Southern Forest Research Partnership, Inc.

Forestry Research in the South

MAY 1, 2011

Carbon & Forest Biomass

Carbon Management and Forest Biomass Center of Excellence

In 2010, the Southern Forest Research Partnership realigned our work strategies and developed six Centers of Excellence to better represent our members' research and research capacity. The Carbon Management and Forest Biomass Center of Excellence was one of the first created due to the importance and need for coordinated research activity in this area.

Carbon management and forest biomass have been important functions and contributors to forested landscapes for centuries, but renewed interest and public policy debates have increased the need for additional research and study. Collectively, the following research contributes immensely to allowing informed decisions at the biological, management and policy level.

The overviews have been constructed by each institution and the intent is to give you a brief snapshot of current and recent research on the topic. For more in-depth information, please contact the researchers directly.

FIRST QUARTERLY FORESTRY RESEARCH IN THE SOUTH

We are pleased to bring you the first quarterly publication in a new series titled "FORESTRY RESEARCH IN THE SOUTH" where we will be highlighting activity of SFRP members each quarter, based upon our ***Centers of Excellence.*** The intent is not to be an extensive literature review of each issue area, but more an opportunity for each research institution to highlight research and activity they feel is of interest to research consumers and help to better understand where additional research opportunities or needs may reside. The six SFRP Centers of Excellence are: ***Carbon Management and Forest Biomass, Forest Biodiversity, Forest Finance and Policy, Forest Water Quality and Yield, Forest Health Management and Forest Productivity and Products.***

The Southern Forest Research Partnership serves as a forum to help facilitate necessary research directly between our membership and research consumers.

- Carbon Market Financial Returns
- Carbon Storage in Roots
- Cell Based Stratification
- New vs Old Carbon
- Biomass Environmental Effects
- Hardwood Biomass Recovery
- Private Land Biomass Potential

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Agroforest Systems for Bioenergy Crop Production and Ecosystem Services

Our goal is to develop economically and ecologically sustainable agroforest systems for producing dedicated cellulosic bioenergy crops on marginal agricultural land in the Lower Mississippi Alluvial Valley (LMAV). To accomplish our goal, we established agroforest systems composed of alley cropped mixtures of cottonwood trees (*Populus deltoides* L.) and switchgrass (*Panicum virgatum* L.) as well as pure stands of cottonwood and switchgrass at three sites which have soils with low potentials for growing conventional row crops. These sites are located along the LMAV from northeast Arkansas through northeast Louisiana. Biomass production, fuel characteristics, carbon sequestration (above and belowground), greenhouse gas emissions, nitrogen retention, and small mammal population dynamics are being monitored at each site and cropping system. Second year yields of switchgrass averaged between 1 -3 oven dry tons/ac. Initial productivity of the cottonwoods has been less than that of the switchgrass. Initial harvests of cottonwood are planned at the end of the fifth growing season of the study.

Hal O. Liechty, Matthew Pelkki, and Donald White; University of Arkansas-Monticello

"FERTILIZATION HAD A POSITIVE BUT NOT SIGNIFICANT IMPACT ON ABOVEGROUND BIOMASS."

COMPARISON OF FEEDSTOCKS GROWN WITH AND WITHOUT FERTILIZATION

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 questions concerning biomass yields and sustainability of these sites, a study was installed in 2009 to compare three SRWC species on marginal cropland in eastern Arkansas. Black willow, eastern cottonwood, and American sycamore were established on plots with and without fertilization. Trees were planted at 8 x8 ft spacing in roughly 0.25 ac plots. Measurements include diameter, height, aboveground biomass, and coarse and fine root biomass. Soil carbon is also being monitored on each plot. Preliminary results (year 1) indicate that American sycamore achieved the greatest aboveground biomass on both fertilized and unfertilized treatments. Fertilization had a positive but not significant impact on aboveground biomass.

Jamie L. Schuler, University of Arkansas-Monticello

CHARACHTERIZATION OF IN-FOREST WOODY BIOMASS

In-forest biomass residues were studied through five examples of harvesting/ collection operations in South Arkansas, 2 chipping operations and 3 grinding operations. Particle size distribution, moisture content, Btu value and ash content were determined from samples taken. On average, IFR characteristics were 87% MC (dry weight basis), 7945 Btu/lb and 3.1% ash content.

Starr Environmental—

Matthew Pelkki, , University of Arkansas-Monticello

EVALUATING CARBON MARKET FINANCIAL RETURNS

Karen Rawlins—bugwood.org

The financial impacts of carbon sequestration on three different models of pine management are being examined by the Arkansas Forest Resources Center. Historical inventory data that provide stand and stock tables for multiple stands over extended time periods on uneven-aged, natural even aged, and plantation pine in South Arkansas. A consistent yield equation was applied to the data to determine pulpwood and sawtimber yields and carbon sequestration rates for above- and below ground live carbon as well as carbon stored in long-lived wood products (LLWP). Various carbon trading rules are being applied to determine the effects of differing carbon pools allowed for trading, carbon contract length, carbon reserve buffer definition and pricing, carbon market prices, and interest rates. Preliminary results show that carbon markets can provide added value to all forms of pine management, with additional returns of $136/ha for uneven aged stands, $400/ha for natural even-aged stands, and $672/ha for pine plantations. Carbon returns are increased by initiating carbon contracts early in even-aged rotations and by including the value of carbon sequestered in wood products in the carbon trading pool.

Matthew Pelkki and Jamie L. Schuler, University of Arkansas-Monticello

"CARBON RETURNS ARE INCREASED BY INITIATING CARBON CONTRACTS EARLY IN EVEN-AGED ROTATIONS "

METHOD TO ESTIMATE C STORAGE IN DECAYING ROOTS

Mary Ann Fajvan

Decaying root systems of harvested trees can be a significant component of below-ground C storage, especially in intensively managed forests where harvest occurs repeatedly in relatively short rotations. We have developed a method to estimate C storage in decaying roots due to timber harvest based on published data. Using this method, we estimated that the amount of C stored in decaying roots of loblolly-shortleaf pine forests in South Carolina, harvested between 1995 and 2005, was 7.09 Tg. We are currently developing a method to estimate C stock in decomposing roots resulted from natural mortality based on published data.

Geoff Wang; Clemson University

"OVERSTOCKED YOUNG LOBLOLLY PINE STAND MAY CONTAIN A LARGE QUANTITY OF BIOMASS, A POTENTIAL FEEDSTOCK FOR ENERGY"

BIOMASS PRODUCTION OF OVERSTOCKED LOBLOLLY PINE STANDS

Across the southeast region, natural regeneration or planting with volunteer natural regeneration often results in very dense loblolly pine stands. Management of these stands requires pre-commercial thinning, which is often cost-inhibitive to many landowners. However, overstocked young loblolly pine stand may contain a large quantity of biomass, a potential feedstock for energy. We are currently studying biomass production of overstocked young loblolly pine stands as well as silvicultural practices that may facilitate biomass production and harvest at Clemson Experimental Forests.

David Stephens—bugwood.org

Geoff Wang; Clemson University

SOUTHERN PINE CLIMATE CHANGE MITIGATION AND ADAPTATION

Karen Rawlins
Bugwood.org

The overarching goal of this project is to create, synthesize, and disseminate the knowledge necessary to enable southern pine landowners to harness forest productivity to mitigate atmospheric CO_2, more efficiently use nitrogen and other fertilizer inputs, and to adapt their forest management approaches to increase resilience in the face of changing climate. Our focus is on planted pine forests in the Atlantic and Gulf coastal states from Virginia to Texas, plus Arkansas and Oklahoma, managed by industrial and non-industrial private landowners. We will integrate disciplinary expertise from all major regional university forestry cooperative programs, as well as accumulated data, germplasm, and infrastructure, with outreach and education specialists from major research universities and minority-serving institutions in the region, the USDA Forest Service, and climate scientists associated with the multi-state SE Climate Consortium and state climate offices. Project duration: March 1, 2011 – February 28, 2016

Timothy A. Martin, University of Florida School of Forest Resources and Conservation

DEVELOPING TOOLS FOR ECOLOGICAL FORESTRY AND CARBON MANAGEMENT IN LONGLEAF PINE

The Department of Defense's Strategic Environmental Research and Development Program (SERDP) identified a need for basic and applied research that supports the transition of DoD forest management toward an ecological forestry model that will balance military mission support with the maintenance of native biodiversity, sustainable yield of forest products, and enhancement of forest carbon sequestration with a view toward offsetting facility carbon emissions. Our goal is to develop the research knowledge necessary to meet this need through the creation of a carbon management model that can be used by DoD to facilitate optimal allocation of resources to improve integrated natural resource management plans designed to restore native longleaf pine ecosystems, protect the environment, manage carbon and maintain flexibility in mission training.

The overall goal of this project is to complete the development of an even-aged longleaf pine model and a single-tree longleaf pine stand model that can accurately and robustly simulate carbon dynamics in response to the range of management actions that occur on DoD bases across the longleaf pine range, including calibration with extensive field measurements and validation.

Karen Rawlins
Bugwood.org

PI: Lisa Samuelson (Auburn University) Co-PIs: Tim Martin, Wendell Cropper (University of Florida), Kurt Johnsen (USFS SRS)

"...LONGLEAF PINE STAND MODEL THAT CAN ACCURATELY AND ROBUSTLY SIMULATE CARBON DYNAMICS IN RESPONSE TO THE RANGE OF MANAGEMENT ACTIONS "

CELL BASED STRATIFICATION

Perceived profits from the application of Precision Forestry techniques and the quantification of forest carbon credits have increased the desire for spatially explicit forest inventories. Since in a typical forest inventory not every stand is sampled and averages are used to characterize those that are, such inventories are spatially explicit only above the scale of collection. In these cases, no attempts are made to characterize the variation in the spatial distribution of the trees within the stand. Meaning that within a stand the average conditions described in the inventory may not exist, even if that stand was sampled.

Remotely sensed imagery offers the advantage of providing information from all points of the sampled region. This information can be correlated to the desired forest metrics and estimates made for all sampled portions of the landscape. Cell-based stratification leverages the advantages of remotely sensed imagery and works by dividing the area of interest into small spatially contiguous areas, cells. An initial sample is placed within the cells to develop models that are used to ensure that the full meaningful range of conditions are represented in the final sample. Predictions of the forest metrics of interest are made for each cell based on the initial sample. These initial predictions are used to non-spatially stratify the cells for a final sampling. The final sample is conducted and the data modeled for the relationship of the forest metrics to the remotely sensed data.

Ultimately, predictions are made for each cell based upon the final sample and may be aggregated to spatial regions of interest. Being cell based they retain their spatial location thus reducing the spatial granularity of the final estimate and increasing understanding of variation within management units.

"THIS REMOTE SENSING DRIVEN FOREST STRATIFICATION AND SAMPLING APPROACH HAS THE POTENTIAL TO BOTH REDUCE THE COSTS OF INVENTORY AND INCREASE THE ACCURACY AND PRECISION OF THE RESULTING INVENTORY ESTIMATES"

Application to the Garcia River forest

The use of Light Detection and Ranging data (LIDAR) and color-infrared imagery (CIR) is a well established approach to estimating forest parameters spatially. One challenge to using LIDAR data is finding ways to cost-effectively apply this data to typical forest management activities at the landowner scale. A new method is proposed to create a forest stratification based on LIDAR and CIR paired with plot data to partition the variability of forest structure. This approach provides a flexible means to rapidly measure and monitor any forest variable of interest and can be applied across a wide range of scales using the best data available.

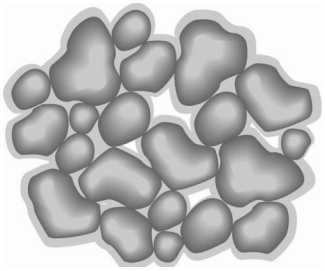
In the first step of the stratification process an initial grid size is chosen and overlaid on the forest. An unsupervised classification of this preliminary grid based on each grid cell's aggregated remote sensing data is calculated using Independent Component Analysis. This initial stratification is then used to locate an initial set of plot locations randomly within each strata. This initial set of plots is then used to develop regression models that relate remotely sensed data to plot level data. Lastly, the regression models are used to find estimates of the parameters of interest within each grid cell and these estimates are then used to create a final supervised stratification of the forest using a Tabu Search optimal binning heuristic.

This forest stratification and sampling method have been applied to a 24,000 acre redwood (*Sequoia sempivirens*), Douglas-fir (*Pseudotsuga menziesii*), and tanoak (*Lithocarpus densiflorus*) forest located in Mendocino County, CA. The strata developed by this approach explained a significant proportion of the forest variation and allowed for more accurate inventory estimates with half as many plots as the existing traditional stand-based inventory used on this property.

The grid based approach to forest stratification allows for efficient management of forest inventory data and a flexible and powerful planning approach for harvest projection and habitat classification. For large forest ownerships, this remote sensing driven forest stratification and sampling approach has the potential to both reduce the costs of inventory and increase the accuracy and precision of the resulting inventory estimates. **Dr. Mark L Hanus- Senior Biometrician**

DISTINGUISHING "NEW" FROM "OLD" ORGANIC CARBON ON RECLAIMED COAL SITES

Reclaimed coal mine sites represent a potential terrestrial carbon (C) sink. However, there is currently no cost-effective, rapid, and reliable method to quantify soil organic matter (SOM) accumulation in soils containing appreciable quantities of coal and carbonate media. A thermogravimetric (TG/DTG) method was evaluated as a potential analytical tool for differentiating C in spoils that may contain both recently derived ("new") and ancient ("old") C fractions. Grass litter and coal were used to represent "new" and "old" organic C respectively and limestone to represent the carbonate fraction. TG/DTG (derivative thermogravimetry) curves showed pyrolysis peaks at distinctively different temperatures. Petrographic analysis was used to validate TG/DTG findings. Results indicate that organic petrography can be a useful approximation of "new" organic C but it may be limited by particle density differences and time constraints. Thermogravimetry appears to be the superior of the two methods as it proved to be a more cost-effective, rapid, and direct method for differentiating and quantifying C. **S. Maharaj, C. D. Barton, A.D. Karathanasis, H. D. Rowe, S. M. Rimmer; University of Kentucky**



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Bugwood.org

"A MORE RELIABLE, COST-EFFECTIVE, AND RAPID MEANS TO DETERMINE THE NEW ORGANIC C FRACTION IN MIXED GEOLOGICAL MATERIAL"

QUANTIFYING SEQUESTRATION OF "NEW" CARBON IN REFORESTED COAL MINE SITES

Thermogravimetry (TG/DTG) was used under laboratory conditions to differentiate "new" and "old" organic carbon (C) by utilizing grass litter, coal, and limestone to represent the different carbon fractions. TG/DTG curves showed pyrolysis peaks at distinctively different temperatures with the peak for litter occurring at 270-395 ^{o}C, for coal at 415-520 ^{o}C, and for limestone at 700-785 ^{o}C. To validate this method in a field setting, we studied four reforested coal mine sites in Kentucky representing a chronosequence since reclamation. Results suggest that stable isotopes and elemental data can be used as proxy tools for qualifying soil organic carbon (SOC) changes over time on the reclaimed coal mine sites but cannot be used to determine the exact SOC accumulation rate. This suggested that the TG/DTG method can be used as a metric for SOC accumulation quantification as it has the potential to be more a more reliable, cost-effective, and rapid means to determine the new organic C fraction in mixed geological material, especially in areas dominated by coal and carbonate material. .

Maharaj, C. D. Barton, A.D. Karathanasis, H. D. Rowe, S. M. Rimmer; University of KY

CARBON SEQUESTRATION ON REFORESTED MINELANDS IN APPALACHIA

Research to address mechanisms by which atmospheric concentrations of CO_2 may be reduced is of global significance. Reforestation of abandoned and previously reclaimed minelands has been identified as a method for increasing terrestrial C sequestration. A chronosequence approach was initiated to evaluate carbon accumulation on mined sites. A whole-tree harvesting method was employed for this approach where trees were extracted and soils sampled. Four tree species: Sycamore, White Ash, White Oak, and Yellow Poplar, representing 3 age classes (2, 3 and 7 years of age) on loose spoil material were examined. The C contents in trees varied by tree age and tree species. This study showed that successful reclamation and reforestation of mined sites will largely restore the potential of forests and forest soil systems to sequester carbon at pre-mining levels. **C.D. Barton, B.J. Koo, S. Maharaj, and D.H. Graves; University of KY**

DEMONSTRATING TECHNIQUES FOR ESTABLISHING WOODY BIOENERGY PLANTATIONS ON RECLAIMED SURFACE MINED LANDS

Short rotation woody biofuel plantations on reclaimed surface mines in Appalachia can diversify domestic energy supplies and facilitate the reforestation of these disturbed lands. This study examined growth, survival, biomass accumulation and allocation, and nitrogen concentrations following two growing seasons in American sycamore and black locust seedlings receiving irrigation, granular fertilization, and irrigation + fertilization compared with untreated controls. Fertilization increased basal diameter, height, and stem mass of American sycamore following two growing seasons. Increased stem production was attributed to accelerated development and not shifts in biomass allocation due to treatment. Irrigation and irrigation + fertilization treatments did not enhance growth or biomass accumulation of American sycamore. Similarly, black locust basal diameter, height, and stem mass did not differ among the treatments. Browse surveys showed that more than 76% of black locust seedlings experienced arrested or retrogressed growth due to browse; less than 3% of American sycamores were browsed. Survival was unaffected by treatment in both species, but mean survival was greatest in American sycamore compared to black locust. Per tree total nitrogen uptake was highest in fertilized American sycamore and lowest in irrigated American sycamore. The results of our study suggest that granular fertilizer applications can accelerate seedling growth on reclaimed surface mines in the Appalachian region.

Christopher D. Barton, John M. Lhotka, Richard C. Warner, Carmen T. Agouridis, Songlin Fei, and Joshua S. Brinks; University of Kentucky

"GRANULAR FERTILIZER APPLICATIONS CAN ACCELERATE SEEDLING GROWTH ON RECLAIMED SURFACE MINES IN THE APPALACHIAN REGION"

CYCLING AND DISTRIBUTION OF CARBON ON RECLAIMED MINELANDS

Increasing C storage in soils of degraded lands, such as surface mine lands, is of interest because of its potential role in reducing atmospheric CO_2. While it has been shown that reforesting degraded lands can significantly increase carbon storage in soils, there are limited studies addressing what biological and chemical processes control soil carbon in these systems. The objectives of the study were to 1) quantify the amount of soil C accumulating on reforested minelands, and 2) examine several ecosystem processes that govern the amount of C sequestered into soil organic matter (decomposition, soil respiration and microbial dynamics). From a C budgeting perspective, our results suggest that the young mine sites are a source of C to the atmosphere due to an abundance of carbonate mineral weathering. After the readily dissolvable carbonates are removed from the system (by age 8), SOC, litterfall and microbial biomass C and N increase and the reforested surface mines become a sink for C. Rates of SOC accumulation are greater on the mine sites when compared to unmined young regenerating forests because the young minelands are initially devoid of SOC. **Tara Littlefield, Chris Barton, Mary Arthur; University of KY**

A PRIVATE LANDOWNER WILLINGNESS TO SUPPLY FOREST BIOMASS

The development of an economically viable bioenergy market in the U.S. is dependent on a sustainable low-cost supply of feedstock. The goal of our study will be to explore the social availability of woody biomass from private lands in Kentucky. The Theory of Planned Behavior will be used to design a survey instrument that will be mailed to family forest owners in Kentucky. Half of the participants will be randomly selected to receive an extension publication designed to educate them about wood energy harvesting. Analysis of survey data will quantify willingness to participate in wood energy harvests among Kentucky family forest owners and test the effect of educational materials on intended participation. It will also identify landowner characteristics, motivations, and activities that significantly affect intention to supply wood for energy. Estimates of private landowner participation and an increased understanding of factors affecting landowner decisions will be provided by the study. **John M. Lhotka, Zachary Leitch, G. Andrew Stainback, Jeffrey W. Stringer, and Billy Thomas; University of Kentucky**

Joseph Bozell; University of Tennessee

The biorefinery separates lignocellulosics into individual process streams of greater utility than the raw material itself. We are examining solvent-based systems to fractionate lignocellulosic biomass into separate streams of cellulose, hemicellulose and lignin. Solvent separation gives each fraction in high yield, with little crosscontamination from other components. The process is being examined as a pretreatment for switchgrass, expected to become a dominant bioenergy crop across the United States. We recently completed a lab scale demonstration combining fractionation of switchgrass and conversion of the cellulose to ethanol.

Lignin is a valuable high volume source of renewable carbon. However, lignin has typically been restricted to fuel use because its structural heterogeneity has resisted selective chemical conversion. Our research is examining a biochemical/chemical route for transforming lignin initially into higher value liquid fuels, and ultimately, biobased chemicals.

"LIGNIN IS A VALUABLE HIGH VOLUME SOURCE OF RENEWABLE CARBON. HOWEVER, LIGNIN HAS TYPICALLY BEEN RESTRICTED TO FUEL USE BECAUSE ITS STRUCTURE."

Darren Baker; University of Tennessee

Current research program include the manufacture of carbon fiber and related advanced carbon materials from engineered, genetically improved and biomass lignins; the development of coupling agents for polymeric interfaces; the recovery, chemical modification and use of cellulose nanofibrils for materials improvement and advanced carbon nanomaterials; and the manufacture of nanofibers via electrospinning.

David Harper; University of Tennessee

We have had success in screening candidate lignins for the production of carbon fibers. The lignin is being produced in the Center for Renewable Carbon (CRC) via an organosolv fractionation process. The fractionation process is able to produce lignins with a variety of thermal characteristics from the same feedstocks by varying processing conditions. This allows for optimization and tuning of lignin for melt spinning.

Nicole Labbe; University of Tennessee

Investigating new environmentally friendly approaches to pre-treat and fractionate ligno-cellulosic material to embrace the biorefinery concept, where fuels, chemicals and products are generated, making the biorefinery economically viable and sustainable. The goals of the fractionation approaches are to release the cellulosic components of biomass into monosugars (glucose, xylose…) and provide a clean lignin fraction that can be used to produce high value products such as carbon fibers and carbon foams. Also conducting a series of initial experiments to lay the foundation for a systematic, vertically integrated research program that focuses on optimization of the C-sequestration potential of biochar (a co-product of biomass pyrolysis) addition to soil in the context of maximizing bioenergy crop yields in southeastern United States.

"THE LIFE-CYCLE ENVIRONMENTAL IMPACTS OF FOREST PRODUCTS, INCLUDING BIOFUELS"

David Mercker; University of Tennessee

As an Extension Specialist, I develop and deliver educational programs to landowners of family forests, loggers, natural resource professionals and educators with focus on 1) improving the profitability of forest ownership, 2) promoting forest certification, and 3) facilitating a better understanding of ecology of forest development and succession. Specific programs related to carbon management include an extension publication titled:

Mercker, D. 2009. The Business of Carbon Credit Trading for Forest Landowners. The University of Tennessee Extension. W217.

Adam Taylor; University of Tennessee

We are currently involved with a number of research projects that examine the life-cycle environmental impacts of forest products, including biofuels. Specifically we are compiling life cycle inventories for wood and switchgrass fuel pellets, modelling the reductions in environmental impact associated with improved oriented strandboard (OSB) production, and developing a list of the carbon impact factors for a range of wood products. The holistic environmental impacts of products from renewable resources are becoming important in policy and marketing decisions and we are trying to develop and disseminate accurate data for forest products.

ENVIRONMENTAL EFFECTS OF BIOMASS PRODUCTION IN PINE FORESTS

Utilizing forest biomass for biofuel production has emerged as a promising alternative to fossil fuels. However, very little research has focused on how to simultaneously grow biomass for biofuel production while still managing for high quality wood products in an intensive silvicultural system. Furthermore, understanding the effect that such a dual system could have on long-term soil productivity, water quality and quantity, and wildlife is critical for the viability of such an intensive management system. As a result of this gap in scientific knowledge, a set of comprehensive studies have been initiated by Catchlight Energy LLC (a joint venture between of Chevron and Weyerhaeuser) on Weyerhaeuser Company timberlands across the southeastern United States. The objective is to examine multiple environmental responses to biomass treatments, specifically intercropping of switchgrass within planted pine stands and removal of forest residuals and non-crop tree biomass. The study includes multiple study areas in 3 states (AL, MS, and NC) with study designs ranging from traditional plot-based experimental treatments to watershed scale treatments. To date, parameters to be examined include soil measures (physical and chemical properties, nutrient availability, and carbon storage and cycling), water quality and quantity, wildlife habitat response, and sampling of wildlife communities (birds, small mammals, herpetiles, and invertebrates). Additionally, a tool has been created for carbon life cycle analyses. Scientists from over 10 companies, universities, and government agencies are collaborating and results from these studies will provide direction for developing guidelines and management practices for biomass production.

"MULTIPLE ENVIRONMENTAL RESPONSES TO BIOMASS TREATMENTS, SPECIFICALLY INTERCROPPING OF SWITCHGRASS WITHIN PLANTED PINE STANDS AND REMOVAL OF FOREST RESIDUALS AND NON-CROP TREE BIOMASS. "

Zakiya Leggett, Eric Sucre,
Jami Nettles, and Darren Miller; Weyerhaeuser

BIOMASS RECOVERY IN HARDWOOD FOREST MANAGEMENT

Mary Ann Fajvan

Forest managers have many options for treating hardwood forests to address growth, forest health, species composition, wildlife habitat or other forest attributes. A team of researchers implemented a study to compare five different silvicultural treatments that could improve forest condition and vigor. The treatments represented a range of thinning including oak shelterwood, understory thinning, oak woodland and a chemical-thinning. Each treatment included measures of stand condition and structure, regeneration, soil disturbance, wildlife habitat and an index of resistance to insect attack.

The results showed that cost per ton nearly doubled as the removal volumes fell—light treatments had much higher costs. This was a result of decreasing operational productivity as the volume per acre was reduced. Interestingly, the cost per acre for the treatments followed a different pattern. The heavier removals took more time and thus the cost per acre was nearly twice as much in the shelterwood treatment as in the thinning treatment. The implications for forest managers are significant. Depending on market values for biomass and sawlog products these treatments have vastly different returns to the forest.

"THE HEAVIER REMOVALS TOOK MORE TIME AND THUS THE COST PER ACRE WAS NEARLY TWICE AS MUCH IN THE SHELTERWOOD TREATMENT AS IN THE THINNING TREATMENT."

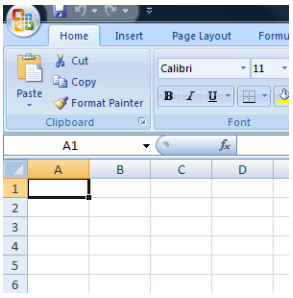
Jason Thompson and Bob Rummer; Forest Service, Southern Research Station

BIOMASS SAMPLING DEVELOPMENTS

When the Biomass Crop Assistance Program (BCAP) was initiated, payments to eligible material owners were made on a dry moisture content basis. This program required the qualifying biomass facilities that were purchasing biomass to determine the moisture content of deliveries. To examine the variability in moisture content of delivered loads, SRS scientists obtained a large dataset of biomass delivery information from a biomass purchaser. The dataset was analyzed to determine relationships between moisture content and delivery location, month of delivery, and species related data. The intent of this type of analysis was to determine the sampling intensity needed to determine moisture content levels within a given acceptable range (confidence interval).

Dana Mitchell and Bob Rummer; Forest Service, Southern Research Station

BIOMASS UNIT TRANSLATOR



New bioenergy markets are primarily interested in transactions of actual energy content (dry matter) while many traditional forest products markets use a green weight basis as a matter of convenience. The Biomass Crop Assistance Program introduced significant confusion as people tried to convert from traditional measures. SRS scientists developed a spreadsheet-based biomass converter. The tool takes inputs of material moisture content and provides conversions between green and dry ton cost and between green and dry ton weight. The converter provides an exact conversion as well as charts that can be used for quick reference. The converter also provides information about the effect of moisture content on net heating value. The initial version has been widely distributed by Smallwood News and an improved version will be developed based on user feedback.

John Klepac; Forest Service, Southern Research Station

"The tool takes inputs of material moisture content and provides conversions between green and dry ton cost and between green and dry ton weight. "

UNDERSTANDING BIOMASS POTENTIAL ON PRIVATE LAND

The inclination of private landowners to harvest timber is a critical issue for understating the future of wood-based bioenergy markets as well as traditional forest products markets. SRS scientists developed a framework for linking an analysis of harvest choices based on detailed forest inventory data (FIA) that provides estimates of potential timber supply. Because this framework is built from the FIA inventory it provides a mechanism for not only estimating timber supply, but also for estimating how changes in land use and forest conditions will affect changes in biomass supplies in the future. This study provides a foundation for understanding the future of biomass harvests in light of biophysical changes such as climate change and institutional factors such as energy policy. Policy analysts will be able to explore various scenarios regarding policy and climate and their impacts on forest productivity and timber production. **Dave Wear; Forest Service, Southern Research Station**

WOODY BIOMASS CONVERSION

Management of forested land has many objectives, primary of which is the utilization of removed woody biomass. With emerging woody bioenergy markets and the carbon neutrality of energy from woody biomass, there has been a dynamic push towards developing low- and negative-value woody material into bioenergy feedstocks. SRS scientists have been evaluating the thermochemical characteristics of commercial and non-commercial woody biomass and the role this biomass will play in a national effort to produce energy from woody biomass. Various biomass samples are subjected to two treatments. Small samples are milled to a powder and analyzed for their thermal potential (calorimetry, ash analysis, thermogravimetric analysis).

Les Groom; Forest Service, Southern Research Station

CARBON STORAGE IN MATURE PINE-DOMINATED FORESTS

Karen Rawlins
Bugwood.org

Carbon sequestration is an increasingly important issue for land managers in the southeastern United States, especially regarding the pine-dominated forests of the region. We have recently embarked upon an effort to better quantify the carbon sequestered in pine-dominated forests of the region. There are also a range of different treatments, allowing for consideration of the role of silvicultural system on ecosystem carbon storage. Other data will be developed from more recent short-term observations of existing mature pine stands from other locations, ranging from uncut second-growth to managed stands to unmanaged old-growth. Finally, data has also been generated from the analysis of historical records to consider how much carbon was sequestered in the virgin pine-dominated forests of the region. This research program should provide a better understanding of both the past and present carbon dynamics of these forests. This work should also provide carbon storage benchmarks that public land managers may be interested in when determining the relative contribution of their properties to national—and even global—scale carbon patterns.

"THIS WORK SHOULD ALSO PROVIDE CARBON STORAGE BENCHMARKS THAT PUBLIC LAND MANAGERS MAY BE INTERESTED IN WHEN DETERMINING THE RELATIVE CONTRIBUTION OF THEIR PROPERTIES TO NATIONAL—AND EVEN GLOBAL—SCALE CARBON PATTERNS."

Don Bragg; Forest Service, Southern Research Station

FOREST SERVICE BIOMASS RESEARCH SUMMIT

Biomass utilization from the Nation's forests is a complex issue encompassing production, harvesting/transportation, conversion and environmental factors. On April 27-29, 2010, our laboratory hosted the Forest Service Biomass Research Summit in Washington, DC. The group included scientists with expertise in soils, ecology, genetics, forest products, economics, carbon cycling, and inventory and analysis, evaluated the current status of the science, capabilities within the various research stations, and how our knowledge should be brought to bear on biomass utilization. The group of 22 Forest Service scientists and an advisory panel of twelve additional members are drafting a coordinated research plan for implementating Forest Service strategic initiatives in biomass research and an executive summary detailing the objectives and projected outcomes.

Les Groom; Forest Service, Southern Research Station

INFLUENCE OF ANNUAL CLIMATIC ON TREE GROWTH AND ABOVEGROUND CARBON SEQUESTRATION

Mary Fajvan
WVU

Upland hardwood forests are highly diverse and productive forests occupying as much as 50% of the forested land base in the Central Hardwood Region of the eastern US. In the SE US, temperatures are predicted to increase between 2.5°C and 5.8°C, and changes in precipitation patterns and amounts expected. Thus, there is a need to better understand the role active forest management may have in mitigating potential declines in tree- and stand-level growth and maintaining overall productivity in upland hardwood forest. This research will use dendrochronological data from long-term research plots, to determine the climatic (e.g., temperature, precipitation.) and non-climatic factors (e.g., stand density, stand age, site index) limiting individual-tree and stand-level growth and aboveground carbon sequestration rates for common tree species of upland hardwood forests of the southern US. Results are providing information that can help land managers increase tree resilience to climate change, and help public and private land owners to offset potential negative effects of climate change.
Tara Keyser; Forest Service, Southern Research Station

ASSESSING THE POTENTIAL FOR BIOMASS ENERGY DEVELOPMENT IN SOUTH CAROLINA

Woody biomass as feedstock for biofuel is one source that has been used to produce heat, steam, and electricity on a moderate scale for well over a century. The potential of woody biomass as a sustainable supply for biofuel is largely unknown. A cooperative effort between SRS FIA and the South Carolina Forestry Commission (SCFC) was undertaken with the purpose of assessing the potential for developing a sustainable woody biomass energy industry in South Carolina. The assessment offered an opportunity to develop a focused issue-specific report highlighting the use of FIA data in the context of a bioenergy or biomass availability issue.
Study results showed that while 7.7 million tons were currently committed to other uses, the 8.8 million tons of unutilized material produced annually could sustain new facilities that use wood to produce energy. Moreover, this new facilities development could be accomplished without increasing current harvest levels and without overly impacting the State's existing forest industries. **Roger Conner; Forest Service, Southern Research Station**

"THIS NEW FACILITIES DEVELOPMENT COULD BE ACCOMPLISHED WITHOUT INCREASING CURRENT HARVEST LEVELS AND WITHOUT OVERLY IMPACTING THE STATE'S EXISTING FOREST INDUSTRIES"

SOUTHERN TIMBER PRODUCT OUTPUTS SUMMARIZED

Forest industry in the Southern Region is a multibillion dollar business providing jobs and economic value to local communities. Also with the increased interest in bioenergy from forests, this information is critical to keeping a pulse on the forest industry and wood utilization in the South. In 2010, the *2008 Southern Pulpwood* report along with *The South's Timber Industry-An Assessment of Timber Product Output and Use, 2007* were published. Each of these reports gives statistics on various aspects of utilization and product output for removals from the Southern Region. Data will be processed in 2011 and added to the TPO Data Retrieval tool on the Southern FIA Web Site. Individual State timber product output assessments along with *The South's Timber Industry-An assessment of Timber Product Output and Use, 2009* will be published in Fiscal Year 2011. The 2009 Southern Pulpwood report will be published along with three harvest and utilization reports. **Tony G. Johnson; Forest Service, Southern Research Station**

CROSS CARBON STUDY

Brian Lockhart
Forest Service

This project is a collaborative research effort between SRS-4160, ArborGen, and MeadWestvaco that examines how manipulating site organic matter, primarily logging residues, impacts soil nutrient supply, C sequestration and productivity during early stand development and is located in Cross, SC. Post-harvest logging debris and previous stand forest floor represent large pools of Carbon and nutrients. Incorporating logging residues into the underlying mineral soil could potentially increase soil C and nutrient cycling and availability. We also manipulate site N demand by using two distinct loblolly pine genotypes (ideotypes). Both clones have high and similar above-ground productivity, but one produces biomass with approximately half the leaf area of the second. SRS-4160 have collected intensive growth, physiology and soil data over the six years of the study which are being used to construct C budgets, elucidate mechanism(s) for the clonal differences in growth efficiency (i.e. resource use efficiency), and develop a process-based productivity model.

"POST-HARVEST LOGGING DEBRIS AND PREVIOUS STAND FOREST FLOOR REPRESENT LARGE POOLS OF CARBON AND NUTRIENTS"

Kurt Johnsen, Chris Maier and John Butnor; USDA Forest Service Southern Research Station

DUKE FACE

Research is being conducted to assess C sequestration at the Duke Free Air Carbon Enrichment (FACE) study located at the Duke Forest in Durham, NC. The study has examined the impacts of elevated CO_2 and soil nutrition on tree growth and ecosystem processes in a low intensity loblolly pine plantation since 1994. SRS-4160 has studied soil respiration and properties as well as tree growth and stem respiration for over 10 years. Now, at the close of the experiment, we are harvesting full root systems so that we can determine if treatments have impacted biomass partitioning to coarse roots (including tap roots). These data are also critical for determining final C budgets at the site.

Kurt Johnsen, Chris Maier and John Butnor; USDA Forest Service Southern Research Station

LONGLEAF/LOBLOLLY/SLASH PINE C SEQUESTRATION

David Moorhead
UGA

In 1960, a large scale silviculture experiment was installed at the Harrison Experiment Station in Saucier, Miss to examine the growth of longleaf, loblolly and slash pine under different silviculture regimes. While loblolly and slash pine both grew faster than longleaf pine initially, by age 25 there were only minor differences among the species. In 2005, Hurricane Katrina hit the experiment directly. Longleaf had the least mortality (7%) followed by Slash (14%) and loblolly pine (26%). SRS-4160 has been collecting soil and biomass data so that C accumulation can be estimated for the three species nearly 50 years after the experiment was established. The Study is currently being modified to maintain the long-term species comparisons but to also study genetic considerations in longleaf pine ecosystem restoration.

Kurt Johnsen, Chris Maier and John Butnor; USDA Forest Service Southern Research Station

"Carbon accumulation can be estimated for the three species nearly 50 years after the experiment was established."

MEASURE AND MODELLING OF CARBON, WATER AND ENERGY FLUXES

In a collaborative effort with North Carolina State University and the USDA Forest Service, Northern Research Station we are using the eddy covariance technique to measure and model carbon, water and energy fluxes in two coastal plain loblolly pine plantations. The objectives of this research are to examine how management disturbance and climate (i.e. drought, changing precipitation patterns) affect carbon pools, water use and availability, and energy fluxes; link site data with measurements made through remote sensing; and parameterize and validate ecosystem productivity models.
Additional information can be found at:
http://www.forestthreats.org/current-projects/project-summaries/carbon_and_water_fluxes
http://www.forestthreats.org/current-projects/project-summaries/carbon_monitoring_and_forest_management

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SFRP Carbon Management and Forest Biomass Center of Excellence

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SFRP's mission is to foster collaborative relationships that provide new and revised research knowledge that will enable the southeast to remain competitive in the global forestry market while enhancing the forest landscape and assuring that the forest resources are sustained indefinitely.

SFRP WILL:

- Define key research issues
- Create external communications strategies and materials
- Create an efficient and effective networking structure
- Enhance funding opportunities for members