each to 100 years of modeled growth and yield inventory information for a property in the Ozark Mountains, USA for baseline and proposed management scenarios. Results from the three quantification processes are presented for the two scenarios. In addition two different growth model variants were used to estimate future growth of the forests under the same management scenarios. The results are compared and impact on potential amounts of greenhouse gas emission offsets will be presented.

228 **LONG-TERM EFFECTS OF TIMBER HARVESTING DISTURBANCE ON ABOVE-GROUND PRODUCTIVITY AND CARBON CYCLING IN BOTTOMLAND HARDWOOD FORESTS**

Scott E. McKee*, W. Mike Aust, John R. Seiler, Brian D. Strahm, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg VA; **Erik B. Schilling,** National Council for Air and Stream Improvement Inc., Newberry FL

Bottomland hardwood forests are highly valued systems which provide many ecosystem services, yet long-term responses to disturbances are not well understood. This study examines long-term implications of harvesting disturbance on net ecosystem productivity (NEP), carbon (C) pools, and C cycling in an alluvial bottomland hardwood forest. In 1986 a bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*) stand received three disturbance treatments to examine the effects of harvesting disturbances: helicopter harvest (HELI), skidder harvest (SKID), and herbicide disturbance (GLYP). The recovery of the forest from these disturbances has been periodically monitored since establishment. Previous results indicate that different logging practices have created differences in regeneration. SKID areas have more water tupelo and were wetter after harvest. Sediment accumulation in HELI and SKID treatments are similar, however higher than the non-harvested reference area. GLYP treatments have significantly higher sediment accumulation rates than any treatments. Soil properties such as bulk density and temperature were initially affected by disturbance but they are returning to reference levels. SKID and HELI areas are beginning to function similar to the reference area, while GLYP plots are now more like freshwater shrub-scrub/marshes with little woody vegetation and dense herbaceous material. Natural amelioration factors such as annual nutrient rich sediment inputs and shrink swell soils aid the site recovery from the harvesting disturbance and are keeping this site productive. Current C storage and efflux are affected by the original disturbances, subsequent species succession, and sedimentation rates.

230 **GROWTH AND BOLE QUALITY RESPONSES TO THINNING IN A RED OAK-SWEETGUM STAND IN SOUTHEASTERN ARKANSAS: NINE-YEAR RESULTS**

James S. Meadows*, USDA Forest Service, Southern Research Station, Stoneville, MS

Four thinning treatments were applied to a poletimber-sized, red oak-sweetgum stand in southeastern Arkansas in the fall of 1999: (1) unthinned control; (2) light thinning to 70-75 percent residual stocking; (3) heavy thinning to 50-55 percent residual stocking; and (4) B-line thinning to desirable residual stocking for bottomland hardwoods, as recommended by Putnam et al. (1960). Prior to thinning, the stand averaged 343 trees and 123 square feet of basal area per acre. Stocking averaged 116 percent. Light thinning reduced stand density to 125 trees and 80 square feet of basal area per acre and reduced stocking to 70 percent. Heavy thinning reduced density to 106 trees and 58 square feet of basal area per acre and reduced stocking to 52 percent. B-line thinning reduced density to 118 trees and 70 square feet of basal area per acre and reduced stocking to 62 percent. By the end of the ninth year following treatment, all three levels of thinning had more than doubled diameter growth of individual residual trees, especially among red oaks. The increased diameter growth accelerated the rate of stand development, such that the number of red oak sawtimber trees increased from 13 to 41 per acre (averaged across all levels of thinning) compared to an increase from 16 to 26 per acre in the unthinned control plots. All levels of thinning also increased the production of epicormic branches on the butt log of residual trees, but the number of branches has declined somewhat over the past 3 years.

231 **STAND QUALITY MANAGEMENT IN A LATE-ROTATION, RED OAK-SWEETGUM STAND IN EAST MISSISSIPPI: PRELIMINARY RESULTS FOLLOWING THINNING**

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Stand quality management is a new management strategy in which thinning prescriptions are based solely on individual-tree quality rather than on some quantitative level of residual stand density. As long as residual density falls within broad limits, prescriptions are based on tree quality alone. Our new hardwood tree classification system is used to define the residual component for four thinning prescriptions: (1) acceptable growing stock with residual superior poletimber, (2) acceptable growing stock with no residual poletimber, (3) desirable growing stock with residual superior poletimber, and (4) desirable growing stock with no residual poletimber. We applied these four thinning prescriptions, along with an unthinned control, to a late-rotation, red oak-sweetgum stand in east Mississippi during the fall of 2007. Prior to thinning, stand density averaged 106 trees and 117 square feet of basal area per acre. Quadratic mean diameter of the stand was 14.3 inches. Red oaks comprised 50 percent of stand basal area and had a quadratic mean diameter of 17.9 inches. Residual stand density following application of the four thinning prescriptions ranged from 51 to 73 square feet of basal area per acre. Through the first 2 years following thinning, all four thinning prescriptions significantly increased diameter growth of individual residual trees. Thinning had little or no effect on the production of new epicormic branches on the butt logs of residual trees, even among red oaks. Diameter growth response and the production of new epicormic branches varied among species, crown classes, and tree classes within each thinning prescription.

237 **PRESCRIBED BURNING COST ANALYSIS OF SITE PREPARATION AND SILVICULTURAL BURNING FOR NIPF LANDOWNERS IN NORTH CAROLINA**

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An internal cost analysis of prescribed burning was conducted by the North Carolina Division of Forest Resources in 2008 to examine the current costs of both site preparation and silvicultural burning, key variables that can contribute to prescribed burning costs, and recommendations on charging adjustments to recover expenses while still providing valuable prescribed burning services to NIPF landowners. Cost analysis for this study was conducted on 90 site preparation burns totaling 2,559 acres and 76 silvicultural burns totaling 3932 acres, across three physiographic regions of the state. The agency analysis showed that site preparation burning resulted in a net loss of $11 per acre statewide with a greater loss occurring on smaller tracts located in the mountain region. In comparison, silvicultural burning resulted in a net loss of $7 per acre statewide. Summary statistics by physiographic region, tract size, and type of burning are presented. Results from the cost analysis study indicated that for site preparation burning the mean cost of line construction and patrolling is $746 per mile with a net loss of $425 per mile while silvicultural burning is $582 per mile with a net loss of $295 per mile. Patrolling costs were found to be a key component of these costs. Prescribed burning rates need to be analyzed separately by physiographic regions, tract size categories, and type of burning to properly assess charging rates to recover expenses and to ensure that prescribed burning remains an affordable management tool to NIPF landowners.

239 **CARBON SEQUESTRATION POTENTIAL OF SOUTH-EAST COASTAL PLAIN FORESTS**

Asko Noormets*, Jean-Christophe Domec, John King, Siyao Zhang, Guofang Miao, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC; **Steve McNulty, Michael Gavazzi, Ge Sun, Emrys Treasure**, Raleigh Eastern Forest Environmental Threat Assessment Center, USDA Forest Service, Raleigh, NC; **Jiquan Chen**, Department of Environmental Sciences, University of Toledo, Toledo, OH

Carbon accumulation in forests is seen as a significant ecosystem service, helping to slow down the rate of CO_2 accumulation in the atmosphere. Based on net primary production (NPP), southern pine forests are among the most productive ones in the USA, and timber companies with large land holdings stand to potentially gain from selling “carbon credits” once carbon trading becomes widely used. However, the extent of long-term C sequestration in forests is far from clear. Given that about 50% of woody biomass from southern pine forests goes to pulp and paper products with an average lifetime of <3 years, long-term C sequestration occurs due to carbon additions to the soil pool. In current study we present data on soil C balance from two loblolly pine plantations in the coastal plain of North Carolina. At both recently harvested (1-5 years of age) and mid-rotation (13-19-years of age) stands, heterotrophic respiration is estimated to exceed leaf and root litter production by 1.3- to 3.7-fold suggesting that in this particular site no long-term C sequestration is taking place. It is important to note, however, that soil C balance is affected by soil type and properties, moisture and disturbance regime, and thus the patterns observed at these two organic surface soil sites may not be characteristic of other clay or sand based SE-US forests. Nevertheless, the results highlight the sensitivity of C stocks to decomposition even in seemingly very productive ecosystems.

240 **STAND AND INDIVIDUAL TREE GROWTH RESPONSE TO TREATMENTS IN YOUNG NATURAL HARDWOODS**

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Young even-aged upland Piedmont mixed hardwood and pine stands were treated with a variety of fertilizer and release (competition control) inputs. The sites studied are on the NC State University Hill Demonstration Forest in central NC, and are characterized by formerly highly eroded agricultural sites now in their third rotation of tree cover. Tree growth response was assessed periodically over several years, at both an individual-tree and stand-wide bases. Stand-basis response to fertilizer treatments was vigorous, with treated stands growing significantly more than untreated controls. Whereas individual tree response within treated areas, and those treated individually, were less substantive. Responses varied significantly between species, with specific consideration of yellow poplar, red/black oak, white oak, and loblolly pine. Results suggest that significant increases in the rate of stand development through self-thinning, and therefore reduction of anticipated age to final harvest and number of years necessary to attain commercial size stems, can be readily achieved with modest fertilizer inputs on these types of sites. The long term response of individual trees at these young ages to release treatments remains difficult to determine.

244 **LONG AND SHORT TERM CHANGES IN THE FORESTS OF THE CUMBERLAND PLATEAU AND MOUNTAINS USING LARGE SCALE FOREST INVENTORY DATA**

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The Cumberland Plateau and Mountains (CPM) are a significant component of the eastern deciduous forest with biological and cultural resources strongly connected to and dependent upon the forest resources of the region. As a result, continuous inventory and monitoring is critical. The USDA Forest Service Forest Inventory and Analysis (FIA) program has been collecting data within the region since the 1950's, and provides a valuable resource for tracking the status of the CPM forests. Using two different datasets derived from large scale inventories within the region, both historical trends and short-term changes are analyzed. Across the CPM region, timberland has experienced less than a 1 percent decline from the early 1950's to present. Concomitantly, the CPM region has experienced a significant increase in standing growing stock volume. Volume estimates have increased between 100 and 200 percent across the region since the late 1960's and early 1970's. The CPM region currently contains an estimated 9.8 million acres of forest land and 18.2 billion cubic feet of volume. Both long-term and short-term changes indicate a stable forestland base within the region. While forests have shifted within the region from one forest type to another, the CPM continues to be dominated by natural hardwood forests.

245 **WHOLE-CANOPY GAS EXCHANGE AMONG FOUR ELITE LOBLOLLY PINE SEED SOURCES PLANTED IN THE WESTERN GULF REGION**

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Planting of artificially selected, improved seedlings has led to large increases in forest productivity on intensively managed pine forests in the southeastern United States. However, several aspects of clonal plantation management are poorly understood, particularly in the Western Gulf region. For example, the Western Gulf region is subject to regular mid to late summer droughts, which may influence seedling productivity relative to the better-studied eastern portion of loblolly pine's range. The objectives of this study were to understand whole-canopy gas exchange (i.e., C capture and water loss) and biomass partitioning in four rapid-growing loblolly pine seed sources in response to genetics. Four sources of loblolly pine were planted in 0.2-acre plots, with each genotype replicated 12 times. All genotypes were from eastern seed sources, with two representing compact crown (family 7-56 and clone 93) and two representing broad crown (family 8-103 and clone 9) ideotypes. We will present first year whole-canopy C gain and water loss modeled over one summer in four elite loblolly genotypes in their fourth growing season. Biomass allocation data suggests that differences in crown ideotypes and root architecture may make some families/varieties more tolerant to water stress than others.

247 **DEVELOPMENT OF AN APPLIED BLACK WILLOW TREE IMPROVEMENT PROGRAM FOR THE BIOMASS PRODUCTION IN THE SOUTH**

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The development of rapidly growing biomass woody crops is imperative as the United States strives to meet renewable energy goals. The Department of Energy has indicated that biomass is a prime source for renewable energy for the southern United States. Black Willow (*Salix nigra* Marsh.) is a potential bioenergy/biofuels crop for dedicated short-rotation plantations. Unfortunately, there has been very little genetic development of this species. In 2009, 100 individual one to two year-old whips were selected from five geographic areas and grown in a stool bed near Stoneville, MS. One year-old whips were harvested in February 2010, cut into 14-inch dormant unrooted cuttings, and graded by diameter. The initial study in determining genetic worth is a screening trial where all clones are tested, but with limited number of ramets per clone. The 2010 black willow screening trial consist of two locations, four blocks, and 100 clones arranged in two tree-row plots at a spacing of 10 x 3 feet. While age-three selections will be used to determine genetic worth, age-one performance will provide insight into clonal performance among the five geographic areas. Selections from the screening trial will be included in highly replicated clone tests. Selections from the screening trial will provide the first genetically improved black willow clones for use in short-rotation plantations.

248 **ARE GENETICALLY IMPROVED SEEDLINGS WORTH IT?**

Randall J. Rousseau*, **Scott D. Roberts, B. Landis Herrin**, Department of Forestry and Forest and Wildlife Research Center, Mississippi State University, Mississippi State, MS

Forest landowners have several options when it comes to selecting planting stock for loblolly pine plantations. The majority of plantations established over the past two decades have been planted with 2nd-generation open-pollinated (2nd-Gen) seedling stock. Today, landowners can increase their yields using more sophisticated planting stock such as Mass Control Pollinated (MCP) or Varietal (clonal) stock. Substantial gains have been estimated when using either MCP or Varietal stock. Forest biotechnology firms are currently producing loblolly pine varietal planting stock for deployment in the southeastern US. Currently, however, the cost of varietal planting stock is considerably higher than that of both standard open-pollinated and MCP seedlings. Landowners need to know if the increased gains from the improved genetic material will be great enough to offset increased plantation establishment costs. In 2007, a Loblolly Pine Genetic Level Study was installed in northern Mississippi to examine differences in growth and form among 2nd-Gen, MCP, and Varietal planting stock. Third-year measurements showed that on average, MCP trees were significantly taller than either the Varietal or 2nd-Gen stock types. However, the top five performing varieties averaged nearly 0.5 feet taller than the MCP trees, and 1.0 feet taller than the 2nd-Gen stock. Results from fourth-year measurements will be presented.

249 **RESOURCE AVAILABILITY EFFECTS ON GROWTH EFFICIENCY, LEAF AREA DISPLAY, AND GENOTYPE PHYSIOLOGICAL RESPONSES OF EUCALYPTUS CLONES AND HYBRIDS**

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Presentation will be made by **Tom Fox***, Virginia Tech

We compared growth efficiency differences and leaf area display of Eucalyptus globulus clones, *E. nitens* and *E. camaldulensis* hybrids under high and low resource availability conditions (control vs. irrigated+nutrients). After fifteen months large changes in productivity rankings among clones were observed between contrasting resource availability environments and explained in average a 210% difference in volume across genotypes. Genotypes showed a 220% difference at the high and a 166% difference at the low resource availability environment. Large differences in growth efficiency (GE) were observed among clones but more productive genotypes showed the highest GE values. Leaf area at high resource reached 4 times low resource availability conditions. Patterns of leaf area display suggest large differences in responses to the environment. A negative linear relationship was observed between delta C13/12 discrimination and productivity for specific genotypes. Low delta C13/12 discrimination for *E. camaldulensis* clones on not irrigated conditions suggests lack or stomatal response to explain differences in instantaneous water use efficiency compared to other genotypes.

250 **EFFECTIVENESS AND COSTS OF FIVE SKID TRAIL CLOSURE TECHNIQUES IN THE VIRGINIA PIEDMONT**

B. Clay Sawyers, **W. Michael Aust***, **M. Chad Bolding,** Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA

A timber harvest plan was developed and implemented on a twenty-nine acre parcel in the western Piedmont of Virginia to study the effects various harvest closure techniques have on erosion of overland skid trails. Four main skid trails with similar slope, length, aspect, and soils were selected for the study. Water bars were constructed on each skid trail every fifty feet. The five skid trail closure techniques - the application of pine slash, hardwood slash, grass seed, grass seed covered by straw mulch, and water bars only - were randomly distributed on the fifty foot sections of skid trail. Each treatment was replicated one time on each of the four skid trails. Geotextile sediment control devices known as Dirtbags® were used to capture the soil eroded from each treatment area. The erosion was evaluated monthly and converted to a per acre basis. Rainfall and other site characteristics were monitored to assess predicted erosion versus measured erosion. Two erosion models were used for comparisons, Universal Soil Loss Equation and Water Erosion Prediction Project. A secondary focal point of the project was to determine accurate costs to install Best Management Practices (BMPs) after finalizing a timber harvest. Typical methods and equipment were used for these applications, and all associated costs were analyzed. The total costs accumulated until the BMP specifications were met according to *Virginia's Forestry Best Management Practices for Water Quality, Fourth Edition*.

251 **CONTROL OF EASTERN *BACCHARIS* IN RECENTLY ESTABLISHED BOTTOMLAND HARDWOOD PLANTATIONS**

Benton Gann, Jamie L. Schuler*, Lynne Thompson, University of Arkansas-Monticello, Monticello, AR

In the past 15 years, over 370,000 acres of marginal farmland in the Lower Mississippi Alluvial Valley have been planted to hardwoods by federal cost share programs. A trend for federal cost share programs is that planted stands typically have low survival. One factor believed to affect survival is the failure to manage competing vegetation. *Baccharis halimifolia* is a common competing shrub species in many WRP plantings and a dominant invader species in recently established hardwood plantations in southeast Arkansas. This study tested the effectiveness of mechanical and chemical treatments to control *B. halimifolia* in established hardwood plantations. The mechanical treatment involved a dormant and growing season cutting of *B. halimifolia* to determine the coppicing ability of the species. The chemical treatment used a winter broadcast application of 4 different herbicides; RazorPro w/ LI700, Tahoe 4E, Clearcast, and Milestone. Year 1 results will be discussed.

252 **INITIAL RESULTS OF A BIOMASS PRODUCTION SYSTEM USING BLACK WILLOW, COTTONWOOD AND AMERICAN SYCAMORE GROWN WITH AND WITHOUT FERTILIZATION**

Jamie L. Schuler*, University of Arkansas-Monticello, Monticello, AR

The interest in producing woody feedstocks for bioenergy has renewed focus on short rotation woody crop (SRWC) production systems. Much attention is being given to converting marginal agriculture lands into SRWCs. To address the questions concerning production and sustainability of these systems, a study was installed in 2009 to compare three SRWC species on what is considered to be marginal cropland in eastern Arkansas. Black willow, eastern cottonwood, and American sycamore were established on plots with and without fertilization. Survival was excellent (+95%) for all species except cottonwood. First year results pertaining to aboveground biomass and fine root biomass production will be presented.

253 **THE APPLICATION OF SINGLE-TREE SELECTION COMPARED TO DIAMETER-LIMIT CUTTING IN AN UPLAND OAK-HICKORY FOREST ON THE CUMBERLAND PLATEAU IN JACKSON COUNTY, ALABAMA**

Callie Jo Schweitzer*, USDA Forest Service, Huntsville, AL; **Greg Janzen**, Stevenson Land Company, Scottsboro, AL

Cumberland Plateau region upland oak forests have undergone a myriad of disturbances (including periods of few and minor disturbances). Traditional timber harvesting practices such as diameter-limit cutting have negatively altered species composition and skewed stand structure, especially on medium-quality sites. We assessed the ability of single-tree selection to improve stand characteristics by comparing species structural and compositional responses, and assessing changes in productivity and quality with stands harvested by diameter-limit cutting. The single tree selection marking guidelines specified a minimum d.b.h of 6 inches, a maximum d.b.h of 30 inches, and a q-value of 1.4. The diameter-limit cut targeted stems 14 inches d.b.h and greater. Both treatments had a target residual basal area of 65 square feet per acre, a density level that approximates the B-level stocking for upland oaks. All stands were harvested in 2004. Observed residual basal area averaged 61.5 square feet per acre with 66 stems per acre in the single-tree selection stands. The diameter limit cut left a residual basal area of 39 square feet per acre with 64 stems per acre; there were no residual trees 16 inches d.b.h and greater. The single-tree selection targeted all species, and only red maple and yellow-poplar were eliminated by the harvest. For the diameter-limit cut, all chestnut oak and most white oaks were removed, along with red maple.

256 **WILL AFFORESTATION IN TEMPERATE ZONES WARM THE EARTH?**

David B. South*, School of Forestry and Wildlife Sciences, Auburn University, AL

Forest researchers have determined that conifer and hardwood forests have lower albedo than most alternative land uses. Surfaces with low albedo will absorb more solar radiation than more reflective surfaces. As a result, afforestation using conifer species will typically darken the surface of the Earth (when compared to grasslands or deserts). This paper will address the question; will an expansive afforestation effort in temperate zones increase global temperatures?

Planting conifers on 300 million ha might sequester 19 gigatonnes of carbon in 5 decades and this might offset two years of human CO2 emissions (@ 8 billion people and 1.2 tonnes of C $year^{-1}$ $person^{-1}$). When establishment costs are \$500 ha^{-1}, this effort would cost at least \$150 billion dollars. However, the lower albedo (resulting from a change in land use) might override any projected cooling effect due to carbon sequestration. Some computer simulations indicate that afforestation in boreal grasslands would result in a net warming effect. This paper examines some of the research that applies to afforestation in temperate zones (i.e. 10 to 50 degrees North).

257 **CARBON EMISSIONS FROM WILDLAND FIRES IN THE SOUTHERN U.S. UNDER A CHANGING CLIMATE**

Scott L. Goodrick, John A. Stanturf*, Yongqiang Liu, USDA Forest Service, Athens, GA

Wildland fires (wildfires and prescribed burning) burn over 1 million ha annually in the southern United States. Carbon emissions to the atmosphere can be calculated as the product of reported area burned, measured fuel loads, fuel consumption estimates and emission factors developed from experimental burns. We will report total annual carbon emissions from wildfires and prescribed burns under current conditions and discuss sources of uncertainty in our carbon emissions estimates. Changes in fire risk and carbon emissions under future climate and land use change scenarios will also be examined with an emphasis on how the current carbon emissions balance between wildfire and prescribed fire may evolve. The potential policy implications regarding the future acceptance of prescribed fire as a management tool will be discussed.

258 **BEETLE-KILLED STANDS IN THE SOUTH CAROLINA PIEDMONT: FROM FUEL HAZARD TO REGENERATING OAK FORESTS**

Aaron D. Stottlemyer*, Wildlife Technology Department, Penn State University, DuBois Campus, DuBois, PA; **G. Geoff Wang,** Department of Forestry and Natural Resources, Clemson University, Clemson, SC; **Thomas A. Waldrop,** US Forest Service, Southern Research Station, Clemson, SC

Spring prescribed fire, mechanical mastication or “mulching,” and no-treatment (control) were tested for reducing heavy fuel loading in beetle-killed stands in the South Carolina Piedmont. In addition, competitive oak and other hardwood tree regeneration (stump sprouts and saplings) was monitored for two consecutive years following the treatments. Relationships between (1) fuel reduction and fire behavior, and (2) tree regeneration and fire behavior were also examined. Burning significantly reduced 1-hour fuel loading, and litter (Oi) and duff (Oe + Oa) layer thicknesses in the first post-treatment sampling year. Fuel consumption increased in association with increasing maximum heat pulse temperature (i.e., “fire intensity”) and the length of time that heating was sustained above 50°C (i.e., “residence time”). Mulching reduced the average dead and down woody fuel height while increasing total woody fuel loading substantially. Oak sprouting increased significantly in the first year after burning. Oak sapling basal area was negatively correlated with fire intensity. However, oak sprout cover was positively correlated with fire residence time in the second year post-treatment. Oak-competitor sprout density increased and sapling basal area decreased with burning. Oak-competitor sprout density and cover were negatively correlated with fire intensity and residence time. In summary, the treatments had vastly different effects on fuel loading. Furthermore, higher fire intensity and longer residence time were associated with increased fuel reduction, the recruitment of competitive oak regeneration, and reduced competition. Results of this study will assist forest managers in evaluating treatment options for reducing fuels and promoting natural oak regeneration in beetle-killed stands.

259 **IMPACT OF THE SAMPLING DESIGN AND STAND STRUCTURE ON THE ESTIMATES**

Bogdan M. Strimbu*, David W. Long, School of Forestry, Louisiana Tech University, Ruston, LA

Foresters routinely estimate basal area of a stand by measuring diameters at breast height of trees within a set of sample plots since measuring every tree in the forest is impractical. The expansion from sample to population is complicated as trees are seldom uniformly random distributed throughout the stand (often showing a clumping pattern), the tree diameters do not have a homogeneous pattern, and the stand density can play a significant role in the estimation process. The objective of the paper is to assess the impact of the spatial distribution and stand structure on the estimates obtained by sampling, for this example the estimations were performed to assess the d.b.h. We used a replicated factorial experiment organized as complete randomized design using the stand density (5 levels), attributes of interest magnitude (8 levels) and spatial association (3 levels) as the factor describing the stand and the sample unit shape (3 levels) and size (6 levels) as the factors describing the sampling design. A total of 21600 samples were generated using an enhanced algorithm initially developed by Wang *et al*. (2009) which incorporate Weibull distribution and degree of clumpiness. The results show that sampling estimates could depend on the sampling design at significance levels 0.1 or less.

260 **ROBUST DATA ACQUISITION SYSTEM FOR MEASURING SIZE AND SPATIAL DISTRIBUTION OF FIBER AND OTHER CELL TYPES WITHIN WOOD: FLATECH**

Bogdan M. Strimbu*, **George Grozdits, Mark D. Gibson,** School of Forestry, Louisiana Tech University, Ruston, LA

Current forest management practices focus on obtaining trees with wood qualities that best fit the preset management goals. Wood quality depends on the cell composition and distribution within the tree. Most approaches assess the wood quality by measuring growth rate, density or specific gravity, fiber (cell) length and cell diameter (i.e., cell size). To quantify wood quality we developed a system that measures the common cell attributes, namely fiber (cell) length, cell diameter and cell wall thickness. The system also computes the area of a cell or fiber using planimetric (the area identified by contour) or discriminant algorithms (the area identified by one click inside the cell or fiber). Additionally, the system allows the delineation between the cells types (i.e., longitudinal parenchyma, latewood, earlywood, ray cells, etc.) and the distribution of the cells within the wood structure. Furthermore, the system allows fast and accurate description of an increment core, rate of growth, ratio of earlywood / latewood, and the derivation of the proportion or volume of juvenile wood based on the latewood percentage within the increment core. The system requirements are a high resolution digital camera and a computer with Java installed. The software, which is less than 2 Mb, can be obtained from the School of Forestry, Louisiana Tech University, or Nano Pulp and Paper Company, both from Ruston LA.

263 **ABOVEGROUND BIOMASS ALLOCATION FOR LOBLOLLY PINE MANAGED UNDER DIFFERENT CULTURAL REGIME AND PLANTING DENSITY**

Santosh Subedi*, Dr. Michael Kane, Dr. Dehai Zhao, Dr. Bruce Borders, Warnell School of Forestry and Natural Resources, University of Georgia

We destructively sampled 12 years old 192 trees of loblolly pine (*Pinus taeda*, L.) from four different installations of Plantation Management Research Cooperative (PMRC) across the Piedmont and Upper Coastal Plain (PUCP) region of Georgia and Alabama to test the effect of cultural intensity and planting density on biomass allocation and biomass production. Each installation had 12 plots with two different cultural treatments (intensive and operational) and six different planting densities ranging from 300 trees ac^{-1} to 1800 trees ac^{-1}. From each destructively sampled tree both stem and crown measurements were taken. Stem measurements include DBH, diameter measurements at six inches and every four feet interval up to diameter at the end of the live crown and stem weight. Similarly, crown measurements include crown width, length, green branch weight and dry branch weight. Then, the disc samples were taken from each sampled tree at every four feet interval along the stem and processed in lab for specific gravity and bark measurements. From the data collected, we will report the results on above ground biomass allocation and production due to planting density and cultural intensity and their interaction.

264 **THE ROLE OF VARIOUS FOREST BASED FEEDSTOCKS PRODUCTION SYSTEMS ON C-CYCLING: WEYERHAEUSER'S INTEGRATED APPROACH FOR SUSTAINABILY MANAGING OUR FORESTS FOR BIOMASS, WOOD PRODUCTS AND C-SEQUESTRATION.**

Eric B. Sucre*, **Zakiya H. Leggett**, Weyerhaeuser NR Company, Vanceboro, NC; **Scott M. Holub**, Weyerhaeuser NR Company, Albany, OR

Over the last 100 years, Weyerhaeuser Company has maintained a strong commitment to responsible and sustainable land management. During 2001 to 2002, all of Weyerhaeuser's US based ownership became SFI® certified. This was an important milestone for Weyerhaeuser. Precision stand and site level management is the best method to ensure that forests are managed sustainably, while maximizing environmental goods and services. Weyerhaeuser's research and development program has investigated the potential impacts of various intensive plantation management scenarios on long-term soil productivity for decades in collaboration with the USFS and Universities. The focus of this paper is on how various management practices affect long-term C-cycling and soil quality in primarily loblolly pine plantations highlighting outcomes from older and more recently established long-term sustainability studies. Specifically, discussions will focus on: 1) importance of carbon forms and functions in forest soils, 2) potential carbon benefits associated with producing energy from biomass (i.e. life-cycle analysis of pine biomass production), 3) current models for predicting aboveground and belowground carbon pools and fluxes, 4) environmental impacts associated with the removal of logging residuals, natural understory vegetation, and forest floor on soil organic carbon/organic matter and C-sequestration potential and 5) the potential benefits that intercropping herbaceous crops (e.g. switchgrass) in pine plantations have on these processes. Throughout this paper specific knowledge and data gaps associated with the various key topics will be discussed. Description of current research and where future research should be directed to fill these gaps will be presented.

265 **IS ROOT SYSTEM ARCHITECTURE THE MAIN FACTOR CAUSING LONGLEAF PINE SAPLINGS TO LEAN OR TOPPLE AFTER STRONG WIND EVENTS?**

Shi-Jean S. Sung*, James D. Haywood, Tom Eberhardt, Mary Anne Sword Sayer, USDA Forest Service, Pineville, LA; **Stanley J. Zarnoch**, USDA Forest Service, Asheville, NC

A long-term study of the effects of container cavity size (54, 93, and 170 ml) and cavity copper coating on longleaf pine (*Pinus palustris* Mill.) (LLP) field performance was implemented in November, 2004 in central Louisiana on moderately well-drained, gently sloping soils. Seedlings were planted at a 2 x 2 m spacing in each of 24 plots. All plots were prescribed burned in February, 2006 and in May, 2009. As being reported by many, between age 5 and 10 years, some LLP saplings lean or topple after strong wind events. This phenomenon only happens to saplings originating from container stock. The study site was affected by Hurricane Gustav in September 2008 and by a wind event in August 2009. Saplings were assessed for stem straightness in December 2009. In May 2010 one non-straight sapling and one straight sapling were selected from each plot and both saplings were of similar height and within 5 m of each other. Saplings were cut at the ground level and stumps excavated within 1 m of the stump. The following parameters will be determined: 1) growth and biomass allocation; 2) root system architecture; and 3) wood quality (latewood width, ring width, earlywood density, and latewood density) at 30, 100, and 140 cm along the stem length from the ground level. The objective of the current study is to investigate the relationships among LLP sapling leaning and toppling, root system architecture, and stem wood quality.

266 **SURFACE SOIL ROOT RESPONSE TO SEASON OF REPEATED FIRE IN A YOUNG LONGLEAF PINE PLANTATION**

Mary Anne Sword Sayer*, **James D. Haywood**, USDA Forest Service, Southern Research Station, Pineville, LA

On the western Gulf Coastal Plain, the potential exists for interaction between naturally high soil bulk density and low soil water content to create root-growth limiting soil strengths. This problem is commonly remedied by soil structural attributes, old root channels, and other soil perturbations that allow pine root elongation. Just as vegetation manipulation with repeated prescribed fire has an obvious impact on the composition and distribution of understory plants, there may be changes in the rooting pattern of understory plants with frequent fire. Because season of fire affects the understory plant structure in southern pine forests, it may also affect the quantity and distribution of understory roots. On sites where understory roots play a significant role in alleviating excessive soil strength, awareness of how fire-induced vegetation changes affect understory rooting and soil strength is warranted. In a 14-year-old stand of sapling longleaf pine (*Pinus palustris* Mill.) on the Kisatchie National Forest, Rapides Parish, Louisiana, an investigation is underway to quantify surface soil distributions of pine and non-pine roots and soil strengths in response to no prescribed burning and biennial burning in March, May, and July. Preliminary results suggest that season of prescribed fire affects non-pine rooting and therefore, may affect soil strength and pine root distribution. Relationships between soil strength, non-pine rooting, and pine rooting in response to season of prescribed burning will be discussed.

267 **INTEGRATING FOREST STAND PROJECTIONS WITH WILDLIFE OCCUPANCY MODELS TO DEVELOP A DECISION SUPPORT TOOL**

Michelle F. Tacconelli* and Edward F. Loewenstein , School of Forestry and Wildlife Sciences, Auburn University, AL

Natural resource managers must often balance multiple objectives on a single property. When these objectives are seemingly in conflict with each other, the manager's job can be extremely difficult and complex. This paper presents a decision support tool, designed to aid land managers in optimizing wildlife habitat needs while accomplishing additional objectives such as ecosystem restoration, carbon sequestration, and timber production. A growth and yield model, the Forest Vegetation Simulator, is used to project future stand structure based on three management scenarios: no management, active manipulation of species composition through harvesting and underplanting, and single tree selection based on the Proportional-B method. At five-year time steps, predicted forest structure is input into species specific wildlife occupancy models to estimate probability of occurrence of focal species. This in turn allows quantification of these species response to the silvicultural prescription. By integrating these two models (stand projection and habitat occupancy) a unique tool is available for land managers to both gauge the efficacy of their management plans before their implementation and to develop a predicted timeline of forest structure development that can be used for comparison in adaptive management.

269 **POTENTIAL EFFECTS OF CLIMATE CHANGE ON SPECIES DISTRIBUTIONS AND PRODUCTIVITY IN THE SOUTHERN US – IMPLICATIONS FOR CARBON SEQUESTRATION**

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As the climate warms there is a high likelihood that the distributions of tree species in the southern US will expand northward. The extent of the climate-driven expansion will be species dependent. In this talk predicted changes in the estimated ranges of important pine and hardwood species will be described, along with a critical analysis of the assumptions and procedures used in making these predictions. Climate change will affect forest productivity throughout the region, and therefore the potential for forests to sequester carbon. Our recent research indicates that elevated temperatures and elevated CO_2 concentrations have synergistic effects on growth rates of loblolly pine, i.e., elevated temperatures increase the length of the growing season and elevated CO_2 concentrations increase carbon gain throughout the period of growth. This appears to be due to the physiological characteristics of the species, which include a high degree of temperature acclimation of respiration and a very broad temperature optimum for photosynthesis. In comparison, northern red oak exhibited a negative response to elevated temperatures because it lacks similar characteristics, suggesting the effects of climate change on productivity will be also be driven by species characteristics. We used 3-PG+, a process-based growth and yield model, to estimate the potential impact of climate change on productivity throughout the current and potential loblolly pine range. Our simulations indicate that in the future an enhancement of productivity and carbon sequestration should be expected for loblolly pine across much of its range, except on sites where there is limited soil water availability.

273 **SILVICULTURE OF VARIETAL LOBLOLLY PINE PLANTATIONS: SECOND YEAR IMPACTS OF SPACING AND SILVICULTURAL TREATMENTS ON VARIETIES WITH DIFFERING CROWN IDEOTYPES**

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Despite the large gains in productivity resulting from previous forestry research, growth rates in many pine plantations in the southern U.S. are well below what is possible. As silvicultural inputs become more intensive and tree improvement produces more intensively selected and less genetically heterogeneous full-sib families or clones, there is a greater need to understand how elite genotypes respond to silvicultural manipulations. A long-term study was established at two installations in the southeastern U.S. (Virginia Piedmont, North Carolina Coastal Plain) to address the following objectives: 1) Evaluate the crown ideotype approach to clonal testing in loblolly pine; 2) Determine impacts of increasing genetic uniformity on growth and uniformity of loblolly pine plantations; 3) Compare growth response, carbon allocation patterns (above and below ground), and ecophysiological processes of clones of loblolly pine under different management intensities and planting densities; and 4) Compare the effects of different climatic and edaphic conditions and silvicultural regimes on growth and ecophysiology of loblolly pine varieties. A split-split plot design was use in this study with the main plot treatments being two levels of silviculture (operational, intense), the split-plot treatment being six genotype entries (1OP, 1 CMP, 4 clones), and the split-split plot treatments being three different planting densities (250 tpa, 500 tpa, 750 tpa). The clones represented a range in crown ideotypes, with two having moderately wide crowns and two having broad crowns. Second year survival and growth responses and other characteristics are presented.

274 **THE END OF ROTATION EFFECTS OF WEED CONTROL AND FERTILIZATION ON THE CARBON AND NITROGEN DYNAMICS OF A SLASH AND LOBLOLLY PINE FOREST IN NORTH CENTRAL FLORIDA**

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The effects of fertilization, weed control, and fertilization+weed control on vegetation and soil carbon (C) and nitrogen (N) pools were examined for a loblolly pine (*Pinus taeda* L.) and slash pine (*Pinus elliottii var. elliottii* Engelm.) forest at 18 years and at the end of rotation (26 years). The total C accumulated in fertilized forests without weed control was 20% (slash pine) and 40% (loblolly pine) greater than in the control forests at the end of rotation. Weed control increased pine C content at 18 years, but by the end of rotation weed control effectively resulted in no gain in ecosystem C and when the two treatments were combined, weed control slightly subtracted from the net C benefit produced by fertilization. This result occurred because of decreased forest floor and soil C in the weed control plots. Fertilization significantly increased multiple N pools in the forest, and N retention was 63% and 103% of the applied N in the slash and loblolly pine forests, respectively. Weed control with fertilization reduced ecosystem N retention efficiency, but weed control alone did not negatively affect ecosystem N accumulation. These results suggest that the optimal treatment for increasing C accumulation and N retention in managed pine ecosystems is fertilization without weed control.

275 **EROSION CONTROL ON BLADED SKID TRAILS**

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Within silvicultural operations soil erosion can be a major concern and can greatly reduce the productive capacity of a stand. Soil erosion rates are greatest on areas where bare soil is exposed. Typically these areas are highly disturbed areas and include log decks, haul roads, and skid trails. Forestry Best Management Practices (BMPs) have been developed to mitigate soil erosion. BMP implementation is particularly important on skid trails because trails are built to lower standards and present the potential for increased erosion. The objective of our study was to determine the effectiveness of the following five closure and cover BMPs for bladed skid trails: 1) water bar only (Control); 2) water bar and grass seed (Seed); 3) water bar, grass seed, and mulch (Mulch); 4) water bar and piled hardwood slash (Hardwood Slash); and 5) water bar and piled pine slash (Pine Slash). Treatments were installed on bladed skid trail sections that were 15.24 m (50 ft) long by 3 m (10 ft) wide. Runoff was collected and sediment was filtered out by geotextile devices known as Dirtbags®. Bags were weighed monthly to assess the amount of erosion. In addition to field measurements, three soil erosion models were used to determine treatment effectiveness. The models used were the Universal Soil Loss Equation for Forestry (USLE), Water Erosion Prediction Project for Forest Roads (WEPP), and the Revised Universal Soil Loss Equation version 2 (RUSLE2). Results indicate significant treatment differences with Mulch, and Slash treatments being the most effective at reducing erosion.

277 CARBON STORAGE IN DECAYING ROOT SYSTEMS OF HARVESTED TREES

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Decaying root systems of harvested trees can be a significant component of below-ground carbon storage, especially in intensively managed forests where harvest occurs repeatedly in relatively short-rotations. Based on destructive sampling of root systems of harvested loblolly pine trees, we estimated that root systems contained about 32% (17.2 Mg ha^{-1}) of the soil carbon at the time of harvest and about 13% (6.1 Mg ha^{-1}) of below-ground carbon 10 years later. Based on published roundwood output data, we estimated belowground biomass, at the time of harvest, for loblolly-shortleaf pine forests harvested between 1995 and 2005 in South Carolina. We then calculated C remained in decomposing root systems in 2005 using the decay function developed for loblolly pine. Our calculations indicated that C storage in decaying roots of loblolly-shortleaf pine forests in South Carolina, harvested between 1995 and 2005, was 7.09 Tg. If timber harvesting in South Carolina represents the average of the 13 states in the southern US, the total C storage of decaying roots due to timber harvesting would be 92.17 Tg.

278 **THE 3PS OF OAK REGENERATION: PLANNING, PERSISTENCE, AND PATIENCE**

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Oak regeneration research has been ongoing in earnest since the late 1950s-early 1960s. Most research has focused on specific silvicultural practices, regeneration processes, relationships to site factors, and local limiting factors such as deer browsing or problems with interfering species. Research has evaluated the effects of thinning on regeneration development, methods for oak planting, post-harvest treatments to control competing vegetation, and many other aspects of oak silviculture. All of these have provided solutions to individual problems in oak regeneration for local to regional areas. However, with all this research we still have difficulty regenerating oak forests. We believe that the long-term and more universal solution is based on the 3Ps of oak regeneration: planning, persistence, and patience. Because these three steps are currently not followed or their importance recognized, oak regeneration does not succeed. Research and operational silviculture have been focused on the application of one or several treatments over a short period of years. Oak regeneration is a long-term ecological process requiring long-term planning. Persistence in treatments both pre- and post-harvest is required to enable oak regeneration to develop and remain competitive. And because oak is a species physiologically adapted to repeated disturbances over decades, patience in the regeneration process is necessary. We will review research focusing on those studies that support each of the 3Ps. By completing these three steps, oak regeneration can be accomplished.

279 **EFFECTS OF ABOVE- AND BELOW-GROUND COMPETITION ON WIREGRASS ESTABLISHMENT IN A XERIC SANDHILLS LONGLEAF PINE FOREST**

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Restoring the graminoid-dominated groundlayer vegetation is essential to longleaf pine (*Pinus palustris*) ecosystem restoration. In May 2008, we planted wiregrass (*Aristida stricta*) seedlings and sowed wiregrass seed in frequently-burned upland longleaf pine forests on the Carolina Sandhills National Wildlife Refuge to determine how vegetation competition affects wiregrass establishment and seedling survival. We used a split-plot design with three whole-plot, above-ground (understory vegetation) treatments and two split-plot, below-ground (root) treatments. Whole-plot treatments were based on existing understory vegetation. One was dominated by wiregrass, one by turkey oak (*Quercus laevis*), and one lacked understory vegetation. All plots had a comparable pine overstory. Split-plot treatments were created using root exclusion devices to reduce below-ground competition. Seedling establishment, survival, and growth were significantly higher where root competition was excluded throughout the first two growing seasons. In the month following germination and planting, seedling establishment and survival were significantly lower on turkey oak-dominated plots, but at all later sampling times, similar wiregrass productivity was noted across all vegetation treatments. Soil moisture was higher on root exclusion subplots, but did not vary among vegetation treatments. These results suggest that soil moisture may be a limiting factor to wiregrass establishment in the xeric sandhills, but that competition from turkey oaks, at the densities we monitored, may not limit wiregrass productivity or restoration efforts.

285 **SOIL DISTURBANCE AND SITE IMPACTS RELATED TO A THINNING OPERATION IN KENTUCKY**

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A study was undertaken in 2007 to evaluate the impact of implementing specific management prescriptions to sustain oak regeneration and improve forest health in the Daniel Boone National Forest, Kentucky, as outlined in the new Land and Resource Management Plan. Soil disturbance classes and soil impacts were evaluated for one method of stand regeneration: shelterwood with reserves. Soil disturbance classes were tabulated throughout the harvest stand while subsections of the stand were delineated and soil physical properties measured within each subsection. Soil physical properties were also measured in an unharvested stand in close proximity to the harvest tract. Soil disturbance class data and soil impact data will be presented.

286 **ASSESSING SOIL IMPACTS RELATED TO FOREST HARVEST OPERATIONS**

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Forest operations related to harvesting and thinning often have unintended consequences including stand damage, rutting, soil displacement, and soil compaction. The change in soil volume (compaction) is of concern to land managers due to its impact on soil structure, soil aeration, soil water availability, nutrient and organic matter status and erosion potential. Soil compaction is often reported as either a change in soil volume, resistance to penetration, or both and the final compaction status dependent upon the interaction of soil properties, machine systems, and landscape position. Methods employed to assess compaction levels throughout a harvest stand have included linking soil changes with tabulation of surface disturbance classes, monitoring of machine movements by the GPS, and measuring ground pressures as a result of machine trafficking. The integration of these methods with compaction data can be utilized to depict site response to harvesting and its variability within the harvest tract. A significant consequence of forest compaction is an increase in erosion potential that can be estimated by use of bound plots or the application of GPS derived data to form digital elevation models (DEM) to monitor water flow paths in a harvest tract subject to erosion. The results of studies that illustrate the means of assessing soil compaction and erosion potential will be presented. In addition, the consequence of soil compaction and erosion on soil/site productivity will be addressed.

287 **DISTRIBUTION OF SMALL DIAMETER TREE BIOMASS IN MISSISSIPPI**

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Fire suppression and selective cutting of high grade timber during the last few decades have resulted in an unprecedented accumulation of small diameter trees (5~11 inch d.b.h) biomass in the understory and mid canopy across the southern forest land. Resource analyses of small diameter trees for biomass, value-added utilization and forest health restoration have emerged as one of the top priorities for resource management agencies and landowners. Based on the Mississippi Institute for Forestry Inventory (MIFI) database, availability of small diameter tree biomass was analyzed by forest type, species, ecoregion and county, and mapped in Mississippi. A stand health indicator was developed based on the relative proportion of large diameter trees (>11 inch d.b.h), small diameter trees (5-11 inch d.b.h) and seedlings/saplings (<5 inch d.b.h) for small diameter tree management and biomass harvest.

288 **EFFECTS OF ECOLOGICAL AND SOCIOECONOMIC DETERMINANTS ON TALLOW TREES IN SOUTHERN COASTAL FOREST LAND**

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Tallow tree (*Triadica sebifera*) as a major nonnative species invades and threatens southeast forest land by competing native species and altering ecosystem components. The presence and percent cover class of Tallow tree and related driving variables including stand and site conditions, as well as natural and anthropogenic disturbances collected from US Forest Service Forest Inventory Analysis (FIA) database were analyzed by using ArcGIS and other geospatial tools to study the relationship between tallow tree spread and potential driving factors. Of the 10,756 plots from the 2001 to 2008 inventory panels at Alabama, Arkansas, Georgia, South Carolina and Texas, there were 191 plots that were recently invaded by tallow trees. It showed that tallow tree introduction and colonization were significantly correlated to silvicultural activities (clearing, slash burning and chopping, etc.) and natural disturbances (tornado, hurricane and flooding). Forest fragmentation had significant impacts on the spread of tallow trees. Most of newly infested plots were found in perforated forests, followed by forest edges, and then forest interiors.

289 **THREATS OF MAJOR NONNATIVE INVASIVE PLANTS IN THE SOUTHERN FOREST LAND: CONDITION, EXTENT AND POTENTIAL DRIVING FACTORS**

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Southern forests are experiencing increasing invasion, spread and establishment of non-native invasive plants (NNIP). Sixteen potentially harmful NNIPs were selected from the 2001-2008 southern FIA database to study their current condition and extent of spread in southern forests. Gaussian kernel density was used to estimate the presence probability/risk of a species over space explicitly. Based on the overall presence probability and the generated risk maps sixteen selected NNIPs were coarsely classified into four groups: 1) regionally prevalent species (overall presence probability > 30% and species widely distribute over the southern region), which include Japanese honeysuckle and Chinese-European privet; 2) locally prevalent species (species concentrated locally with one hotspot of risk>0.5, overall presence probability>3%,but ≤ 10%), which include Tallow tree, Bush honeysuckles, Mimosa, Japanese climbing fern and Tall fescue; 3) regionally spreading species (species that have more than one hotspot of risk>0.1,but ≤ 0.5,overall presence probability >3%,but ≤10%), which include Chinese lespedeza, Nepalese browntop, Tree of heaven and Japanese glossy privet; 4) regionally introducing species (Species have more than one hotspot of risk ≤ 0.1,overall presence probability <3%), which include Kudzu, Cogongrass, Chinaberry tree, Autumn olive, and Princesstree. Potential geographical, ecological, and socio-economic factors that affect the invasion, establishment and spread of NNIPs were examined for NNIPs' management and control.

292 **GENETICALLY IMPROVED LOBLOLLY PINE AND CARBON SEQUESTRATION**

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As atmospheric CO_2 concentrations continue to rise, highly-productive genetically improved loblolly pine (*Pinus taeda* L.) genotypes provide a potential means of increasing C sequestration and offsetting further fossil fuel emissions. The use of highly productive open-pollinated families, mass-control pollinated (MCP) families, and clonal varieties has greatly enhanced loblolly pine plantation productivity across the landscape and has increased the potential to maximize future genetic gains, biomass production, and therefore, C sequestration. Despite the potentially enormous role of improved loblolly pine varieties in C sequestration, variability in physiological traits, C allocation, and above- and below-ground biomass production among a diverse range of improved genotypes has received little attention. Variability in such traits may confer differences in C sequestration and resistance to shifts in climate. Given that the domestication of loblolly pine is still in its infancy, significant variation in growth and adaptability remains within the species, and this variation will be vital for loblolly pine C sequestration and sustainability under changing climatic conditions. In this review, we examine the historical impact of loblolly pine genetic improvement on C sequestration across the Southeast, and discuss our current understanding of genetic differences in traits that influence productivity, sustainability and C sequestration. We also discuss the obstacles, tradeoffs, and potential for maximizing growth and C sequestration under changing environmental conditions.

293 **COMPARATIVE ECONOMICS OF FOREST CARBON SEQUESTRATION**

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This paper assesses the viability of forest project offsets, relative to other carbon offset options in order to examine how competitive non-industrial private forest (NIPF) lands are with alternative methods for offsetting greenhouse gas (GHG) emissions. First, factors affecting forest offset costs are discussed including: species and site characteristics, management practices, opportunity costs of land, and price effects on forest and agricultural products. Then, the competitiveness of forest based offsets with alternatives sources is evaluated by comparing the costs of reducing GHG in terms of CO2 equivalent (CO2e) for the various alternatives. We conclude by examining the current policy environment focusing on the cap and trade bills before the Congress, emphasizing how different eligibility criteria may impact forestry offset projects and potential strategies for increasing the competitiveness of NIPF offset projects

294 **EFFECTS OF SILVICULTURAL MANAGEMENT ON LOW GRADIENT STREAM WATER QUALITY IN LOUISIANA**

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Oxygen depletion in rivers and streams is among the top 5 impairment types in the U.S., and is an issue among many forested watersheds in the South. Such impairments are based on state water quality standards and require the development of Total Maximum Daily Loads (TMDLs) or other strategies to ameliorate low dissolved oxygen (DO) levels or high biochemical oxygen demand (BOD). TMDLs allocated to forested waterways in some states have called for reductions in BOD through appropriate harvesting and site preparation techniques. Specific silvicultural prescriptions for riparian areas following best management practice (BMP) guidelines can help mitigate elevated BOD levels in streams. However, recent surveys and research on streams in the South, including unimpaired waterbodies, have encountered naturally-occurring low DO concentrations that are already below state water quality standards. As part of a larger study conducted by LSU, this body of research examines changes in DO for a low gradient stream in north-central Louisiana, the role of common silvicultural practices, and the effectiveness of BMPs in maintaining water quality. While DO impairments are still a problem in the South, this study also demonstrates pre-harvest DO concentrations are naturally low particularly in response to high stream temperatures and organic loadings, but are still able to support aquatic life. In light of this, standards set by the Louisiana Department of Environmental Quality (LDEQ) and other state agencies should reflect site-specific and/or seasonal conditions. Post-harvest results from this study, as well as those by researchers in other Southern states, also suggest silvicultural management practices have little or no impact on water quality when BMP guidelines are followed. Impairment determinations and TMDL allocations for existing impairments, therefore, should not only consider the demonstrated effectiveness of forest BMPs, but also need to account for the natural conditions exhibited in many low gradient streams and other waterbodies in the South.

295 **SPATIAL AND TEMPORAL PATTERNS OF WILDFIRE OCCURRENCES IN MISSISSIPPI**

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Wildfire, particularly infrequent, large-sized, catastrophic fires, has significant impact on Mississippi's forest. In this study, we analyzed the spatial and temporal patterns of wildfire occurrences reported between 1990 and 2008 in Mississippi, where 57% of wildfires are incendiary wildfires. K-function and Moran 's I were used to investigate the randomness of the distribution of wildfire occurrences and to identify the spatial and temporal clusters of wildfire occurrences. And the effect of topographic, climatic and socio-economic factors on wildfire occurrences was investigated. We found that: 1). Wildfire occurrences were not randomly distributed in Mississippi and occurred more frequently in the south and in the consecutive dry years; 2) Wildfire occurrence was negatively associated with the two human-caused factors; 3) Wildfire occurrences were positively associated with PDSI and population density. Foresters and resource managers can incorporate this information in forest management to mitigate the threat of wildfires.

297 **LONG-TERM MONITORING OF THE EFFECTIVENESS OF FORESTRY BEST MANAGEMENT PRACTICES IN THE FLAT CREEK WATERSHED, LOUISIANA**

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Design of forestry best management practices (BMPs) depends on site conditions, such as climate, topography, geology, and soils, as well as forestry activities associated with each unique watershed. Many drainage basins in Louisiana are low-gradient with slow-moving streams containing high organic matter and low dissolved oxygen. These systems possess not only different forest types but also unique hydrologic and biogeochemical processes that are fundamental to stream water quality. In forestry management, little is known about how field operations can maintain and/or improve water quality of these eutrophic water bodies. Over the past two decades, many studies have been conducted on forest practice impacts immediately adjacent to streams. Overall, these plot-scale studies have demonstrated that forest operations with BMP implementation can reduce nonpoint source (NPS) pollution to adjacent waterways. However, there is a knowledge gap of how the small-scale benefits translate to protecting water quality at the larger landscape scale. As watersheds increasingly become the primary planning unit for natural resource management, a need exists to understand the effectiveness of current voluntary forestry BMPs in protecting stream water quality from NPS pollution beyond an operational boundary. In 2005, we initiated a paired watershed study with a Before-After-Control- Impact design to address two critical questions: 1) Are Louisiana's current forestry BMPs effective in maintaining or improving the quality of low-gradient, eutrophic headwaters? 2) Will forestry BMP implementation bring any basin-wide benefits in water quality protection? This paper discusses 5-year results of this study in three components, hydrology, water quality, and stream biology.

298 **SPATIAL AND TEMPORAL DYNAMICS OF DISSOLVED OXYGEN, NITROGEN, AND PHOSPHORUS IN A LOW-GRADIENT WATERSHED, LOUISIANA**

Abram DaSilva*, Y. Jun Xu, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA; **George Ice**, National Council for Air & Stream Improvement, Corvallis, OR; **John Beebe**, National Council for Air & Stream Improvement, Western Michigan University, Kalamazoo, MI; **Richard Stich**, Plum Creek Timber Company, Crossett, AR

In Louisiana, voluntary best management practices (BMPs) have been implemented to protect water quality from non-point sources of pollution. However, little is known about the effectiveness of these BMPs, and few long-term studies have been conducted to monitor forestry effects in low-gradient, highly organic headwater streams like those found in Louisiana. The goals of this study were to (1) test effectiveness of Louisiana's current BMPs through monitoring spatial and temporal variations of nitrogen (N), phosphorus (P), and dissolved oxygen (DO) concentrations, and (2) to determine any necessary BMP additions/changes. The study took place in the Flat Creek watershed, North-Central Louisiana, whereby 15 sites were selected including five extensive sites (monthly water sampling), six intensive sites (monthly and storm water sampling), and two sites where multi-parameter water quality sondes were deployed. These two sondes took measurements of DO, temperature, and pH every 15 minutes, and were located directly above and below a forested tract that was harvested and site prepared using BMPs. Monthly site visits were conducted during which water samples were collected for N and P analysis and stream flow at each site was measured. Data has been collected from January 2006 through 2010, during which timber harvest occurred at known tracts in the summer and early fall of 2007, and site preparation followed in late 2008 and early 2009. Analyses of pre- and post-impacts are underway. Results from this study will provide insights into site-specific conditions and the effectiveness of BMPs at preventing water quality degradation from forestry practices.

299 **CHARACTERIZING BENTHIC MACROINVERTEBRATE COMMUNITIES IN LOW-GRADIENT, OXYGEN-DEPLETED STREAMS OF FORESTED HEADWATERS IN CENTRAL LOUISIANA**

Derrick Klimesh*, Y. Jun Xu, School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA; **Adrienne Viosca,** Louisiana Department of Environmental Quality, Southeast Regional Office, New Orleans, LA

Aquatic organisms are affected by a stream's physicochemical conditions and can, therefore, be indicative of stream health. There is a knowledge gap on the ecological associations of benthic macroinvertebrates in low-gradient, oxygen-depleted headwater streams common to forested watersheds in central and northern Louisiana. These headwater streams are typically slow moving, capable of accumulating large amounts of organic material, and often become intermittent during the dry season. Dissolved oxygen (DO) levels in these streams commonly reach hypoxic levels (less than 2 mg/L) in summer months, yet abundant and diverse macroinvertebrate communities exist. To better understand communities associated with these headwater streams, a benthic macroinvertebrate survey has been conducted each in the spring and late summer from 2006 to 2009 across a low-gradient, forest-dominated watershed in central Louisiana. Benthic macroinvertebrate samples were collected at thirteen locations in 1st to 3rd order streams. During this time period, multiple forest stands in the watershed were harvested and replanted. To reflect changes in stream physiochemical conditions, water quality measurements were taken monthly over the entire study period. The study found that these streams were taxonomically dominated by Dipterans, mostly *Chironomidae*. Prevalent functional feeding groups were collectors and predators. The mayfly *Hexagenia* was positively correlated with DO levels, while other metrics including percentages of *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) taxa differed between sites with varying DO levels and stream flow permanence. During the post-harvest period, the percentage of EPT taxa decreased at all sampling locations, accompanied by an increased level of total dissolved solids.

300 **A WATERSHED-BASED ENVIROMENTAL AND REGULATORY DATA ANALYSIS SYSTEM FOR THE FOREST PRODUCTS INDUSTRY**

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A hydrogeographic analysis system was created as a tool for the forest products industry, including commercial timberland owners and pulp and paper mills, to better understand potential regulatory implications of water quality initiatives and other developing water resource challenges. This tool, also known as The NCASI Receiving Water Database (RWDB), will be discussed including applications involving the analysis of potential changes in critical habitat designations, aquatic life and nutrient criteria, as well as other resource management policies. These analyses are important to the industry as they provide information on potential regulatory developments pertaining to water and land management. The database has played a key role in the development of projects designed to identify the industry's involvement in areas (from forestland to mill product) where waters have been identified as impacted. The system has supported the establishment of studies that bring spatial information together on research and management activities from forest product companies. For example, the information in the data system has been used in combination with company research objectives to identify potential locations for the collection of environmental data for investigating the attainability of water quality standards. The database has also been used to respond to site-specific questions pertaining to watershed-based permitting, evaluation of stream temperature data for criteria development, as well as threatened and endangered species evaluations. The current system is being utilized in conjunction with an ongoing long-term study on pulp and paper mill receiving waters, and is undergoing several major revisions to make it a more efficient and comprehensive environmental data resource for the forest products industry.

302 **SHORT-TERM CARBON PARTITIONING FERTILIZER RESPONSES VARY AMONG TWO FULL-SIB LOBLOLLY PINE CLONES**

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We investigated the effects of fertilizer application on the partitioning of gross primary productivity (GPP) between contrasting full-sib clones of *Pinus taeda* (L.). Our objective was to determine if fertilizer growth responses resulted from similar short-term changes to partitioning. A modeling approach incorporating respiratory carbon (C) fluxes, soil CO_2 efflux (F_S), and biomass was applied to a factorial design with two clones, fertilizer and control treatments, and four sequential monthly harvests of seedlings planted in a greenhouse. Partitioning was integrated over 121 days to above, belowground, and total net primary production (ANPP + BNPP = NPP), total belowground C flux (TBCF), aboveground plant respiration (APR), and F_S. While both clones showed similar GPP and responses to fertilizer application, they did so by partitioning GPP in different ways. Fertilizer application increased GPP and resulted in corresponding increases in ANPP, BNPP, and TBCF ($p < 0.01$). When considered as a fraction of GPP partitioned, differences between clones emerged. Clone-by-fertilizer interactions for carbon use efficiency (i.e. NPP / GPP), ANPP / GPP, and APR / GPP were all observed ($p < 0.10$). TBCF was significantly greater in one clone, indicating that plant-soil interactions could be affected by clone-specific partitioning. The other clone had greater growth efficiency (ANPP / GPP) without fertilizer, but with fertilizer application the clones were similar. Our results suggest multiple possible short-term ecophysiological mechanisms are responsible for fertilizer growth response in different yet closely related clones.

306 **DROUGHT EFFECTS ON THE ENERGY AND WATER BALANCES ON TWO NORTH CAROLINA LOWER COASTAL PLAIN LOBLOLLY PINE PLANTATIONS**

Ge Sun*, A. Noormets, **J-C. Domec**, **S.G. McNulty**, **M.J. Gavazzi**, **J.S. King**, **J. Chen**, **D.M. Amatya**, and **R.W. Skaggs,** respectively, Research Hydrologist, Biological Scientist, and Research Ecologist, respectively, Eastern Forest Environmental Threat Assessment Center (EFETAC), Southern Research Station, USDA Forest Service, Raleigh, NC; Research Assistant Professors, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC; Associate Professor, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC; Professor, Department of Earth, Ecological, and Environmental Sciences, University of Toledo , Toledo, OH; Research Hydrologist, Center for Forested Wetlands Research, USDA Forest Service, Cordesville, SC; Professor, Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, NC

Forests are increasingly recognized for their important role in mitigating global climate change through sequestering carbon and for their biophysical control on land surface energy balance. We constructed energy and water balances for a mid-rotation loblolly pine (*Pinus taeda*) (19-yr old in 2009) and a recently established loblolly pine (5-yr old) stands in eastern North Carolina by combining eddy flux, sap flux and hydrometeorological measurements during 2005-2009. The 5-year study spanned a wide range of precipitation regimes (900-1467 mm/yr) including two exceptionally dry years during 2007-2008. We found that the 19-yr old site had higher net radiation (R_n) due to its lower albedo (ÿ =0.11-12), compared with that at the CC (ÿ=0.15-0.18). In general the 19-yr stand had higher latent flux (LE) (i.e. evapotranspiration (ET)) rates than that of the 5-yr old stand, but ET rates were similar between the two sites during the growing season of 2006 and 2009 that had above average precipitation. However, monthly-scale sensible heat fluxes (H) were similar at both sites. During the historic 2007-2008 drought years, both plant transpiration and soil evaporation decreased greatly due to reduced soil water availability. We hypothesize that the observed pattern in energy partitioning is due to high groundwater level, and evapotranspiration being energy- rather than water-limited. This study suggests that climatic variability must be considered in evaluating the effects of vegetation on water and energy balances of forest ecosystems.

307 **GENETIC EFFECTS ON STAND-LEVEL UNIFORMITY, AND ABOVE- AND BELOW-GROUND BIOMASS PRODUCTION IN JUVENILE LOBLOLLY PINE**

Michael J. Aspinwall*, John S. King, Steven E. McKeand, and Bronson Bullock, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC.

Genetic effects on stand-level above- and belowground biomass production could impact southern pine plantation sustainability and carbon sequestration. Furthermore, differences in uniformity within genotypes with varying amounts of inherent genetic variation could impact stand-level resource capture. To compare genotype differences in stand-level uniformity and biomass production, we grew ten different genotypes in a plantation setting for three years and used site-specific allometric relationships to estimate standing biomass and annual biomass production. Over the study period, genotypes showed significant differences in total and component (i.e. foliage, stem, etc.) standing biomass, and annual above- and below-ground biomass production. After 3 years of growth, genotypes differed in above-ground and total above- and belowground standing biomass by as much as ~2000 kg ha^{-1} and ~2700 kg ha^{-1} (or 46%), respectively. Genetic differences in biomass production rates were of a similar magnitude with peak rates of total dry mass production during the third year as high as 4272 kg ha^{-1} yr^{-1} and as low as 2090 kg ha^{-1} yr^{-1}, depending upon genotype. Less genetically diverse genotypes (i.e. clones) did not show greater uniformity at the site tested, and by the end of the third growing season, the CV's within individual clones were similar to the CV's within individual half-sib genotypes. Our results suggest that genetic differences in stand-level above- and belowground biomass production may confer genetic differences C sequestration. Also, within an operational plantation setting where resources and competition may vary greatly, individual clone uniformity may be similar to that of more genetically diverse genotypes.

308 **SILVICULTURE AND THE ASSESSMENT OF CLIMATE CHANGE GENETIC RISK FOR SOUTHERN APPALACHIAN FOREST TREE SPECIES**

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Changing climate conditions and increasing pest and pathogen infestations will increase the likelihood that forest trees could experience population-level extirpation or species-level extinction during the next century. Management, gene conservation and silvicultural efforts to preserve forest tree genetic diversity present a particular challenge in species-rich regions such as the Southern Appalachian Mountains of the southeastern United States. To facilitate the effective use of limited resources and to guide silvicultural activities, we developed a system that ranks the risk of genetic degradation for more than 130 Southern Appalachian tree species.

Species differ in their silvicultural requirements, physiological tolerances, life-history strategies and population dynamics (extinction, colonization, dispersal abilities). These differences could drive variation among forest tree species in their potential responses to changing climate conditions. Given these potential changes, diverse silvicultural and genetic strategies to support future desired conditions will be needed to ensure successful regeneration and restoration efforts.

Ecological and life-history traits were used to rank the predisposition of species to genetic degradation from climate change and other threats. This approach would serve as a tool for planning silvicultural treatments, conservation efforts, evaluating species' genetic resources and detecting vulnerabilities.

Several forest tree species of the Southern Appalachians are at particular risk because they occur in limited high-elevation ranges and/or are currently threatened by insects and diseases. We will present examples of Southern Appalachian forest tree species with high, moderate and low expected risk to climate change-related genetic degradation. Subsequent gene conservation strategies and prospective silvicultural tactics applied to those species will be discussed.

310 **EFFECT OF HERBICIDES AND TIMING ON LONGLEAF SEEDLING SURVIVAL AND PERCENTAGE OUT OF THE GRASS STAGE ON OLD-FIELD PLANTED SITES – TWO YEAR RESULTS**

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Many non-industrial private forest landowners question which herbicides and application timing to best control weeds in their old field planted longleaf pines. Over 110,000 old-field acres in Georgia were planted to longleaf pine since 1999. Four newly planted longleaf old-field sites (two scalped and two non-scalped) were located in southeastern Georgia to perform a herbicide trial using Oust + Arsenal, Oustar, or Arsenal, and a control, with two or three application dates, replicated three times at each site. As of July 2008, one to four months after the herbicide treatments, longleaf survival was significantly reduced (by 22 to 32 percentage points) where the herbicide was applied within two months of planting. Overall second year longleaf pine seedling survival on these four sites ranged from 51 percent (Jenkins County site, planted 24 February 2008) to 96 percent (Treutlen County site, planted 24 September 2007). On the two scalped sites, the best herbicide treatments (mid-April, mid-May Oustar or Arsenal) improved seedling survival by zero to eight percentage points, whereas on the two non-scalped sites the best herbicide treatments (mid-April, mid-May Oustar or Arsenal) improved seedling survival by ten to twelve percentage points through two years. The mean percentage of longleaf seedlings out of the grass stage through two years were as follows: the Jenkins County scalped site at 5 percent, the Laurens County scalped site at 39 percent, the Laurens non-scalp site at 45 percent, and the Treutlen County non-scalped site at 95 percent.

312 **THE EVALUATION AND MANAGEMENT OF FOREST OFFSET REVERSAL RISK**

David M. Cooley, Christopher S. Galik*, Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, NC; **Carolyn Kousky**, Resources for the Future, Washington, DC

Carbon offsets offer added opportunities to mitigate greenhouse gas (GHG) emissions while helping to keep overall regulatory compliance costs down. Despite these potential benefits, offsets can also be vulnerable to certain environmental integrity issues, such as impermanence, in which carbon stored in soil or biomass is released back to the atmosphere following a fire, drought, pest infestation, or other disturbance. Offset policy generally addresses the risks of impermanence by requiring projects to hold insurance or to place a portion of their generated credits into an offsets buffer, to be withdrawn in the event of a reversal. A requirement to hold insurance is a valid solution only if relevant insurance products exist to service individual offset projects. Alternatively, buffers run the risk of being overwhelmed by a catastrophic loss of sequestered carbon, potentially damaging the environmental integrity of the offsets program.

Given the uncertainty for how to address impermanence and reversals in a policy context, emerging risk theory should be employed to ensure that risks to offsets projects are fully understood. To this end, we examine potential risks to offsets projects in southeastern forests, paying special attention to spatial correlation of risks and correlation across risks, such as interactions between risks of fire and pest infestation. We also make recommendations as to how to include more complete assessments of reversal risk in a policy context, taking note of the balance that must be struck between rigorously maintaining environmental integrity and avoiding undue burdens on landowners or project developers.

313 **WHAT MAKES CARBON WORK? A SENSITIVITY ANALYSIS OF FACTORS AFFECTING FOREST OFFSET VIABILITY**

Christopher S. Galik*, David M. Cooley, Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, NC

An established body of research suggests great potential for forest carbon offsets in the Southeastern United States. Early implementation experience and a handful of empirical analyses in the literature, however, indicate that this raw potential may be constrained by, amongst other factors, transaction costs, access to markets, and carbon accounting rules and regulations. Offset projects can be further inhibited by uncertainty generated by a constantly-shifting regulatory landscape and a host of other land use options available to forest landowners, including biomass cultivation, conversion to agriculture, or even sale for development. Collectively, these multiple factors threaten to undermine the supply of carbon offsets and diminish a once-heralded business opportunity for private landowners.

Using a forest growth and carbon accounting model, we will assess a variety of key accounting, financial, and market variables to determine their influence on forest carbon offset project viability in the Southeast. In particular, we will ascertain the relationship between accounting rules and regulations and the volume of carbon that may be sold by a forest landowner, examine the influence that traditional forest product production has on offset project competitiveness, and investigate the role of project scale in determining financial feasibility. The findings will shed light on those aspects of policy design most important for decision makers to address when crafting rules and regulations governing forest offset projects. It will also highlight issues that private landowners should consider when considering implementation of forest offset projects on their land.

314 **GEOSPATIAL RELATIONSHIPS OF TREE SPECIES DAMAGE CAUSED BY HURRICANE KATRINA IN SOUTH MISSISSIPPI USING MIFI DATA AND GIS**

Mark Garrigues*, Dr. Joseph Fan, Dr. David Evans, Department of Forestry, Mississippi State University, Mississippi State, MS; **Dr. Bill Cooke**, Department of Geosciences, Mississippi State University, Mississippi State, MS

Hurricane Katrina generated substantial impacts on the forests and biological resources of the affected area in Mississippi. According to Mississippi Institute for Forest Inventory (MIFI) and United States Forest Service Forest Inventory and Analysis assessments, over one half million hectares of forest land and approximately 39 million m^3 of timber was damaged across the Southeast Forest District of Mississippi due to Hurricane Katrina. This equates to an estimated total biomass loss of 50-140% of the net annual U.S. carbon sink in forest trees. Although salvage operations were conducted, damage occurred across all ages and forest types and subsequently increased the amount of fuel loading dramatically. Tree mortality and damage has been shown to vary according to species and site characteristics. This study utilizes the MIFI database and advanced GIS techniques in ArcGIS to produce damage maps based on type of wind damage (shear or windthrow). These maps are in turn correlated with layers showing physiographic features of the Southeast Forest District such as slope, aspect, and soil texture, and forest conditions including species composition, density and mean diameter. Finally a geospatial model was built to predict wind damage based on important stand and physiographic factors. By studying tree species and areas that may be more prone to damage, disaster relief agencies will have a better idea of where to concentrate debris removal efforts and allocate necessary resources.

315 **DOES FREQUENT BURNING AFFECT LONGLEAF PINE (*PINUS PALUSTRIS*) BARK THICKNESS?**

G.Geoff Wang*, Steve R. Wangen, Department of Forestry and Natural Resources, Clemson University, Clemson, SC

Bark thickness plays a critical role in defending a tree's cambium from damage by fires. Does frequent burning stimulate bark production compared to fire suppressed control? Based on data collected from an ongoing, long-term prescribed fire study, we explored differences in the bark thickness of longleaf pine (*Pinus palustris*) trees in burn and control sites at different heights along the tree stem up to 200 cm above the ground. We found that burn plots had a smaller DBH (diameter at breast height), which resulted in thinner bark, when compared to control. After adjusting differences in tree size, we found no difference in bark thickness between burn and control sites, except for bark thickness measured at 0 cm aboveground where control had significantly thicker bark than burned sites. Our results suggested that frequent burning did not stimulate bark production in longleaf pine.

316 **SPATIAL ANALYSIS OF LONGLEAF PINE STAND DYNAMICS AFTER 60 YEARS OF MANAGEMENT**

John C. Gilbert*, John S. Kush, Rebecca J. Barlow, Longleaf Pine Stand Dynamics Laboratory, Auburn University, Auburn, AL

There are still many unanswered questions and misconceptions about the dynamics of naturally-regenerated, even-aged stands and uneven-aged management of longleaf pine (*Pinus palustris* Mill.). To understand more of these stand dynamics and to learn more about long-term management of longleaf pine, the "Farm Forty" was selected as the study site. The "Farm Forty" is a forty-acre tract located on the USDA Forest Service Escambia Experimental Forest near Brewton, Alabama. The "Forty" was established in 1948 as a demonstration area for the small private forest landowner. The initial stand was an under stocked second-growth longleaf pine forest, but the management objectives for the tract were to create high quality wood products, to successfully promote natural regeneration, and to minimize management costs. The site has been inventoried every five years with the only management consisting of periodic harvests and prescribed burning. These harvests created an uneven-aged stand structure with a range of age classes including trees over 100 years old. To evaluate the current stand dynamics of the "Forty", a GIS (geographical information system) database was created by compiling information about past harvests and stem-mapping all pines greater than or equal to 3.1 inches d.b.h (diameter at breast height). This database contains information for over 5,000 trees and provides a unique opportunity to explore longleaf pine stand dynamics spatially. The variations in densities and size classes across the tract will be evaluated to provide information about how longleaf pine grows and the dynamics of long-term management.

318 **THE EFFECTS OF THINNING AND STAND CHARACTERISTICS ON ABOVEGROUND CARBON STOCKS IN MIXED-HARDWOOD FORESTS OF THE SOUTHERN APPALACHIANS**

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The effects of thinning on individual-tree and stand-level volume growth have been intensively studied, however relatively few studies have examined the effects of thinning on carbon (C) storage. Furthermore, of those studies that have examined the effects of thinning on aboveground C storage, most report only short-term results or rely on model projections to quantify the long-term effects of thinning on C storage. This study examines the effects of thinning on live tree C stocks over a 25-year period while controlling for the effects of site quality and stand age in upland mixed-hardwood forests of the southern Appalachians. In 1974, 81 plots ranging in size from 0.06 to 0.1 ha were established in mixed-hardwood forests in Georgia, western North Carolina, eastern Tennessee, and southern Virginia. All trees >11.4 cm dbh within each plot were tagged and measured. In 1975, plots were thinned to a randomly assigned residual basal area (RBA; m2/ha). Re-measurement of all trees occurred every five years through 2000. Biomass of individual trees will be determined using species-specific allometric equations and converted to aboveground live tree C (Mg/ha). Regression analysis will be used to examine the effects of thinning intensity (as defined by RBA), stand age, and site quality on live tree C dynamics. Although limited in regards of assessing the effects of thinning on total ecosystem C, this study provides information about the effects of intermediate silvicultural disturbance on C dynamics of the aboveground live tree pool in a highly diverse and heterogeneous landscape.

321 **CARBON SEQUESTRATION OPPORTUNITIES IN NATURALLY-REGENERATED SOUTHERN PINE STANDS MANAGED USING EVEN-AGED AND UNEVEN-AGED SILVICULTURAL SYSTEMS**

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By the year 2050, 25% of the South's timberland will be in pine plantations, and these will be crucial in meeting the timber and fiber needs of the South. But the importance of the remaining 75% of the Southern timberlands, which will be managed using methods other than plantation silviculture, should not be overlooked--especially in the context of carbon sequestration on public lands and in the family forests of the South. Naturally-regenerated southern pine stands managed using even-aged and uneven-aged silvicultural systems produce trees of large size, which can be harvested as sawlogs and manufactured into solid wood products, but there is little information in the literature on the carbon sequestered in standing wood volume in managed naturally-regenerated southern pine stands. In this paper, carbon stocks based on long-term growth and yield data from managed even-aged and uneven-aged southern pine stands at the Crossett Experimental Forest in the upper west Gulf Coastal Plain in southern Arkansas will be presented. Preliminary calculations show that mean increment of carbon in the merchantable component of these managed naturally-regenerated southern pine stands is on the order of 1.6 tons C per ac annually, of which 75% is in sawlogs and 25% in pulpwood and tops. The patterns of carbon accumulation in thinned 50-yr even-aged stands versus uneven-aged stands managed over a similar length of time using 5-yr cutting cycles will also be discussed, as will the implications of these data for long-term post-harvest sequestration in sawlog products versus pulpwood products.

322 **LOW-COST REGENERATION TECHNIQUES FOR MIXED-SPECIES MANAGEMENT – 20 YEARS LATER**

Thomas A. Waldrop*, Helen H. Mohr, USDA Forest Service, Clemson, SC; **Elizabeth M. Blizzard**, University of Missouri, Columbia, MO

Mixed species management became a research emphasis in the late 1980's because regeneration costs were lower than those for pine plantations and nonindustrial private forest land owners might be attracted to improving stand productivity. A site preparation technique, known as fell and burn, was developed in the mountains of Arkansas and South Carolina (Phillips and Abercrombie 1987) and was adapted by Waldrop and others (1989) for the Piedmont region. Early tests of the system indicated that planted loblolly pines could survive among hardwood sprouts but the long-term survival and growth of pines was unknown. In one study, planted pines remained overtopped by hardwoods through 5 growing seasons after four variations of the fell-and-burn technique (Waldrop 1997). Treatments included felling of residual stems after clearcutting, done either in the winter or spring, followed by summer burning or no burning. This paper examines the same study sites with re-measurements taken at 10, 15, and 20 years. Relative growth of pines and hardwoods will be discussed for each treatment combination along with management recommendations to achieve desired species mixtures.

325 **CUT STUMP CONTROL OF YAUPON, SWEETGUM, AND CHINESE TALLOWTREE WITH AMINOCYCLOPYRACHLOR**

Mike Link, E.I. DuPont de Nemours, Byron, GA and **Jimmie Yeiser**, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX.
Oral Presentation will be presented by **Jason Grogan***, Stephen F. Austin State University

The purpose of this study was to investigate the potential of cut stump treatments of MAT28 for the control of unwanted woody rootstocks of yaupon, sweetgum, and Chinese tallowtree occupying recently harvested pine sites. An east Texas site was selected for testing MAT28+basal oil against standard treatments. Test treatments were: (1) MAT28 2.5%, (2) MAT28 5%, (3) MAT28 10%, (4) MAT28 15%, (5) Garlon 4 Ultra 30%, (6) Garlon 4 Ultra+Stalker 20+1%, (7) MAT28+Stalker 10+1% and (8) Untreated check. Herbicides were applied on 4-Feb-09. Stems were severed with a chainsaw 4 inches above the ground and herbicide applied immediately and sufficiently to thoroughly wet the surface, edges, and top 2 inches of the stem. Rootstocks were free of sprouts 30 and 60 days after treatment (DAT). One year after treatment, Chinese tallowtree total heights for checks averaged 6.1-ft. Sprout total height decreased as the rate of MAT28 increased. MAT28 at (10%), Garlon Ultra, and mixtures all exhibited 100% control. Sweetgum total heights for checks averaged 4.2-ft. Sprout total height decreased as the rate of MAT28 increased. Least sprouting occurred on rootstocks treated with Garlon Ultra alone. Only one of thirty sweetgum rootstocks treated with Garlon Ultra alone sprouted and it exhibited a total height of 0.04-ft. After one growing season, yaupon checks were 2.9-ft tall. All treated rootstocks, regardless of rate and product, averaged <2-inches in total height. No sprouts were detected on rootstocks treated with mixtures. Cut stump treatments of MAT28 show potential for reducing rootstocks of yaupon, sweetgum, and Chinese tallowtree invading recently harvested pine sites.

326 **GLYPHOSATE FORMULATIONS WITH AND WITHOUT LI 700 FOR CONTROL OF ROADSIDE NONCROP PINE IN SE OKLAHOMA**

Jimmie L. Yeiser, Stephen F. Austin State University, Nacogdoches, TX **Moe Finke,** Loveland Products, Inc. Greeley, CO, and **Jason Grogan***, Stephen F. Austin State University

Makaze is fully loaded and contains 4lb glyphosate isopropylamine salt (41% glyphosate). Accord XRT II is a fully loaded 5.4lb glyphosate, dimethylamine salt (50.2% glyphosate). Li 700 is a soy-oil derived, non-ionic penetrating non-ionic surfactant, acidifier, and deposition aid/drift control agent. The purpose of this study was to compare selected glyphosate herbicide treatments for control of unwanted loblolly pine. Test treatments were (herbicide name-qts prod/ac): (1) Razor Pro-10, (2) Makaze-4, (3) Makaze-6, (4) Makaze-8, (5) Accord Concentrate+Li 700-3+1/2%, (6) Accord Concentrate+Li 700-4.5+1/2%, (7) Accord Concentrate+Li 700-6+1/2%, (8) Accord XRT II-4, (9) Accord XRT II-6, (10) Accord XRT II-8, (11) Accord XRT II+Li 700-4+1/2% (12) Accord XRT II+Li 700-6+1/2% (13) Accord XRT II+Li 700-8+1/2%, (14) Accord XRT II+Milestone VM Plus (4+4), (15) Accord XRT II+Milestone VM Plus+Li 700-4+4+1/2% and (16) an untreated check. The test site was near Broken Bow, OK. Roadsides and ditch banks lined with loblolly pines 3- 8-ft in total height were selected for treatment. Herbicides were applied at 15 GPA on 10-Jun-08. Plots were evaluated for control on 14-Jun-09. The three glyphosate formulations at 4qt prod/ac produced dramatically different results. That is, Accord XRT II+Li 700 yielded 91%, Accord XRT II 79%, and Makaze 40% control. The inconsistency presented here is indicative of many past attempts to control pine with glyphosate. All 6qt and 8qt formulations provided $\geq$86% control. Numerically, highest five pine control treatments all contained Accord XRT II and provided 93-99% control. Rates of Accord XRT II with and without Li 700 were not statistically different but ranged from 79%-99%. Managers seeking to reduce the amount of active ingredient applied on timberlands should consider 6qt of Makaze, which provided statistically similar pine control as more concentrated formulations.

327 **IMPACTS OF CARBON MANAGEMENT ON ECOSYSTEM SERVICES: A STRUCTURAL AND FUNCTIONAL APPROACH TO EXAMINING ECOLOGICAL TRADE-OFFS**

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Managing for maximum carbon accumulation and storage in southern forest ecosystems may involve substantial changes in forest structure and function across large spatial scales. Because of the tight linkages among carbon, nutrient, and water cycling processes it is likely that intensive management for carbon will impact nutrients, water, and a wide array of other co-dependent ecological components. A long history of forest productivity research in the southern U.S. provides considerable insight on the traditional silvicultural practices that may be used, and emerging research and genetically improved/ modified species and harvesting techniques suggest novel management regimes will be deployed in the future. A science-based evaluation of the ecological consequences of maximizing carbon accumulation and storage is critical before widespread implementation; however, the rapid pace of bioenergy and carbon offset policies and incentives will challenge researchers to provide these evaluations with limited field studies. Instead, approaches that evaluate the implications of changes in structure, function, and associate processes will be required. In this paper, I provide a conceptual framework for examining the linkages among structure, function, and ecological services across a range of spatial scales and use a combination of data synthesis and simulation modeling to examine ecological tradeoff's.

328 **CARBON EMISSIONS AND SEQUESTRATION FROM FOREST FERTILIZATION OF *PINUS TAEDA***

Timothy J. Albaugh*, Jose Luis Stape, H. Lee Allen, North Carolina State University, Raleigh, NC; **Eric D. Vance**, National Council for Air and Stream Improvement, Research Triangle Park, NC; **Thomas R. Fox**, Virginia Tech, Blacksburg, VA; **Rafael A. Rubilar**, Universidad de Concepción, Chile

Southern forests account for 60% and 16% of the United States' and the world's timber production, respectively. In recent decades southern pine plantation timber production increased from 2 to 18 Mg ha-1 yr-1 as forest management shifted from extensive naturally regenerated forests to the increasingly intensive management found in today's forests. About 18% of this increase was attributed to improved nutrition management and approximately 400,000 plantation ha are fertilized annually. Southern forests are estimated to sequester as much as 210 Tg of carbon (C) annually, equivalent to 12% of annual U.S. fossil fuel emissions. However, the net carbon flux related to fertilizer use in forestry is not documented. We integrate carbon sequestration and emissions to calculate net carbon change from a one-time application of mid-rotation nitrogen and phosphorus fertilizer at the stand and regional scales. We also examine these parameters over multiple rotations to understand the effect of reduced rotation length on net carbon emissions as a result of fertilization.

330 **TOWARD ECOLOGICAL GENOMICS IN *POPULUS***

Stephen DiFazio*, **Gancho Slavov**, **Hari Chhetri**, **Eli Rodgers-Melnick**, West Virginia University, Morgantown, WV; **Scott Woolbright**, **Matt Zinkgraf**, **Tom Whitham**, Northern Arizona University, Flagstaff, AZ

The era of ecological genomics is upon us in forestry, enabled by advances in high throughput sequencing and other advances in structural and functional genomics. The genus *Populus* provides an excellent model system for exploring ecological interactions at the genomic scale because of the abundance of available genomic resources as well as the burgeoning literature on genetic basis of biotic and abiotic interactions. Interspecific crosses and natural hybrid zones have provided tantalizing initial indications of the influence of tree genomic variation on biotic communities. Now with the advent of whole genome resequencing and high-throughput genotyping, we have the opportunity to focus in on individual loci and begin to deconvolute the mechanistic underpinnings of community interactions. I will review the general approach and highlight recent findings from large-scale association studies to explore the potential of genomics to yield insights into complex, long-standing ecological questions such about the meaning of species and the nature of communities. This is the beginning of an exciting new era that will meld genome-scale investigations with population and community ecology.

331 **ESTIMATING SOIL CARBON CONTENTS ACROSS THE LANDSCAPE: A COMPARISON OF THREE SAMPLING METHODS**

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Obtaining accurate estimates for total soil C over larger spatial scales often requires extensive sampling and is susceptible to error associated with landscape variability. Various sampling methods designed to minimize this error have been described, including a recently proposed method called conditioned Latin-hypercube sampling (cLHS). The potential advantage of cLHS is that it utilizes existing landscape attributes such as those readily available in geographic information systems to select stratified random samples that cover the variance in the existing ancillary data. Although the theoretical basis for cLHS has been demonstrated, few empirical evaluations have been performed. This study analyzed the relative ability of three different sampling methods—simple random, stratified random, and cLHS—to accurately predict soil C content and its associated variability. In order to create an exhaustive soil C population, a total of 903 samples were collected along a 10x10 m grid in the Piedmont of Georgia. Samples were then selected or stratified based on curvature, slope, landcover, and soil type—each of which are known environmental covariates with soil C. Using subsamples representing 1, 5, 12, and 35% of the population dataset, the distributions of each of the three sampling methods were compared to the population of soil C samples. Results showed that the stratified and cLHS methods most often provided the best approximations of the mean and variability of the population data at mid-range sample sizes. Large advantages of cLHS relative to stratified random sampling were not apparent at this site, although cLHS did perform better at consistently sampling the tails or extreme values of the soil C distribution of the population. Stratified sampling techniques are valuable for devising sampling protocols and utilizing ancillary information will improve representative sampling.

332 **GENETIC VARIATION IN PINES INFLUENCING ECTOMYCORRHIZAL SYMBIOSIS: POTENTIAL IMPLICATIONS FOR GENOTYPE SELECTION AND SOIL CARBON SEQUESTRATION**

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Ectomycorrhizal (ECM) fungi provide one of the main pathways for carbon (C) from pines into soils, where these fungi make significant contributions to microbial biomass and soil respiration. However, ECM fungal species vary significantly in traits that likely influence C sequestration, such that forest C sequestration potential may be driven in part by the community composition of ECM fungi. In three recent experiments we found evidence for genetic variation in *Pinus* species controlling ECM fungal community composition, suggesting the potential to influence ECM community composition through pine genotype selection. A bishop pine (*P. muricata*) population in California was found to harbor significant genetic variation for compatibility with one common ECM fungal species exhibiting a high-biomass exploration strategy, Rhizopogon occidentalis. Native populations of Monterey pine (*P. radiata*) were shown to exhibit significant differences in compatibility with three different ECM fungal species in the family Pyronemataceae. A loblolly pine (*P. taeda*) common garden pedigree population exhibited substantial narrow-sense heritability for compatibility with several ECM fungal species, and negative genetic correlations among fungal species differing in exploration biomass. Altogether, these results suggest that selection of particular *Pinus* genotypes could alter the community composition of symbiotic ECM fungi in managed southern pine forests, potentially influencing soil C sequestration.

333 **FIRST YEAR RESULTS OF A CHESTNUT PLANTING ON THE CUMBERLAND PLATEAU OF EASTERN KENTUCKY ILLUSTRATE CHALLENGES FACING REINTRODUCTION**

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In anticipation of widespread planting of blight-resistant hybrid American chestnuts, it is necessary to understand the silvics and competitive ability of the species. This paper examines the first year results from a silvicultural study of chestnut seedlings on the Cumberland Plateau of southeastern Kentucky. Three hundred American, 300 hybrid (BC_2F_3) and 150 Chinese chestnut seedlings were planted in three silvicultural treatments, ranging from high shade to low shade, on the Daniel Boone National Forest in March, 2009. Seedlings were planted in a completely randomized design with a split-plot treatment arrangement, with silvicultural treatments as whole plots, and species in a randomized block design in the sub-plot. After one year, no significant differences were found among the silvicultural treatments; however seedlings in the low shade sites added growth, on average, while seedlings in the higher shade sites lost growth, due to dieback. Hybrids added significantly more height growth than either the American or Chinese chestnuts. American chestnut suffered nearly 40% mortality, hybrids 34%, while only 5% of Chinese seedlings died during the first growing season. High mortality among Americans and hybrid seedlings is thought to have been caused by the native Chestnut Sawfly, *Craesus castaneae* and the non-native *Phytophthora cinnamomi*, both of which were present at the site. These results illustrate potential challenges facing the reintroduction of American chestnut.

334 **ZONING EUCALYPTUS SPECIES ADAPTATION AND BIOMASS PRODUCTION IN THE SOUTHEASTERN US**

Jose Luiz Stape*, Timothy K. Albaugh, North Carolina State University, Raleigh, NC; **Clayton Alcarde Alvares**, University of Sao Paulo, Brazil; **Thomas R. Fox**, Virginia Tech, Blacksburg, VA; **Rafael A. Rubilar**, Universidad de Concepción, Chile

The *Eucalyptus* genera are among the main hardwood species being considered as a future source of biomass/biofuels in the SE US. The reasons for this are their high productivity, ability to coppice and adequate wood quality (density and chemical characteristics). However, climatic conditions in US during winter, with moderate warm periods followed by very cold periods, do not allow the acclimation of the plants. More recently, introductions of *Eucalyptus* species like *E. amplifolia, E. benthamii, E. camaldulensis, E. dunnii, E. grandis, E. macarthurii and E. viminalis* have shown that some species have the potential to be managed under these climatic conditions. Because of the limited *Eucalyptus* plantings on experimental or commercial sites, areas with suitable climate for these species are unknown, reducing our capability to estimate the likelihood for using these species in the biomass/biofuels matrix. To overcome this issue, we developed a detailed adaptation map (resolution of 1 ha) for each *Eucalyptus* species for the SE US. The zoning was based on the similarities of Koppen's climatic classification and minimum temperature during winter in Australia and the US, using a FAOCLIM-2 dataset. The maps of estimated minimum temperatures were based on multivariate regressions using latitude, longitude and altitude (source: Shuttle Radar Topography Mission). The maps of monthly precipitation were interpolated using ordinary Kriging. The Global Biodiversity Information Facility database was used to identify the natural occurrence of the eucalypt species in Australia. For each species, the frequency of occurrence by Koppen-minimun temperature type in Australia was computed, interpreted and then mapped as thermic-bioclimatic adequate zones in the SE US. Available *Eucalyptus* experimental and commercial sites together with expert knowledge were used to validate the zoning and estimate biomass production potential for each species.

335 **FOREST RESIDUE MANAGEMENT EFFECTS ON SITE CARBON POOLS AND PRODUCTIVITY IN CLONAL LOBLOLLY PINE PLANTATIONS**

Chris A. Maier*, Kurt H. Johnsen, Daniel McInnis, Pete H. Anderson, USDA Forest Service, Research Triangle Park, NC; **Phillip Dougherty**, ArborGen, Summerville, SC; **Steve Patterson**, MeadWestvaco, Summerville, SC

Clonal deployment of elite loblolly pine genotypes holds great promise for increased forest productivity. Proactive soil management that stabilizes or increases soil carbon and nutrients is necessary to realize the productive potential of genetically improved material. We examined how forest residue management influenced soil carbon, nitrogen, and early stand growth in clonal loblolly pine plantations. We manipulated forest residues during site preparation by raking (R) the forest floor (FF), adding FF, or adding logging residues (LR). The treatment goals were to create soil organic matter conditions that range in both quantity and quality (C/N ratio). Averaged over the first four years, FF and LR increased mineral soil [C] 24-49%, while R decreased [C] 18%. Decay rate constants for FF and LR treatments were 0.23 and 0.16 $year^{-1}$, respectively with 20.4 and 34.5-year turnover rate. Residue effects on nitrogen mineralization caused small but significant effects on stand productivity. High quality FF increased growth, while low quality LR inhibited growth, but the effect was temporary (treatment x age, p=0.03). Clone growth was fast accumulating between 112–135 m^3ha^{-1}after six years. Early growth trends indicate that the clonal plantation will accumulate biomass matching the previous plantation in 13-15 years and will accrue 80% more biomass by age 23. Our data indicate that combining intensive cultivation of elite clones and proactive management of forest residues can increase soil carbon and early stand productivity. The long-term impact of residue treatments needs to be determined so that other forest management practices, such as fertilization, can be integrated to sustain or increase productivity.

336 **TECHNOLOGY FOR BIOMASS FEEDSTOCK PRODUCTION IN SOUTHERN FORESTS AND GHG IMPLICATIONS**

Bob Rummer*, John Klepac, Jason Thompson, USDA Forest Service, Auburn, AL

Woody biomass production in the South comes from four distinct feedstocks—logging residues, thinnings, understory harvesting, or energywood plantations. A range of new technology has been developed to collect, process, and transport biomass and a key element of technology development has been to reduce energy consumption. We have examined three different woody feedstock systems with detailed field studies including logging residues in central hardwoods, whole-tree pine thinning and clearcuts, and understory baling. Productivity ranged from 3 dry tons per hour to over 25 tons. Corresponding energy consumption varied by a factor of 3 with low production systems such as understory harvesting consuming 9 gal per dry ton while more efficient whole-tree harvesting systems operate at about 3 gal per dry ton. Intensive management technology for short rotation woody crops will have additional energy inputs for planting and cultural practice. Equipment manufacturers are working on even more efficient technology such as energy recovery swing systems, new powertrain designs, and improved productivity. These studies have found that intensive energywood production systems have the lowest energy input per ton of wood produced.

338 **EVALUATION OF SITE PREPARATION AND PLANTING STOCK ON NUTTALL OAK AND CHERRYBARK OAK GROWTH ON A FORMER AGRICULTURE AREA**

Andrew B. Self*, **Andrew W. Ezell**, **Andrew J. Londo**, **John D. Hodges**, **Derek K. Alkire**, **Damon B. Hollis**, College of Forest Resources, Mississippi State University, Starkville, MS

Oaks are an important component of the southern landscape, and are planted on thousands of acres across the region annually. Federal cost share programs, such as the Wetland Reserve Program (WRP), have increased public interest in afforestation of retired agricultural sites in the Lower Mississippi Alluvial Valley (LMAV). Acorns, bare-root, containerized, and potted seedlings of Nuttall oak (*Quercus texana* Buckl.) and cherrybark oak (*Quercus pagoda* Raf.) were tested in a WRP planting near Port Barre, Louisiana to evaluate both groundline diameter (GLD) and height growth following four mechanical/chemical site preparation treatments. These acorns/seedlings were planted on 16 foot by 36 foot centers with soft mast tree species interplanted using nine foot intervals to meet WRP specifications. The entire research site was subsoiled on 16 foot centers with acorn/seedlings planted in subsoil trenches. Control (no mechanical/chemical treatment), subsoil only, subsoil/Chopper EC®, subsoil/Arsenal AC®, and subsoil/OneStep® site preparation treatments were applied in an attempt to evaluate which treatment combination provided the greatest overall growth. Growth was measured for the 2005 growing season with acorn survival being so low as to prohibit statistical comparison. No height or GLD differences were observed among species. However, height growth differences were found among planting stocks, and GLD growth differences were noted among site preparation treatments, planting stocks, site preparation/planting stock combinations, site preparation/species interactions, and site preparation/species/planting stock combinations.

340 **CLONAL LOBLOLLY PINE GROWTH EXPLAINED BY MULTIPLE REGRESSION ANALYSIS OF SOIL PROPERTIES IN THE PIEDMONT PHYSIOGRAPHIC REGION OF VIRGINIA**

Nicholas S. Bonzey*, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA; **Thomas R. Fox**, Department of Forest Resources and Environmental Conservation, Virginia Tech, Blacksburg, VA

A yearlong temporal analysis of soil properties and their influence on Clonal loblolly pine (*Pinus taeda* L.) is being performed on the Piedmont physiographic region of Southern Virginia. During a complete growing season, a set of soil physical and chemical properties will be measured to determine the relationship between soil properties and several tree growth metrics. Using a stepwise linear regression, we are attempting to correlate macronutrient and physical soil properties on tree growth while eliminating the confounding variability of the genetics.

Poster Number	Poster Presentation Abstracts Posters are listed in numerical order and will be displayed in the same manner in the Stono Ballroom.

1 **SHORT-TERM CHANGES IN LOBLOLLY PINE WATER CONDUCTANCE AND PHOTOSYNTHETIC CAPACITY FROM FERTILIZER SOURCE AND STRAW HARVESTING**

Michael A. Blazier*, Louisiana State University AgCenter, Homer, LA; **Keith Ellum**, University of Arkansas-Monticello, Monticello, AR; **Hal O. Liechty,** University of Arkansas-Monticello, Monticello, AR

The organic matter removal associated with intensive straw harvesting in loblolly pine (*Pinus taeda* L.) plantations has the potential to alter tree water regimes and photosynthetic capacity. Fertilization done to remedy nutrient removals from straw harvesting, as well as the type of fertilizer, likewise has potential to change water regimes and photosynthetic capacity. In 2008 and 2009, conductance and light-saturated photosynthesis were measured seasonally in a loblolly pine plantation in north central Louisiana in response to: (1) a non-raked, non-fertilized control treatment, (2) annual straw raking for seven years, (3) annual straw raking for seven years and five years of inorganic fertilizer application, and (4) annual straw raking for seven years and five years of organic fertilizer (poultry litter) application. Precipitation was comparable to or exceeded regional averages throughout the study period. No differences in intrinsic water use efficiency were observed in response to treatments. Annual straw raking had no effect on loblolly pine conductance and photosynthetic capacity. Conductance in spring was greater in response to poultry litter application than to all other treatments. Both fertilization treatments were associated with lower photosynthetic capacity in summer relative to the control treatment.

2 **THINNING AND FERTILIZATION: EFFECTS ON BARK BEETLE ABUNDANCE IN AN INDUSTRIAL LOBLOLLY PINE PLANTATION**

Kathryn R. Booker*, Lori G. Eckhardt, James W. Zanzot, Forest Health Dynamics Laboratory, School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL

Thinning and fertilization practices are commonly used by land managers to reduce density-related stress and increase growth rates in loblolly pine (*Pinus taeda*) plantations. However, these management practices carry both positive and negative consequences. Onsite disturbance and residual damage from thinning operations can attract bark beetles. Historically, bark beetles and weevils have caused extensive destruction in the southeastern United States. The increase in nitrogen levels through application of fertilizer is known to increase growth, but at the cost of an individual tree's defense capacity. Stress induced by elevated bark beetle populations can result in degraded crown conditions, contributing to symptoms of pine decline, and ultimately pine mortalities. We evaluated root-feeding bark beetle abundances following thinning treatments at intensities which reduced stand densities to 500, 300, 200, and 100tpa. One-half of thinned stands were fertilized at a rate of 150 lbs ac^{-1} of nitrogen and 25 lbs ac^{-1} of phosphorous to examine general effects of fertilization and potential interaction with thinning disturbances. Preliminary results indicate the mean number of root-feeding beetles (*Dendroctonus terebrans*, *Hylastes salebrosus*, and *H. tenuis*) and weevils (*Pachylobius picivorus* and *Hylobius pales*) post-treatment was lower in the 500tpa treatment than in stands thinned to 100tpa. Fertilization has resulted in a greater abundance for all root-feeding bark beetle species. This study further discusses potential reasons for differences in observed abundances and stresses the importance of examining consequences of common silvicultural disturbances.

3 **STOCKING RATE MEDIATES GROWTH AND PROFITABILITY OF MID-ROTATION LOBLOLLY PINE IN WEST-CENTRAL ARKANSAS**

David M. Burner*, USDA-ARS, Booneville, AR; **John P. Dwyer**, **Larry D. Godsey**, University of Missouri, Columbia, MO

Growth and financial returns of 13 loblolly pine (*Pinus taeda* L.) plantation designs (i.e., stocking rates in trees ha^{-1} [TPH]) at mid-rotation (14 years old) were measured to 1) determine loblolly pine growth responses, and 2) develop an economic model to estimate financial outputs. Plantations were unthinned and ranged from 490 to 2300 TPH. The financial model allowed costs, returns, growth, and production scenarios to be varied to calculate net present value (NPV) and years to "break even" with and without pine straw. Basal area generally was $\geq$ 30 m^2 ha^{-1}, indicating need for thinning to optimize individual tree growth. Plantations with $\geq$ 2000 TPH and no pine straw harvest had negative NPV and a relatively long break-even period compared to other plantations at a 5% discount rate. Pine straw harvesting nearly doubled NPV at about 1500 TPH compared to no pine straw, and substantially reduced years to break even at $\leq$ 1500 TPH. Besides timber, an array of design-dependent agroforestry and forestry products could drive the selection of specific plantation designs: pine straw or biomass production at $\geq$ 1800 TPH, and alley cropping or silvopasture in single-row ($\leq$ 1000 TPH) and multiple-row plantations (< 1400 TPH). The model demonstrated the potential financial benefit for harvesting pine straw with timber, especially in regions of the south-central US where pine straw is an underutilized resource.

4 **LONGLEAF PINE AGROFORESTRY**

Kristina Connor*, U.S. Forest Service, Southern Research Station, Auburn, AL; **Rebecca J. Barlow, Mark Smith**, School of Forestry and Wildlife Sciences, Auburn University, AL; **Luben Dimov,** Forestry, Ecology, and Wildlife Program, Alabama A&M University, Huntsville, AL

While whole-system restoration of longleaf pine forests represents a worthy ideal, it is not always a practical alternative for landowners. Agroforestry offers the opportunity to provide the multiple benefits of high value timber products and agricultural crop or wildlife production. Agroforestry can be developed from existing natural stands, plantations, or from pasturelands. The possibilities for multiple income sources associated with agroforestry are plentiful and, for forest landowners, may well mean the difference between profit or loss in uncertain times of commodity price fluctuations. Agroforestry can provide income alternatives that range from wildlife, to medicinal plants, mushrooms, carbon credits, pine straw or biofuels, providing landowners with a stable income until overstory trees become merchantable. Alternative income possibilities will be discussed as will the necessity to locate and secure dependable markets to supply a steady cash flow for forest landowners. Additionally, opportunities for the long-term conversion of pastureland to naturally regenerating forest systems will be presented.

5 **EFFECTS OF PRESCRIBED FIRE ON THE SHORT- AND LONG-TERM SEED BANK IN MIXED-HARDWOOD FORESTS OF THE SOUTHERN APPALACHIANS: PRELIMINARY RESULTS**

Tara L. Keyser*, Tracy Roof, USDA Forest Service, Asheville, NC; **Dean Simon**, North Carolina Wildlife Resources Commission, Lawndale, NC; **Gordon Warburton,** North Carolina Wildlife Resources Commission, Marion, NC

We examined the effects of prescribed fire on the seed bank of mixed-hardwood forests in western North Carolina. Prescribed fire is increasingly used by managers to restore structure and increase over- and understory diversity in upland hardwood forests of the Southeast. However, little information exists regarding the potential impacts of prescribed fire on the viability and regeneration potential of the seed bank. Many tree, herbaceous, and shrub species are capable of regenerating from banked seed and may, therefore, greatly influence forest structure and composition following prescribed fire. In 2008, five - 5 ha research units were established in mixed-hardwood stands on North Carolina State-owned Game Lands. Within each of the five stands, six 0.05 ha subplots were established so that two subplots were located at each of the ridge, mid-slope, and lower slope positions. Prior to the prescribed fire and again immediately post-fire, two - 0.0625 m^2 seek bank collections were obtained from the recent (litter and duff) and long-term (mineral soil) seed bank layers in each of the six subplots in two of the five replicate stands. Samples were cold stratified and germinated under greenhouse conditions. After germination, individuals were identified to species-level. Pre- and post-treatment germination data were used to assess the effects of prescribed fire on mortality, viability, and diversity of the seed bank across a topographic gradient. Results from this study will provide information on the effects of prescribed fire on an often overlooked source of diversity in upland forests of the Southern Appalachians.

6 **EXPLORING GENETIC DIVERSITY, PHYSIOLOGIC EXPRESSION AND CARBON DYNAMICS IN LONGLEAF PINE: A NEW STUDY INSTALLATION AT THE HARRISON EXPERIMENTAL FOREST.**

John R. Butnor*, Kurt H. Johnsen, C. Dana Nelson, USDA Forest Service, Southern Research Station, Research Triangle Park, NC

In 1960, an experiment was established on the Harrison Experimental Forest in southeast Mississippi to compare productivity and wood properties of planted longleaf, loblolly and slash pines under different management regimes. It was discovered that longleaf pine lagged in productivity the early years, but eventually surpassed loblolly and slash pine. Hurricane Katrina (August 2005) left the experiment heavily damaged; especially the loblolly plots, providing a new opportunity for continuing longleaf pine research on the site. In addition, there is strong region-wide interest in restoring longleaf pine to its former range, with one important goal being to increase forest resilience to climate change and extreme climate events. However, little is known about how regional seed sources and how within seed source variability affects adaptive traits. Our goal is to better understand genetic control of physiologic traits which enhance survivorship and productivity at a hurricane prone site with relatively low native soil fertility. This new installation will allow a direct comparison of four longleaf pine sources originating from similar latitudes from Texas to South Carolina under three planting densities. Physiologic differences between and within the sources will be analyzed along differences in height, diameter, stem taper and carbon allocation to specific components (foliage, branches, stems, roots) across the planting density gradient. Allelic states of several genes will be related to survival and performance traits to determine which genes affect which traits and to measure and monitor the resident genetic diversity in these sources as the stand matures. Experiments such as this will inform development of genetic guidelines for restoring resilient longleaf pine ecosystems.

7 **PINE STRAW HARVESTING EFFECTS ON WATER CONTENT OF A FOREST SOIL**

Daniel H. Pote*, David M. Burner, USDA-ARS, Booneville, AR

This study addresses concerns that harvesting pine straw from forests may decrease timber productivity by accelerating evaporation of soil water. Pine needles that accumulate on the forest floor help to conserve soil moisture, protect the soil surface against erosion, moderate soil temperature, inhibit weed growth, and provide soil nutrients and organic matter. These qualities make pine straw a valuable landscaping mulch that has become a multi-million dollar business in several southeastern states. However, some forest managers are concerned that removal of the protective pine straw layer from forests allows water to evaporate more quickly from the soil surface, and may decrease timber productivity in areas where pine straw has been harvested. In this study, three harvesting schedules and a control treatment (no straw harvest) were compared to determine harvesting effects on volumetric water content of the soil vadose zone in an established loblolly (*Pinus taeda* L.) plantation. Pine straw harvesting tended to decrease soil water content at depths below 20 cm. The effect was significant ($p<0.05$) primarily near the 50-cm depth in late June, when water content at this depth averaged 20.9% for soils where straw was harvested annually, and 30.2% for soils where the straw was never harvested (control). In soils where pine straw accumulated for at least a year after being harvested, average water content was not significantly different than in control plots. The results indicate that harvesting could potentially lengthen drought-stress periods for loblolly pine during the first year after pine straw removal.

8 **PHYSIOLOGICAL INVESTIGATION OF SHADE TOLERANCE IN LONGLEAF PINE**

Tom A. Stokes*, **Lisa J. Samuelson**, Center for Longleaf Pine Ecosystems, School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL

Longleaf pine (*Pinus palustris* Mill.) has been classified as very shade intolerant based on the need for canopy gaps for successful regeneration. Of the southern pines, longleaf is considered the most intolerant of competition. Shade tolerance of longleaf pine has been defined primarily by seedling survival, height and root collar diameter growth in gaps. However, longleaf may be moderately tolerant when young but become more intolerant of shade with age and therefore exhibit plasticity in shade tolerance. To the best of our knowledge, no study has examined physiological shade tolerance defined by light response curves and leaf morphology in different size longleaf trees and in different geographic sources. Therefore, the objective of this research is to better define physiological plasticity in shade tolerance in longleaf pine by examining shade tolerance in grass stage seedlings from six different provenances from NC, SC, FL, GA, AL and MS and in branches of young longleaf pine approximately 10 m tall. Field and greenhouse studies have been installed and data will be presented on photosynthetic response to light, chlorophyll fluorescence, chlorophyll concentrations and needle structure in one-year-old foliage and in current year foliage subjected to 0%, 50% and 70% reductions in ambient light over a growing season. This study will yield a better understanding of ecological requirements of longleaf pine and will aid in refining process models that model carbon uptake of ecosystems.

9 **UPLAND SHORTLEAF PINE DIAMETER GROWTH AFFECTED BY SEASONAL RAINFALL IN WESTERN ARKANSAS AND EASTERN OKLAHOMA**

Douglas J. Stevenson*, Thomas B. Lynch, Natural Resources and Environmental Management, Oklahoma State University, Stillwater, OK; **James M. Guldin**, USDA – Forest Service, Southern Research Station, Hot Springs, AR

Growth rings of 410 shortleaf pines from an ongoing growth and yield study were correlated with monthly and seasonal rainfall. After detrending to remove the effects of individual tree age, ring width correlated with rainfall totals for the previous fall, previous winter and the months of July, August and September of the current year. Duration of the longest period below 20 degrees Fahrenheit, extreme low temperature from the previous winter, duration of the longest period above 100 degrees Fahrenheit and extreme high summer temperature and duration and ending date of drought periods longer than 30 days were also examined.

10 **TEMPERATURE AND DROUGHT RESPONSES IN LONGLEAF, SLASH AND LOBLOLLY PINE: COMPARATIVE ADAPTATION TO CLIMATE CHANGE**

William D. Whitlow*, Lisa J. Samuelson, Tom Stokes, Center for Longleaf Pine Ecosystems, School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL; **Kurt Johnsen, John Butnor**, USDA Forest Service, Southern Research Station, Research Triangle Park, NC

To better understand how longleaf pine (*Pinus palustris* Mill*.)*, loblolly pine (*Pinus taeda* L.), and slash pine (*Pinus elliottii* Engelm.) may respond to changes in climate, we are examining relationships between temperature and water availability and leaf physiological function in a 50 year-old experimental plantation on the Harrison Experimental Forest in Saucier, MS. We will present data on photosynthetic temperature response curves that will be measured throughout the 2010 growing season using a portable leaf gas exchange system fitted with two water jackets designed to control chamber temperature 10^{o}C above and below ambient temperature. Diurnal patterns of light-saturated photosynthesis, stomatal conductance, dark respiration, soil moisture, and leaf water potential will be measured monthly to examine relationships between water availability, temperature and leaf physiological function. Foliar ^{13}C analysis will be performed on needles to examine seasonal water use efficiency. Because of longleaf is found on xeric, well-drained soil types, we hypothesize that the photosynthetic temperature optimum will be highest in longleaf pine and that longleaf pine will be more drought tolerant and thus better able to adapt to climate change than the other species.

11 **EFFECT OF SIMULATED ICE STORM DAMAGE ON LOBLOLLY PINE TREE AND STAND GROWTH**

Rodney E. Will*, Thomas C. Hennessey, Thomas B. Lynch, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK; **Robert Heinemann, Randal Holeman, Dennis Wilson**, Kiamichi Forestry Research Station, Idabel, OK

Ice and glaze damage to loblolly pine plantations is a recurrent problem in eastern Oklahoma and western Arkansas. A quantitative assessment of tree and stand growth in response to varying levels of ice induced crown damage is currently lacking that would allow informed decisions regarding stand termination or continuance. Our objectives were to determine how varying levels of simulated ice damage affect growth of both damaged and neighboring undamaged trees and determine how aggregate changes in the growth of damaged and undamaged trees affect stand growth. In March 2008, six mid-rotation stands representing two each that were unthinned, thinned, and thinned and pruned were subdivided and portions in each stand were randomly assigned to have 0, 25, 50, 75, or 100% percent of trees crown damaged. Crown damage for individual trees was simulated by shooting out between 20 and 50% of the live crown. We present two-year results of tree and stand growth in relation to degree of simulated ice damage.

12 **PERFORMANCE OF TWENTY ONE-YEAR-OLD OPEN-POLLINATED PECAN PROGENY**

David Gwaze, Missouri Department of Conservation, Columbia, MO; **Phil Sneed**, Missouri Department of Conservation, Chillicothe, MO; **Terry Truttmann**, Missouri Department of Conservation, West Plains, MO.
Poster will presented by **Charly Studyvin***, USDAFS Mark Twain National Forest, Rolla, MO.

A progeny test of pecan (*Carya illinoinensis* (Wangenh.) K. Koch) was established by the Missouri Department of Conservation in Livingston County. The test included 40 half-sib families from the natural range of pecan in Missouri. At age 21, significant family differences were found for frequency of nut production. However, no significant family variation was detected for survival, height, diameter and volume. Five of the most frequent nut production families were from Lincoln, Vernon and Livingston counties, with the best family being from Lincoln County. The five least frequent nut producers were from Bates, Carroll and Vernon counties. Individual tree heritability for frequency of nut production was 0.22 and family-mean heritability was 0.54. Genetic gain when the progeny test is thinned and the top 50%, 33% and 25% individual trees are allowed to cross pollinate was predicted to 26.5%, 71.8% and 94.1%, respectively, for frequency of nut production. These results suggest that pecan in Missouri has high genetic variation for frequency of nut production, and its genetic improvement is effective.

13 **SCIENCE DELIVERY IS A TWO-WAY STREET – DEVELOPMENT OF THE CONSORTIUM OF APPALACHIAN FIRE MANAGERS AND SCIENTISTS (CAFMS)**

Thomas A. Waldrop*, Helen H. Mohr, USDA Forest Service, Clemson, SC

“We have a lot of information but it is scattered and too difficult to find.” “Managers should read our publications, all the information is there.” “Research publications are too specific and difficult to read, especially when units are metric.” “I do not have time to meet and greet every land manager to sell my science.” “I am uncomfortable calling a scientist that I do not know.” These are just a few of the more common comments expressed at three regional workshops in the fall of 2009 to plan the Consortium of Appalachian Fire Managers and Scientists (CAFMS). Over 75 participants from across the Appalachian region were introduced to the topic of Science Delivery and asked what forms of delivery they were familiar with and which of these work well for them. Answers were diverse, reflecting the wide range of cultures and management problems encountered in the Appalachian region.

The overall result of Consortium planning was a clear indication that managers and scientists do not communicate well and that both groups could gain much knowledge by increasing interaction. Suggestions were made for almost 50 types of science delivery but most managers and scientists were looking for very similar products. This poster will introduce the CAFMS and the topic of science delivery. It will also describe some of its unique plans for improving communication between scientists and fire managers.

14 **MORTALITY AND GROWTH OF LONGLEAF PINE SEEDLINGS UNDER DIFFERENT SILVICULTURAL TREATMENTS AT CAMP LEJEUNE, NC**

Huifeng Hu*, G. Geoff Wang, Benjamin O. Knapp, Department of Forestry and Natural Resources, Clemson University, Clemson, SC; **Joan L. Walker,** USDA Forest Service, Southern Research Station, Clemson, SC

In order to determine an optimal silvicultural system for restoring longleaf pine (*Pinus palustris* Mill., LLP) while retaining existent mature loblolly pine (*P. taeda* L., LBP) trees, we conducted a field experiment with a randomized complete block, split-subplot design to test effects of canopy structure and cultural treatments on LLP seedling survival and growth at Camp Lejeune, NC. In each block, seven overstory treatments (four uniform treatments: Control (~14 m^2 ha^{-1}), MedBA (~9 m^2 ha^{-1}), LowBA (~4.5 m^2 ha^{-1}), and Clearcut; three gap treatments of 1256, 2826, and 5024 m^2 in size) were randomly assigned to each main plot, where four cultural treatments (Control, Planting native wiregrasses, Competition control, and Competition control + Fertilization) were randomly assigned to each subplot. Containerized LLP seedlings were planted in a spacing of 6 ft x 10 ft in November 2007. Competition control with herbicide treatment (direct spray of 1% imazapyr with ¼% non-ionic surfactant) was applied in October 2008. The 10-10-10 NPK fertilizer (280 kg ha^{-1}) was broadcast in April 2009. Local wiregrass seeds were broadcast (5 kg ha^{-1}) in March 2010 after implementing prescribed burns in the spring of 2010. The mortality and growth (measured by root collar diameter) of LLP seedlings were and will be monitored in October 2008, 2009, and 2010, respectively. The effects of overstory (main plot level) and cultural (subplot level) treatments on LLP seedling survival and growth will be assessed. LLP seedling survival and growth in relation to available resources (soil available nitrogen, soil moisture, available light, etc.) will also be quantified.

15 **ICE DAMAGE EFFECTS ON THINNED LOBLOLLY PINE STANDS IN SOUTHEAST OKLAHOMA**

Thomas Henessey*, Rodney Will, Doug Stevenson, Thomas Lynch, Giulia Caterina, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK; **Robert Heinemann, Randy Holeman,** OSU Kiamichi Forestry Research Station, Idabel, OK

On December 25, 2000 loblolly pine (*Pinus taeda*) plantations in southeastern Oklahoma were subjected to a severe ice storm. An assessment of the damage to 25-year-old, previously thinned stands was undertaken to determine the impact of the ice on stand density, stand structure, wood formation, and tree survival. In addition, estimates were developed of the predictive power of pre-storm stand parameters to estimate the susceptibility of plantations to ice damage. Measurement parameters included tree diameters at d.b.h and at the point of breakage, pre-storm tree height and height to the point of breakage, height and length of live crown, percent of post-storm live crown missing (none, 25%, 50%, 75%, 100%), post-storm tree lean (none, 30, 60, 90 degrees, or uprooted), and pre-storm insect damage (none or present). Wood cores were obtained in 2002 and annual pre- and post-storm production of earlywood and latewood was determined. Results from the study will be presented and management implications will be discussed.

16 **USE OF A TREE GROWTH REGULATOR TO MANAGE VEGETATION NEAR OVERHEAD POWER LINES**

Thomas Hennessey*, Steven Mathews, Edward Lorenzi, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK; **Louis Anella, Janet Cole,** Department of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater, OK; **Mark Payton**, Department of Statistics, Oklahoma State University, Stillwater, OK

Utility companies spend millions of dollars annually to control vegetation in their rights-of-way to minimize disruptions in power delivery. Power outages increase substantially when trees are present. Aggressive tree trimming cycles are becoming very common for electric utilities, and may be mandated in the near future. Thus, cost-effective methods are needed to extend the length of time between trimming events (i.e., the trim cycle). We investigated the use of soil-injected Cambistat (paclobutrazol) on controlling the growth of five hardwood species commonly found in utility corridors in the southern U.S. We found branch growth was reduced for all species for three years, but five years after treatment most trees had resumed pre-treatment growth rates. Species did not differ in their response to treatment and soil type did not affect branch growth of treated trees. We conclude that paclobutrzol can be a useful tool to control the flush of branch growth that occurs after trimming, thus saving money and time spent on tree trimming during the following maintenance cycle.

17 **IMPACTS OF VOLUNTEER PINE SEEDLINGS ON PLANTED, GENETICALLY IMPROVED LOBLOLLY PINE PLANTATIONS**

A. Gordon Holley*, Ray A. Newbold, School of Forestry, Louisiana Tech University, Ruston, LA; **Michael A. Blazier**, Louisiana State University Ag Center Hill Farm Research Station, Homer, LA; **Eric L. Taylor,** Texas AgriLife, Extension Service, Overton, TX

Intra-specific competition from volunteer seedlings can necessitate the inclusion of pre-commercial thinning operations in loblolly pine (*Pinus taeda* L.) plantation management. In an effort to determine when pre-commercial thinning becomes necessary due to volunteer competition, a case study was established in northern Louisiana. Development of two stands under the stresses of controlled volunteer competition (100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, and 2000 trees per acre) was followed and evaluated from establishment to age 13. Under conditions of intensive site preparation and vegetation control, the genetically improved planted loblolly pine seedlings established themselves as the dominant stand component throughout the 13 growing seasons and showed little growth impacts due to the volunteers. Data will be presented.

18 **SILVICULTURE THAT SUSTAINS AND RESTORES NATIVE BIODIVERSITY OF LONGLEAF PINE GRASSLANDS: A LONG-TERM PROJECT EXAMINING LEGACIES, FIRE AND RECOVERY PERIODS**

Steven B. Jack*, **Robert J. Mitchell**, **Noah A. Jansen**, **Jason D. McGee**, Joseph W. Jones Ecological Research Center, Newton, GA

Longleaf pine (*Pinus palustris* Mill.) forests of the southeastern coastal plain are often managed for broad conservation objectives rather than primarily for timber production. In these instances, a management approach that utilizes ecological forestry principles – incorporating the concepts of disturbances, their ecological legacies, and adequate time for recovery – may be appropriate. While there are some long-standing operational examples of successful ecological forestry in this ecosystem, there are still many unanswered questions regarding response and recovery in longleaf forests following disturbances and silvicultural manipulations, and the mechanisms that control these responses. We established a long-term research project at the J.W. Jones Ecological Research Center at Ichauway to examine some of these questions. Specific topics addressed are: 1) how fuels and fire behavior respond to different patterns of overstory retention; 2) how the groundcover community recovers following harvest; and 3) how regeneration, and especially sapling-sized longleaf pine, responds to canopy manipulations and is recruited to the overstory. Silvicultural manipulations include single-tree selection, group selection, and groups with reserves in addition to control plots. Treatment plots, established in two different categories of groundcover (wiregrass versus *Andropogon* dominated), are 4 ha in size. All trees larger than 10 cm d.b.h were mapped in the plots, and various subplots were established to measure other characteristics (fuels, groundcover, and regeneration). Harvest treatments were implemented in November 2009 following extensive pre-treatment measurements, and post-treatment measurements are underway. We will provide an overview of the project objectives and study design, and will discuss some of the initial results.

19 **DEVELOPMENT OF A BALDCYPRESS PLANTATION OVER 22 YEARS**

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Few plantations of baldcypress (*Taxodium distichium* [L.] Rich.) have been established, and fewer still have been measured to determine optimum silvicultural practices. The lack of data for baldcypress growth and yield in plantation environments hinders development of effective management plans. This study was conducted on an experimental baldcypress plantation of varying replicated spacings established in 1983. We compare growth at ages 1, 5, 17, and 22 to better understand how baldcypress responds to competition in a plantation setting, and compare stand and tree development and structure against expectations based on stand density. Extrapolating height growth rates suggests base-50 site index is about 60-75. By age 22, the densest plots (289 trees per ac) were just achieving crown closure and standing volume was controlled by planting density. Live crown ratios were negatively correlated with density, suggesting crown competition is beginning at the expected threshold densities.

20 **ASSESSING THE LEANING, SINUOSITY AND BENDING OF SAPLING-SIZE TREES**

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Many factors, some obvious (for example weather conditions or animal damage) and others not (for example nutrient levels and genetics), result in trees whose stem straightness is not ideal and there have been many investigations into the causes of sinuosity and bending. However, an important prerequisite to these studies is an ability to assess the straightness of the stem. An ideal system would be easy to implement, objective, and result in an index that incorporates the essential characteristics of the deformity into a single number.
Since many field procedures can be subjective, our system minimizes the amount of field work to simply taking a photograph in the field. Each tree was photographed from the side showing its greatest deformity. A vertical height pole was placed at the base of each stem for scaling and alignment. Image analysis software was used to measure and record the characteristics that define the irregularity and calculate an index of deformity. This system was tested on trees completing their fifth growing season in a long-term study of the effects of container cavity size and copper coating on longleaf pine (*Pinus palustris* Mill.) planted on moderately well-drained, gently sloping soils in central Louisiana. In this study a small portion of trees are showing stem deformities that range from barely-noticeable to severe.

21 **EFFECT OF FIRE INTENSITY ON SHORTLEAF PINE SPROUTING**

Curtis J. Lilly*, Rodney E. Will, Charles G. Tauer, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK; **James M. Guldin, Martin A. Spetich**, USDA Forest Service, Southern Research Station, Arkansas Forestry Sciences Laboratory, Hot Springs, AR

During their first year, shortleaf pine (*Pinus echinata* Mill.) seedlings develop a basal crook that, once covered with duff and/or mineral soil, insulates dormant buds during fire. This ability to sprout from the basal crook following topkill may offer the potential to manage shortleaf pine advanced regeneration using fire. We examined the relationship between basal crook depth, maximum temperature during prescribed fire, and sprouting of shortleaf pine in the Boston Mountains of west-central Arkansas. Surface temperatures adjacent to approximately 200 seedlings were measured during prescribed fire using aluminum tags painted with 20 temperature indicating paints with melting points ranging from 75^{O}C to 575^{O}C. 'Simulated crooks' were built using aluminum tags and temperature indicating crayons and paints (55^{O}C to 150^{O}C) and calibrated to estimate the temperature experienced by dormant buds 2mm under the crook bark. The 'simulated crooks' were buried next to each seedling's crook. Prescribed fires were conducted on April 14th and 15th, 2010 and resulted in a wide range of seedling damage, from slightly charred stems to complete immolation. Thermocouples were used to measure crook temperatures on 32 seedlings for additional calibration during the fires. Post fire sprouting will be measured in June 2010 and will be correlated to fire intensity.

22 **RELATIVE MAXIMA OF DIAMETER AND BASAL AREA GROWTH**

Thomas B. Lynch*, Difei Zhang, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK

Although it has often been noted that diameter growth attains a maximum value at a younger age than basal area growth, it is of interest to provide a mathematical demonstration of this fact. This study shows mathematically that maximum diameter growth occurs at a younger age than maximum basal area growth for any diameter and basal area growth functions that are sigmoid in shape, continuous, and that have first and second partial derivatives. No particular mathematical equation for growth is assumed for this demonstration. However, examples using the Chapman-Richards equation are given. This presentation should be of interest to individual tree growth modelers who may need to develop diameter or basal area growth equations for individual trees.

23 **SYNTHESIS OF KNOWLEDGE OF HAZARDOUS FUELS MANAGEMENT IN LOBLOLLY PINE FORESTS**

Doug Marshall*, Department of Forestry and Natural Resources, Clemson University, Clemson, SC; **Michael Wimberly**, Geographic Information Science Center for Excellence, South Dakota State University, Brookings, SD; **Peter Bettinger**, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA; **John Stanturf**, USDA Forest Service, Athens, GA

This guide provides an overview of hazardous fuels management in loblolly pine (*Pinus taeda* L.) forests as well as a reference guide on prescribed burning and alternative fuel management treatments. Information is presented on treatment feasibility, approximate costs, and effects on soil, water quality, and wildlife. The objectives of fuel management in loblolly pine forests are to reduce the density of some targeted plant vegetation and change the structural condition of the forest. Prescribed burning is the most common tool for managing Southern fuels due to the low cost per acre and the ability to reduce fuel levels rather than rearrange them. Mechanical treatments can be effective in reducing wildfire risk by redistributing the fuels closer to the ground, creating a more compact fuel bed. Mulching (mastication) and chipping are the only common mechanical treatments in the South and are used as precursors to prescribed burning due to the rapid redevelopment of live fuels and higher treatment costs. Herbicide treatments are a realistic option as preliminary treatments to kill or suppress live fuels or following a prescribed burn or mechanical operation to kill resprouting woody species, but cannot replace prescribed burning or mechanical operations where dead fuels must be removed or repositioned closer to the ground. Although livestock grazing is no longer common in southern forests, grazing can be used to reduce certain types of live fuels. Wider impacts of fuel treatments are discussed for several social and ecological factors, such as soil erosion, water quality, wildlife, and public acceptability.

24 **TEMPORAL AND SPATIAL PATTERN OF PINE MORTALITY IN THE SOUTHEASTERN UNITED STATES**

Doug Marshall*, G. Geoff Wang, Department of Forestry and Natural Resources, Clemson University, Clemson, SC; **Joan Walker**, USDA Forest Service, Clemson, SC; **Soung-Ryoul Ryu**, Department of Renewable Resources, University of Alberta, Alberta, Canada

Past analyses of Forest Inventory and Analysis data has led to concerns about possible declines in pine stands in the Southeast. However, little was known about the accompanying spatial and temporal patterns or possible underlying causes. Given the large area of natural pine in the region, this project's goal is to develop management tools for monitoring and predicting forest health changes in pine-dominated stands at different spatial scales. At sixteen locations across the Southeast, plots were established in loblolly (*Pinus taeda* L.), slash (*P. elliotii* Engelm), or longleaf pine (*P. palustris* Mill.) dominated stands of various ages. For each plot, ground-based LAI photos were taken and their locations were recorded via GPS, with management history and site attributes also examined. The LAI photos were then used with aerial photos and satellite images (IKONOS and Landsat) to calibrate separate models. For the aerial photo model, a blue-red ratio specific to a pine species will allow LAI to be estimated in other aerial photos. For the satellite models, red-infrared relationships will perform similar roles. These models will provide land managers with the ability to monitor forest health at different spatial scales, with each model representing a compromise between scale, resolution, and cost. Furthermore, older photos and satellite images will allow long-term trends in forest health to be appraised and to determine if there have been declines in pine stands. If so, decline spatial and temporal patterns will be compared with management history and site attributes to improve predictive ability.

25 **CARBON SEQUESTRATION BY A 58-YEAR-OLD EASTERN WHITE PINE PLANTATION 13 YEARS AFTER THREE THINNING TREATMENTS**

W. Henry McNab*, USDA Forest Service, Asheville, NC

Eastern white pine (*Pinus strobus* L.)(EWP) has long been a desirable species for commercial timber production on low quality sites in the Southern Appalachians. Because of its longevity (>200 yr.), ability to develop dense stands (>200 ft^2 ac^{-1}), good response to thinning, low mortality, resistance to southern pine beetle, and high commercial value, EWP plantations may also have potential to be managed for carbon credits. I evaluated response of a 45-year-old EWP plantation on a low quality, upland hardwood site (oak SI=70 ft) to three thinning levels with respect to basal area and volume increment, and aboveground carbon sequestration. The 5-acre plantation was subdivided into three treatment plots and thinned to three levels: (1) control (0% basal area reduction), (2) light (50% reduction), and (3) heavy (67% reduction). After 13 years, net periodic basal area increment by treatment was 14%, 28%, and 36%, respectively (the unthinned control plot increased from 236 to 269 ft^2 ac^{-1}). Total carbon sequestration (estimated by the component analysis method, including stem wood harvested), by thinning treatment was 55, 55, and 51 tons ac^{-1}., respectively. Results of this exploratory study suggest that (1) thinning may not be needed to maintain growth of older EWP plantations and (2) thinning did not increase carbon stocks after 13 years

26 **30 YEARS OF PINE GROWTH ON RECLAIMED LIGNITE COAL MINE LANDS IN EAST TEXAS**

Christy L. Michaels*, Brian P. Oswald, Hans M. Williams, Kenneth W. Farrish, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX

Since 1980, Luminant Mining (formerly TXU Mining) has been establishing loblolly pine (*Pinus taeda*) plantations on reclaimed mine spoil lands at its Beckville and Tatum mine sites in Panola County, Texas. Stand density and growth (height and diameter) over time has been recorded for approximately 220 stands in six 5-year age categories. The results were compared to density and growth characteristics of loblolly pine plantations in east Texas managed with more traditional silvicultural treatments.

27 **IMPACT OF ICE DAMAGE ON OVERSTORY CANOPY STRUCTURE AND OAK REPRODUCTION ESTABLISHED FOLLOWING MIDSTORY REMOVAL**

David L. Parrott*, **John M. Lhotka, Jeffrey W. Stringer**, Department of Forestry, University of Kentucky, Lexington, KY

Damaging meteorological events such as ice storms can be seen as a hindrance to forest management since they can counter silvicultural treatments. However, disturbance due to ice events may have influenced forest structure historically throughout the eastern hardwood forest region. In this observational study, 1-0 bareroot white oak, black oak, and northern red oak seedlings grew for three years following a midstory removal treatment prior to the 2009 ice storm that removed a considerable amount of the overstory canopy. To monitor the impact of the ice event on canopy structure and the underplanted oak reproduction, we examined the resulting canopy density and height growth response of the underplanted seedlings in the growing season that followed the storm. We compared post disturbance height growth with average height growth across the previous four years. Ice damage reduced the once continuous canopy to approximately 50 percent canopy cover. Yearly height growth significantly increased ($p<0.05$) for white oak, black oak, and northern red oak. Average seedling growth went from 13.8 cm yr^{-1} prior to the disturbance to 25.3 cm yr^{-1} after the disturbance. The increased height growth suggest the underplanted seedlings were able to respond to the enhanced light environment created by the overstory damage after three years of growing in the diffuse light conditions created by a previous midstory removal treatment. Results display the potential benefit of some natural disturbances occurring in conjunction with silvicultural treatments that enhance development of oak reproduction and the historical role ice damage may have played in oak recruitment.

28 **ESTIMATING THE PROBABILITY OF SURVIVAL OF INDIVIDUAL SHORTLEAF PINE TREES**

Shrestha Sudip*, Thomas B. Lynch, Difei Zhang, Department of Natural Resource Ecology and Management, Oklahoma State University, Stillwater, OK; **James M. Guldin,** USDA Forest Service Southern Research Station

An individual tree survival model was developed for shortleaf pine (*Pinus echinata* Mill*.)* trees*.* Data for this study were from more than 200 permanently established plots on even-aged natural shortleaf pine stands that were located in the Ozark and Ouachita National Forests. Plots were established during the period of 1985-1987. Plots have been remeasured every 4, 5 or 6 years, and individual tree survival or mortality was recorded at each measurement. These plots were selected to represent a range of ages, densities and site qualities. Logistic regression was used to find the best sets of significant predictor variables in which the response variable was a binary variable '1' for the survival tree and '0' for the mortality tree. Significant variables found in predicting the survival were mid-period basal area per acre (Mid-BA), inverse of ratio of quadratic mean diameter to diameter at breast height (DBH) (DRINV), their interaction and square of DBH. Parameters of the logistic equation were estimated using iteratively re-weighted nonlinear regression. A nonlinear mixed-effects approach was also applied to investigate the plot level effect on the model. Model performance was evaluated using chi-square goodness-of-fit test, and it was found that the model worked better while estimating the parameters using iteratively reweighted nonlinear regression than with the nonlinear mixed model. This individual tree survival model can be used to predict the annual survival rate of individual trees of even-aged shortleaf pine forests located in Ozark and Ouachita National Forests and in the surrounding regions.

29 **AN OVERVIEW OF CELLULOSIC BIOMASS PRODUCTION RESEARCH BY THE ARKANSAS FOREST RESOURCES CENTER**

H. Christoph Stuhlinger*, Hal O. Liechty, David W. Patterson, Matthew H. Pelkki, Jamie L. Schuler, Philip A. Tappe, Arkansas Forest Resources Center, University of Arkansas, Monticello, AR

Economic, security, and environmental concerns related to energy production have focused attention on the development and production of cellulosic-based feedstocks. The Arkansas Forest Resources Center is currently addressing several aspects of feedstock production, including (1) biomass production and management, (2) biomass retrieval and operations, and (3) ecosystem services. Several studies to screen potential species and production systems have been implemented. Species being studied include several hardwood species and switchgrass. A clonal bank containing more than 80 clones has been established for the evaluation and screening of cottonwoods, hybrid poplars, and willows. Biomass harvesting, storage options, chip quality, and fuel values are also under investigation. Environmental dimensions of biomass production, such as soil, water, and wildlife habitat quality, are being examined in the context of different management systems.

30 **A COMPARISON OF HARVEST METHODS IN A BOTTOMLAND HARDWOOD FOREST: INITIAL OBSERVATIONS**

H. Christoph Stuhlinger*, Jamie L. Schuler, K. Kyle Cunningham, Arkansas Forest Resources Center, University of Arkansas, Monticello, AR

Bottomland hardwood forests can present unique management challenges for conducting intermediate and regeneration harvests. This replicated demonstration project will compare harvest techniques for stand improvement operations and methods of regeneration that are intended to favor oaks. Harvest techniques to be demonstrated include timber stand improvement, crop tree release, selection thin, shelterwood, and clearcut areas. Trees to be felled were marked during 2009, and treatment measurements were collected during 2010. Harvest is scheduled for summer 2010. Early observations will be presented.

31 **COMPARISONS OF IN-WOODS WOODY BIOMASS DENSIFICATION OPTIONS IN THE WESTERN GULF REGION OF THE UNITED STATES**

Eric L. Taylor*, Texas AgriLife, Extension Service, Overton, TX; **A. Gordon Holley**, School of Forestry, Louisiana Tech University, Ruston, LA; **Mike Blazier**, Louisiana State University Ag Center Hill Farm Research Station, Homer, LA, USA

In the Western Gulf region of the southern United States (Louisiana, southern Arkansas, southeastern Oklahoma, and eastern Texas) the most accessible and readily available sources of woody biomass include harvest residues and non-utilized, small diameter trees collected from thinning and fuel reduction treatments. Significant woody biomass is also available from relatively frequent extreme weather events (e.g., hurricanes).

A major hurdle in utilizing this scattered, low bulk material exists with economically handling, transporting, and delivering the woody biomass feedstock to a centralized biomass utilization facility. As a result, several options exist or are theorized to comminute biomass into a form that can be efficiently transported to a centralized location. These included the common pre-processing operations of chipping, grinding or shredding. Woody biomass may also be compacted into cylindrical bales or bundles that may be handled similarly to roundwood. In-woods “prefining” through mobile pyrolysis units can also densify bulky, low-value forest biomass into higher-value, low bulk feedstocks for the energy and chemical industry. The objective of this study is to provide a feasibility comparison of in-wood preprocessing activities to densify woody biomass feed stocks in the Western Gulf region.

32 **A MIXED-EFFECTS HEIGHT-DIAMETER MODEL FOR COTTONWOOD IN THE MISSISSIPPI DELTA**

Curtis L. VanderSchaaf, Texas Forest Service, College Station, TX; **H. Christoph Stuhlinger***, Arkansas Forest Resources Center, University of Arkansas at Monticello, Monticello, AR

Eastern cottonwood (*Populus deltoides* Bartr. ex Marsh.) has been artificially regenerated throughout the Mississippi Delta region because of its fast growth and is being considered for biofuel production. This paper presents a mixed-effects height-diameter model for cottonwood in the Mississippi Delta region. After obtaining height-diameter measurements from the plot/stand of interest, a mixed-effects model can be calibrated often improving height estimates relative to an uncalibrated fixed-effects model. When using an independent validation dataset, the calibrated mixed-effects height-diameter model vastly improved height predictions compared to a completely fixed-effects model. When using only one tree in calibration, bias decreased from -1.1159 m to -0.4269 m while the mean square error (MSE) decreased from 1.9102 to 0.4621 for the fixed-effects and mixed-effects models, respectively. When using three trees in calibration, the bias and MSE were reduced to -0.2660 m and 0.2181, when using 10 trees in calibration, bias was nearly eliminated (-0.1165 m).

33 **INTENSIVE FOREST MANAGEMENT MAY REDUCE TIME REQUIRED TO SAMPLE PLANTATIONS**

Curtis L. VanderSchaaf, Texas Forest Service, College Station, TX; **Dean W. Coble,** Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX; **David B. South***, School of Forestry and Wildlife Sciences, Auburn University, AL

Reducing the amount of inherent variability among tree diameters, heights can reduce the number of points/plots needed to obtain a desired precision when conducting plantation inventories. We present a simple analysis examining the potential reduction in sampling time requirements when assuming advanced silviculture will reduce inherent stand variability (due to combining superior genetic stock with intensive site preparation). We examine the effect on net present value when assuming the coefficient of variation in sample point estimates will be reduced from 25% to 10% (as a result of planting more uniform genotypes with more intensive management). With this level of improvement in uniformity (and depending on discount rate, the desired probability, allowable percent error, and stand age/size) the number of sampling points per acre could be reduced by 67% or more. This reduction in time might lower costs associated with inventory.

34 **THE IDENTIFICATION AND CORRELATION OF THE COMPETITIVE INFLUENCE OF CHINESE TALLOW ON MORPHOLOGICAL AND PHYSIOLOGICAL ATTRIBUTES OF ARTICIALLY REGENERATED HARDWOOD SPECIES**

Keith R. Dailey, Levi B. Gibson, Hans M. Williams*, Warren C. Conway, Brian P. Oswald, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX

Since its introduction in the mid-18th century, Chinese tallow tree (*Triadica sebifera* (L.) Small [Formerly *Sapium sebiferum* (L.) Roxb.]; *Triadica* hereafter) has spread to form monospecific stands. In many cases, Triadica replaces native species in a particular area. Because of this, research is needed to determine the competitive influence of *Triadica* on desired native species.

In 1996, a wetland mitigation study identified the control of *Triadica* during site prep in southeast Texas. However, the long-term effects of *Triadica* competition have yet to be identified. This study uses a novel approach at quantifying the competitive influence of *Triadica* on artificially regenerated hardwood species on a wetland mitigation area. Using ESRI ArcInfo® 9.3, each Triadica stem is plotted respectively to a hardwood species used as plot center for a 1/100th acre plot. Each tree, the plot center artificially regenerated hardwood and the *Triadica*, will have a buffer area placed using ArcInfo ® 9.3 using the predetermined BAF. The area of overlap can then be determined through geometry calculations in ArcInfo® 9.3, and the competition quotient can then be compared across plots and sites. The area of overlap will be assumed to be the competitive ability of the tree. Regression analysis will be employed to study relationship between the competition quotient, as the independent variable, and my dependent variables. The morphological dependent variables will be DBH, height, crown width, live crown ration, and height to first live branch.

35 **EFFECTS OF PRESCRIBED BURNING TO RESTORE A LONGLEAF PINE GRASSLAND ON BREEDING BIRD POPULATIONS ON THE TALLADEGA NATIONAL FOREST, AL**

Daniel Wright*, Robert Carter, Department of Biology, Jacksonville State University, Jacksonville, AL

The study area consisted of twelve sites with experiencing burn treatments of 1 year, 2 year, 5 year and 15+ year control sites. Point surveys for breeding birds were conducted in late May when breeding males are most active. Species common in the 1 and 2 year burn area were prairie warbler (*Dendroica discolor*), yellow-breasted chat (*Icteria virens*), and indigo bunting (*Passerina cyanea*). Red-cockaded woodpeckers (*Picoides borealis*) were not uncommon in the study area. Present but uncommon was Bachman's sparrow. In the 5 and 15+ treatment sites common species included yellow-throated vireo (*Dendroica dominica*), summer tanager (*Piranga rubra*), and Eastern wood peewee (*Contopus sordidulus*). The open grassy habitat in the 1 and 2 year burn treatments should support larger populations of Bachman's sparrow. It is plausible that a larger fire return interval is required to produce ideal Bachman's sparrow habitat.

36 **PATTERNS OF GENETIC VARIATION IN A LONGLEAF PINE POPULATION: A LONG-TERM FIELD STUDY OF A 13-PARENT DIALLEL CROSS**

James E. Grissom, Steven E. McKeand*, Fikret Isik, North Carolina State University, Raleigh, NC; **James H. Roberds, C. Dana Nelson**, USDA Forest Service, Saucier, MS; **Michael Stine**, Tallahassee, FL; **Randall Rousseau,** Mississippi State University, Starkville, MS

Genetic and environmental effects on growth were quantified in a population of longleaf pine (*Pinus palustris* Mill.) full-sib families growing over 45 years on two sites in southern Mississippi. This long-term field experiment is unique for longleaf pine, a tree species of renewed interest and wide reforestation in the southern United States. A strong genetic basis, coupled with superb silvicultural management of the sites, allowed us to successfully partition the genetic components and environmental components of variation in terms of growth and survival traits.

The genetic foundation of this experiment consists of progenies produced by making all possible crosses among 13 parent trees in a diallel mating scheme. The parent trees were randomly chosen from a natural, open-grown longleaf pine stand located on the Harrison Experimental Forest near Saucier, MS. At establishment, the experiment consisted of plots for 76 full-sib families of the 78 required for a complete half-diallel array of crosses plus plots representing open-pollinated progeny for each parent tree. Tests at each site were installed in a randomized complete block design made up of eight-tree family row plots arranged in four replications. Growth data were collected for all trees at various stages of stand development, including ages 3, 7, 17, 30, and 40 years.

We found evidence of substantial genetic variability in growth among these longleaf pine families. Specific results of age-related, stand development trends and genetic parameters will be presented.

37 **QUANTIFYING SOIL RESPIRATION RATES AND THE EFFECT OF SITE DISTRUBANCE IN TWO NORTH CAROLINA PLAIN LOBOLLY PINE PLANTATIONS**

Michael Gavazzi*, Steve McNulty, Emrys Treasure, USDA Forest Service, EFETAC, Raleigh, NC; **Asko Noormets**, North Carolina State University, Forestry and Environmental Resources, Raleigh, NC

North Carolina's coastal plain in characterized by inland areas with deep organic soils that store up to 80 kg carbon per square meter. Much of this area has been converted from bottomland hardwoods to loblolly pine plantations through intensive management, including ditching and bedding. While these practices encourage rapid pine growth and shorter rotations, their impact on soil respiration rates have not been fully quantified. In 2005 we began measuring soil respiration on two sites near Plymouth, NC to assess the effect of forest management on soil respiration rates. One site had been in active pine management for over 50 years, with the current rotation recently thinned, and the other site had been converted from a bottomland hardwood forest to a pine plantation. Soil respiration rates averaged 150% higher on the recently converted site compared to the older pine site for the first two years of measurements. There was no statistical difference in soil respiration rates between the two sites over the next three years, a period with two years of extreme drought. Results indicate that soil respiration rates can be strongly affected by forest management practices, especially site conversion, ditching and bedding; however the period of increased soil CO_2 efflux due to site disturbance may last only a few years.

38 **EFFECTS OF VARYING RIPARIAN BUFFER WIDTHS ON C AND N POOLS AND INPUTS AFTER TIMBER CUTTING IN SOUTHERN APPALACHIAN HEADWATER CATCHMENTS**

Barton D. Clinton*, James M. Vose, USDA FS, Southern Research Station, Coweeta Hydrologic Laboratory, NC

Carbon and nitrogen pools and inputs were assessed before and after timber harvest in southern Appalachian headwater catchments. Four first-order catchments were selected for study. Three riparian buffer widths were delineated prior to cutting; 0-m (no-buffer), 10-m, and 30-m, and a reference. Two-age timber harvesting was conducted on all treatment sites. Line transect method was used at 0, 10, 20, 30, 40, and 50-m from the stream for CWD estimates. Forest floor was sampled along four transects running perpendicular to the stream at intervals of 0, 1, 4, 7, 10, 20, 30, and 50-m on each site. Samples were separated into small wood (< 7.5-cm), litter and humus. Litter fall was collected bi-weekly on each site along four transects at 10-m intervals. Pre-harvest woody debris mass, C, and N decreased and forest floor mass, C, and N increased with distance from the stream. Following harvest, CWD mass, C and N increased; litter and humus mass, C and N decreased substantially. Overall, litter fall quality (N content) decreased with distance from the stream prior to harvest, and total litter production decreased on average from 68% to 93% across sites the first year after harvest. Harvest resulted in substantial shifts in the distribution of mass, C and N along the stream to upland gradient.

39 **DECOMPOSITION OF LOBLOLLY AND ASPEN STAKES AT THE CROATAN NATIONAL FOREST LONG TERM SOIL PRODUCTIVITY SITE**

Robert Eaton*, USDA Forest Service, Durham, NC; **Deborah Page-Dumroese**, USDA Forest Service, Moscow, ID; **Brian Forschler**, University of Georgia, Athens, GA; **Brad Kard**, Oklahoma State University, Stillwater, OK; **Marty Jurgensen**, Michigan Technical University, Houghton, MI

The Long Term Soil Productivity (LTSP) experiment is a United States Forest Service effort to test the effects of organic matter removal, soil compaction, and competition control on forest soil productivity. Studies have shown a positive relationship between the rate of organic matter decomposition and site productivity. Stakes of loblolly pine (*Pinus taeda*) and aspen (*Populus tremuloides*) were placed in selected treatment plots on the LTSP site on the Croatan National Forest in the coastal plain of North Carolina. Bare and meshed wrapped stakes were placed on the surface of the forest floor, at the interface of the forest floor and mineral soil, and buried vertically in the mineral soil. Mass loss and extent of termite attack on the stakes are used to estimate decomposition rates. Treatment effects on decomposition rates and incident of termite attack from three sampling periods will be presented.

40 **WHOLE-CANOPY GAS EXCHANGE AMONG ELITE LOBLOLLY PINE FAMILES SUBJECT TO DROUGHT STRESS**

Wilson Hood*, Michael C. Tyree, Dylan N. Dillaway, School of Forestry, Louisiana Tech University, Ruston, LA; **Michael Blazier**, Louisiana State University Ag Center Hill Farm Research Station, Homer, LA; **Mary Anne Sword Sayer**, USDA Forest Service, Southern Research Station, Pineville, LA

Future climate change models predict that the southeastern United States will experience hydrologic patterns similar to that currently in the Western Gulf Region. Additionally, elite loblolly clones planted in the southeast as well as those currently planted further west will be subject to dry, hot summers, and there is little research on how these fast growing pines will perform. The objectives of this study are to measure specific leaf net CO_2 assimilation and transpiration among four elite loblolly pine families from May to September 2010. Four families of four-year-old loblolly pine are planted in 0.2-acre plots (n =3). All families are from Atlantic seed sources with two representing compact crown (7-56 and CL93) and two representing broad crown (8-103 and 9) ideotypes. Preliminary fine-root data suggest that there are substantial differences in fine-root area between elite families that may further lead to differences in productivity under drought stress. Measurements of specific leaf area and relationships between DBH and biomass partitioning determined by destructive harvest will be used to calculate whole-canopy gas exchange among treatments. Changes in whole-canopy gas exchange over increasing levels of drought stress, as determined by midday leaf water potential and soil water potential, will be observed for each family. Results of whole-canopy gas C capture, water loss, and water use efficiency will be compared among family.

41 **POPULUS SPECIES AND HYBRIDS FOR USE ON BOTTOMLAND AND UPLAND SITES IN THE SOUTH**

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The development of a variety of woody biomass species and hybrids in the South will be necessary to meet the bioenergy and biofuel goals set by the United States. Populus species, such as eastern cottonwood (*Populus deltoides* Bartr.), have been shown to produce significant amounts of biomass, when grown on suitable bottomland alluvial sites in the Lower Mississippi Alluvial Valley (LMAV). However, when moved offsite this species easily stagnates following crown closure. Although a wide variety hybrid poplar taxons have been tested on LMAV sites the results were very similar with near complete mortality from Septoria stem cankers. Breeding of new hybrids using more current selections of various species could provide disease resistance and greater site adaptability. Hybrid aspen species have shown potential on upland sites in Kentucky and Tennessee. Increased testing of these hybrids on upland sites across the South may prove extremely beneficial.

42 **PHOTOGRAPHIC ESTIMATION OF CANOPY CLOSURE IN BROADLEAF DECIDUOUS FORESTS DURING WINTER**

Daniel J. Twedt*, Andrea J. Ayala, Madeline R. Schickel, U. S. Geological Survey, Vicksburg, MS

We estimated canopy closure, percent light transmission, and leaf area index within broadleaf deciduous forests in Mississippi and Louisiana during summer (leaf-on) and during winter (leaf-off). Assessments were made using Gap Light Analysis of hemispherical photographs that were obtained during repeated visits to the same locations. Forest types evaluated included: an unmanaged mesic upland forest, a managed bottomland hardwood forest after partial harvest, and hardwood plantation forests before and after partial harvest. To provide a means of predicting leaf-on canopy conditions when only data from leaf-off conditions are available, we used linear regressions to evaluate the relationships between summer and winter measurements for canopy closure, light transmission, and leaf area index.

February 17, 2011 Field Tour Information

Field Tour 1: High-Yield Forestry Field Tour
Location: Arborgen facility in Summerville, SC
Tour Guide: Phillip Dougherty, Arborgen, Summerville, SC

This tour will examine state-of-the-art intensive management of loblolly pine (*Pinus taeda*). Different stops during the tour will discuss changing genetics in southern forestry, new silvicultural systems for producing biomass and saw timber, using varietals in mixed biomass – saw timber Flex stands, stand carbon sequestration potential using varietals under advanced silviculture systems, and the future for intensive pine plantation silviculture and tree improvement in the Southeastern United States.

Field Tour 2: Silvicultural Systems in the Lower Coastal Plain
Location: Francis Marion National Forest and the Santee Experimental Forest
Tour Guide: Carl Trettin, USDA FS SRS, Center for Forested Wetlands, Cordesville, SC

This tour will examine the development, application and effectiveness of silvicultural systems in the lower Coastal Plain that are designed to deal with the dense stands which regenerated stands after Hurricane Hugo and the complexities of multiple management objectives in the wildland-urban interface. A variety of pre-commercial and commercial thinning, and harvesting prescriptions that are used in combination with prescribed fire will be shown in different landscape settings. Discussions will capitalize on research and monitoring as a basis for considering the effectiveness of the treatments, including effects on hydrology, water quality, carbon cycling, vegetation, and wildlife. The tour will be conducted on the Francis Marion National Forest and the Santee Experimental Forest, which provide excellent examples of Coastal Plain forests and silviculture.

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