

PROJECT NARRATIVE

**USDA National Institute of Food and Agriculture
Climate Change: Regional Approaches to Climate Change, Program Code A3101
Continuation Application—2014**

**Integrating Research, Education, and Extension for Enhancing Southern Pine Climate
Change Mitigation and Adaptation**

Pine Integrated Network: Education, Mitigation, and Adaptation Project (PINEMAP)

NIFA Award number 2011-68002-30185

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Team Plan-of-Work for next year of funding (Year 5)

PINEMAP has six disciplinary Aim teams (Aim 1: Silviculture & Ecophysiology; Aim 2: Modeling; Aim 3: Genetics; Aim 4: Economics & Policy; Aim 5: Education; and Aim 6: Extension). As the project has evolved, cross-aim multidisciplinary groups (dubbed “PINEMAP integration platforms”) have been formed to enable analysis and synthesis of information across disciplines, across space and time, and among research, Extension, and education. The Aim level work plans in Table 1 incorporate the efforts of these integration platforms.

Table 1. Preliminary year 5 (March 1, 2015-February 29, 2016) PINEMAP work plans.

Aim 1: Silviculture & Ecophysiology	<ul style="list-style-type: none"> • Continue data collection at the four Tier III (throughfall exclusion x fertilization) sites • Continue data collection at Tier II (active experiment) sites Sap flux, soil respiration, Tier II regional analyses <ul style="list-style-type: none"> • Sap flux: standardize sapwood calculation radial corrections • Sap flux: complete transpiration monthly estimates at all sites, send data to modeling aim • Sap flux: deliver daily Oklahoma gas exchange, growth, and transpiration • Soil Respiration: validate total soil respiration measurements • Soil Respiration: further exploration of heterotrophic and autotrophic respiration values • Soil Respiration: deliver total soil respiration and heterotrophic and autotrophic respiration confirmation to modeling aim • Tier II: complete field sampling • Tier II: complete ½ plots into TerraC and to modeling aim. • Tier II: data to modeling groups • Tier II: complete bulk density paper
Aim 2: Modeling	Regional modeling: 3-PG, WaSSI, growth and yield, Community Land Model, SRTS <ul style="list-style-type: none"> • Complete integration of 20 model MACA climate projections into input datasets • 3-PG: compare parameter sets to baseline WaSSI and growth and yield • Complete manuscript on 3-PG prediction of stand growth • WaSSI: use NPP:GPP from 3-PG for WUE output, incorporate improved ecosystem respiration models • WaSSI: compare modeled drought impacts to field data • Growth and yield: more runs with downscaled climate data • Community Land Model: Compare modeled Rh to observed, simulate RCP 4.5 forecast • Common validation data across models • SRTS test runs
Aim 3: Genetics	<ul style="list-style-type: none"> • Complete genotyping (sequencing done, data analysis ongoing) • Upload ADEPT2 phenotypes into TerraC • Incorporate final seed deployment tool into DSS
Aim 4: Economics & Policy	<ul style="list-style-type: none"> • Final assessment of policies and programs that may affect C mitigation in planted pine • Synthesis of landowner adoption of mitigation and adaptation strategies • Finalize analysis of net present value and regional market impacts of adaptation strategies and altered disturbance risks

Aim 5: Education	Undergraduate Internship Program <ul style="list-style-type: none"> • Conduct interviews of program participants • Mentor researchers train 4th cohort of undergraduate fellows
	PLT Secondary Module <ul style="list-style-type: none"> • Complete summative evaluation of module
Aim 6: Extension	Extension outreach <ul style="list-style-type: none"> • Facilitate development of presentations; publicize, test, and evaluate • Develop landowner fact sheets • Implement professional development webinars • Publish journal articles
	Corporate landowner outreach <ul style="list-style-type: none"> • Develop research summaries (video and PDF format) • Plan and implement online trainings on tools and data sets • Conduct sub-regional workshops focused on the DSS and integrated research • Conduct virtual meetings/conferences on PINEMAP research • Plan and implement a PINEMAP wrap-up symposium (in-person)
	Decision Support System (DSS) <ul style="list-style-type: none"> • Finalize climate risk and opportunity tools • Complete version 1 of the southern pine beetle, fire risk and density management tool • Finalize website look, design, feel • Conduct DSS training; climate tools; seed deployment
Administration/ Management	<ul style="list-style-type: none"> • Conduct All Team PINEMAP virtual meetings every other month • Conduct 2015 Annual Meeting • Plan and implement wrap-up symposium • Finalize and publish year 4 annual report • Write, compile, edit year 5 (final) annual report • Plan and lead quarterly Executive Committee meetings • Compile interim progress report (Sept. 2015) • Compile and support annual progress through REEport system (Dec. 2015) • Continue updating PINEMAP external web site and intranet site with relevant progress • Continue synthesis of team science and integration research data; draft reports and manuscripts

Team Outcomes/Impacts

Overview

Pine Integrated Network: Education, Mitigation, and Adaptation Project (PINEMAP) focuses on the 20 million acres of planted pine forests managed by private landowners in the Atlantic and Gulf coastal states from Virginia to Texas, plus Arkansas and Oklahoma. These forests provide critical economic and ecological services to U.S. citizens.

PINEMAP's overall goal is to create, synthesize, and disseminate knowledge that enables southern pine landowners to

- manage forests to increase carbon sequestration by 15% by 2030;
- increase the efficiency of nitrogen and other fertilizer inputs by 10% by 2030;
- adapt forest management approaches and plant improved tree varieties to increase forest resilience and sustainability under variable climates.

These goals require that the PINEMAP team conduct interdisciplinary research and integrate research, education, and Extension activities. To meet these goals, we have launched a number of synergistic and creative groups to build opportunities and facilitate integration.

In the past year, PINEMAP faculty, staff, and students have continued their disciplinary research and also worked to share and synthesize information and efforts seamlessly among institutions as we scale up our analyses from forest plots to regional landscapes. Multidisciplinary and multi-institution groups work to apply new knowledge in order to further PINEMAP outcomes.

NIFA funded PINEMAP to produce and disseminate the knowledge necessary to better manage planted southern pine forests in a changing world. PINEMAP is charged with producing real-world outcomes, and, accordingly, our research and deliverables are structured around a set of outcome themes and associated activities, outputs, and outcomes which are described below.

Outcome theme: Increased carbon (C) sequestration from silvicultural and genetic enhancement of productivity and efficiency of fertilizer use, and resilience to climate variability and disturbance.

Planted southern pine forests already contribute to climate change mitigation by taking up and storing (sequestering) enormous amounts of atmospheric CO₂ in trees, soil, and long-lived wood products. PINEMAP produces knowledge necessary to increase the amount of CO₂ sequestered through enhancement of forest productivity, more efficient use of fertilizers, and management of forests for resilience to climate variability and disturbance. Central to this effort is the establishment and measurement of a three-tiered monitoring network quantifying productivity, carbon, and nutrient pools on hundreds of region-wide experimental plots in pine forests across 11 states. A multi-scaled modeling program produces region-wide, fine-scale projections of pine forest carbon sequestration, productivity, and timber supply under future climate scenarios using newly-developed or enhanced statistical growth and yield, process-based, and bio-economic models driven by state-of-the art downscaled climate projections. A full life cycle assessment of carbon sequestration associated with production and use of wood products from southern pine systems enables us to quantify the impacts of changes in management and product flows on regional C balance. Finally, analysis of genetic variation relative to climate adaptation and productivity traits will enable the acceleration of breeding of future generations and improve deployment decisions.

Outcome theme: Engaged and literate public with the capacity to make informed, practical decisions related to climate, forest ecosystems, and forest management.

In a democratic society, rational public policy and decision making depend to a large extent on public understanding of and engagement with societal problems. PINEMAP's education programs are designed to help nonscientists better understand and grapple with the complex issues surrounding climate and forest management.

Educational activities contribute to project-level outcomes and impacts through educating graduate and undergraduate students, along with high school teachers and students, on climate science, forestry, and interdisciplinary research. These activities contribute to project-level outcomes and impacts through educating graduate and undergraduate students, along with high school teachers and students, on climate science, forestry, and interdisciplinary research. The PINEMAP Undergraduate Fellowship Program's third year began in May 2014 as 12 undergraduate fellows were paired with PINEMAP graduate students at seven host institutions. This internship experience will be used in the fall 2014 Effective Communication Skills course where fellows educate public secondary school students about forest resources and climate change, develop a scientific abstract, a scientific poster, and a PowerPoint® presentation. The Project Learning Tree/PINEMAP secondary module, *Southeastern Forests and Climate Change*, was completed, with more than 140 people helping through writing and reviewing activities, participating in the advisory committee, providing expert content review, or pilot testing. The final module is ready for distribution as of September 15, 2014. We are in the process of completing the accompanying website, which will include all the module materials, videos, and online training resources. Through educator training opportunities,

including a Climate Change Symposium and a teacher workshop, the team has reached more than 65 teachers to date. Two facilitator trainings are being planned for fall 2015.

The Tier III site in Oklahoma hosted two on-site, intensive authentic research experience programs in the summer of 2014. During the first training PINEMAP researchers, graduate students, and technicians spent a week working with eight Oklahoma high school science teachers to learn about project goals and objectives, experimental design, and instrumentation used to measure tree water use, soil respiration, and soil moisture. Teachers then developed formal study plans for classroom use. The formal curriculum was developed through the University of Oklahoma K20 Center.

During the second training, the Oklahoma Tier III site hosted 10 minority and female undergraduates as part of a three week internship in Oklahoma, Texas and Louisiana. The Tier III site was visited as a demonstration of an intensive ecological research site, and information was provided by PINEMAP researchers, graduate students and technicians.

Outcome theme: Public policy that supports sustainable management of planted pine under future climate scenarios.

The biophysical and human dimensions research produced by PINEMAP provides information critical for guiding the development of rational natural resource policy.

Multi-scale modeling and analysis of climate change and management impacts on forest economic values, and tradeoffs/ synergies between wood products and ecosystem services will inform decisions which weigh economic vs. non-economic values of forest system. Analysis of impacts of feasible land management and policy alternatives on environmental and economic sustainability of Southeast U.S. forests will help guide policy for sustainable management. Finally, analysis of stand- to regional-scale economic impacts of climate change-forced disturbance risks (e.g., wildfires, southern pine beetle, and hurricanes) and the role of adaptation in risk mitigation will guide both public and private land managers as they manage for resilience in a changing climate.

Outcome theme: Enhanced capacity for regional, interdisciplinary collaboration among climate and forest scientists and Extension and education professionals.

PINEMAP's unprecedented coalition of over 120 forestry researchers, educators, Extension professionals, and students is building new networks and new infrastructure for cutting-edge, collaborative, outcome-based science. Central to this effort was the establishment of a three-tiered monitoring network and the coordination and standardization of field ecology measurements across >120 locations from Virginia to Texas. Interface of the monitoring network efforts with ongoing model development and testing has built important ties between field scientists and regional modelers. The education team has led meaningful engagement of research and Extension professionals in the production and delivery of PINEMAP educational research across several programs. The Extension team planned and conducted a climate change workshop series for 1890s Land Grant Universities in the region. The first Southern Region Extension Climate Academy offered training and ongoing support to 90 agents and specialists across the South. To better understand the process of collaboration, an ongoing social network analysis is documenting changes in relationships among project collaborators through time.

Outcome theme: Enhanced connections between corporate and noncorporate forest landowners and forestry and climate researchers and education and outreach professionals.

Research performed in isolation has little impact on society. PINEMAP strives to strengthen existing and build new connections to on-the-ground forest management so that the science can be quickly translated to outcomes that benefit society.

PINEMAP Extension activities focus on both the corporate landowners in the region who manage more than 20 million acres of planted pine and produce > 95% of seedlings planted, as well as non-corporate landowners and the government and consulting foresters who help them manage their land. Extension activities contribute to project-level outcomes and impacts through the development and dissemination of informational products and tools, which provide stakeholders with knowledge and skills needed to address planted pine mitigation and adaptation issues related to climate and climate change. We conducted a survey of climate change perceptions among Extension faculty and agents across the region. We are developing partnerships among state climatologists and Extension foresters and establishing a PINEMAP Extension network in the Southeast. These partnerships and networks will be critical to the efficient and effective dissemination of PINEMAP Extension programs and products. Programs and products being developed include a Decision Support System (DSS), a web-based, open-source set of current and future decision support tools directed at the innovative management of southern pine; eXtension modules for the Climate Science and Forests Interaction Community of Practice (CoP); and additional resources such as fact sheets and web-based education modules.

- To date, PINEMAP information has reached 72 silviculturists through the Western Gulf Silvicultural and Technology Meeting representing 9 million acres- 5 of those million in pine. Based on what they learned from this effort, changes will be made to management plans covering at least 250,000 acres.
- Texas Forestry Agency Training - 16 foresters have participated in the initial run, representing around 200,000 northeast Texas landowners. They have incorporated PINEMAP strategies into their forest management plans and landowner outreach efforts. This group represents roughly 4 million acres across the Western Gulf region.
- About 150 southeastern extension agents (ranging from foresters to agriculture and natural resource agents) have been trained on climate science, change and mitigation efforts through three different workshops (Huntsville, AL May 2013; Wilmington, NC January 2014; and Athens, GA September 2014).
- The Western Gulf workshop and the Woodlands Owner workshop in August 2014 collectively reached 150 attendees (Diboll, TX). A workshop in Wilmington, NC reached 15 foresters.
- Upcoming workshops include a Spring 2015 herbicide training on adaptive silviculture (northeast TX region) and a multi-state SAF meeting with an estimated 250 participants entitled “Reflections on Water” on adaptive silviculture.

Outcome theme: A more robust and resilient forest-based economy in the Southeast U.S.

PINEMAP research enables pine landowners in the Southeast U.S. to continue producing economic and ecological services that benefit society. PINEMAP activities in this theme contribute to project-level outcomes and impacts by providing economic analysis that will underpin land manager decision-making in future management and climatic conditions. Multi-scale analyses of tradeoffs, costs, and benefits associated with forest management under future climate conditions will enable landowners to better understand their options as climate changes. The PINEMAP southern pine decision support system (DSS) is providing tools for capitalizing on opportunities and mitigating risk associated with projected future climate. It includes downscaled climate projection maps, a seed deployment tool, interactive productivity maps, and risk assessment tools.

Team Outputs

PINEMAP developed and published an annual report containing 23 articles summarizing preliminary research results and education and Extension programs (<http://www.pinemap.org/reports/annual->

reports/Year_3_Annual_Report.pdf). Hard copies were distributed to partners and stakeholders, and the report is available for download via the PINEMAP web site. The PINEMAP web site (<http://www.pinemap.org>) is a valuable outreach tool, and is continually updated with project updates, research results, and outreach materials.

The research, education, and Extension efforts of PINEMAP team members resulted in an impressive array of outputs produced during year 3, including products (peer-reviewed publications, fact sheets, white papers, research summaries, and audio/video products) and events/activities (oral and poster presentations, workshops/trainings/courses, and experiments, data collection, and surveys). A complete summary of team outputs produced and disseminated from August 2013 to present can be found in Appendix A.

Team Milestones and Deliverables

Aim 1 (Silviculture & Ecophysiology) Milestones and Deliverables:

Sap Flux regional analyses

Soil moisture assessment and standard index

Internal web meeting conducted on July 25, 2013. Group decision was to proceed with approach to gap filling using 12 cm wireless probes at Virginia site at other sites for use in cross-site sap flux analyses.

TerraC formats and 2013 data

Terra C template formatted and distributed. Data for 2013 sap flux will be submitted by Oct. 1, 2014.

2013 Florida, Georgia, and Virginia analyses

Analysis of 2013 Florida sap flux completed; manuscript in preparation. Analysis of 2013 Georgia sap flux completed; manuscript currently in preparation. Manuscript on Virginia sap flux data in preparation, for submission to journal by Oct 1, 2014. The manuscript uses continuous half-hourly sap flux measurements of 80 trees from June 2012 until March 2014 (>32,000 data points) and associated stand-level biometric data and meteorological data.

Initial meeting on improving LAI measurements

Meeting to be held in early October 2014.

Data through 9/30/14 in TerraC with LAI corrections

Data submitted to University of Florida and is being put into TerraC.

Soil respiration regional analyses

R_H/R_S to modeling via Tier III synthesis

A study to investigate how R_H (heterotrophic respiration) / R_S (total soil respiration) ratio changes with age has been installed in central Virginia within the Appomattox-Buckingham State Forest (close to the Tier III installation). Three replications of four age classes (2-3, 7-9, 16-18, and 23-25 years-old) are being measured using established PINEMAP protocols. Data from this study will be used to further inform the Aim 2 models.

In the Virginia Tier III installation, a study has also been installed to investigate how the soil microbial processes and litter chemistry is linked to decomposition.

At the Georgia Tier III installation: Measurements were made of soil CO₂ efflux and its components—autotrophic CO₂ efflux, heterotrophic CO₂ efflux and CO₂ efflux from the ectomycorrhizal hyphae.

R_S validation

A region wide dataset of R_S has been reanalyzed. A four-parameter model (temperature, temperature x moisture, bulk density, and soil nitrogen) explains 56% of the variance in R_S. A simple one-parameter model (temperature) explains 48% of the variance in R_S. Multiple datasets from across the region are being combined and analyzed to validate and further current models.

R_H/R_S further exploration, to modeling group via Tier II synthesis

We are exploring the effects of stand age and season on R_H/R_S partitioning. Sampling of R_H/R_S is ongoing across the Tier II network. At least three Tier II sites in each sub-region were identified for R_H vs. R_A (respiration) measurements using the established PINEMAP protocol. Equipment has been installed for late summer measurements.

Tier II regional analyses

Tier II inventory extracted from Tier I and Bulk density pedotransfer functions

Approaches are under development.

Bulk density variation PINEMAP NRCS

This deadline is dependent on the next item but will likely be met.

Aboveground metrics to TerraC

Field measurements are ongoing but this deadline will be met.

Complete field sampling, complete 1/2 plots into TerraC, Bulk density paper, Final analysis all plots, Outputs to modeling groups, C analysis of existing data, and Carbon upscaling kriging

These deadlines will likely be met.

Aim 2 (Modeling) Milestones and Deliverables

Regional modeling: Climate projection dataset

The Multivariate Adaptive Constructed Analogs (MACA) dataset was created using a statistical downscaling method with 20 global climate models from IPCC's 5th Assessment Report and two different emission scenarios across a baseline period (1950-2005) and future period (2006-2100). This state-of-the-art climate projection dataset provides the best data available for PINEMAP's modeling simulations. Unfortunately, processing and aggregation of the datasets to the appropriate spatial scale, and integration with the PINEMAP soils dataset, is very time intensive, both in terms of computer processing and project personnel. This has led to delays in the production of input datasets and subsequent regional modeling runs.

Regional modeling: 3-PG

Climate and scenarios

Scenarios have now been developed to guide choices for model runs. Climate data from 20 different models is being processed, allowing for estimation of variability of 3-PG outputs.

3-PG FR SI relationship and regional site index categories

Initial comparison of two models for taking SI to FR complete, preliminary results suggested a need to recalibrate other parameters in 3-PG. Recalibration is ongoing. As an effect of the recalibration, additional parameter sets and SI-FR models are being considered as well. Initial regional runs will be used to compare pre-determined combinations of parameter sets and models, with emphasis on comparison to existing WaSSI and growth and yield baseline results.

Regionalization of 3-PG

Region-wide soil and site index inputs have been extracted and aggregated to the HUC-12 level. Pending climate variables at the same level, it is now feasible to run 3-PG across the PINEMAP region for any year between 1950 and 2100, with likely emphasis being on comparing 1980-1990 with 2060-2070 to facilitate model comparisons between 3-PG, WaSSI, and G&Y.

Climate-based variability assessment

An initial assessment of the ability of 3-PG to predict stand growth has been made on 14 specific sites across the loblolly pine region. A manuscript is currently being written.

Baseline runs and model refinement

Baseline runs will be possible, once climate data are available and the final selection of parameters has been made. The effect of CO₂ on photosynthesis and stomatal conductance has now been incorporated into 3-PG.

Regional modeling: Growth and yield

Climate and scenarios

Climate data from 20 models is pending, allowing for estimates of variability in growth and yield predictions. Scenarios will match those for 3-PG and WaSSI.

Baseline runs and model refinement

Initial baseline runs for 1980-1990 and 2060-2070 have been made and presented. These runs cover two management scenarios and two climate scenarios. Pending climate data, further runs will be made, adding estimates of variability to the outputs. LAI relationships have been provided to WaSSI.

Regional modeling: WaSSI

Ecosystem respiration, and CO₂ fertilization model changes (WUE, LAI)

We developed an ecosystem respiration (ER) model for loblolly pine plantations using 8 years of data collected from a drained wetland site on the eastern North Carolina coastal plain. The model can be used to simulate ecosystem respiration with air temperature and soil moisture. We found monthly mean ER is highly correlated with evapotranspiration. The scaling of the transpiration numbers for FACE and should be done with the full ET balance by the end of the August, 2014. Following that, we will use the NPP/GPP ratio from 3-PG to get a WUE for WaSSI.

We are testing several ecosystem respiration models developed from Fluxnet. Improved ER models will be implemented in WaSSI for use in PINEMAP project to understand the tradeoffs between carbon and water.

Baseline runs

WaSSI is ready to receive the MACA climate dataset. We are also testing light use efficiency-based GPP model as an alternative to WaSSI. We applied the WaSSI model to examine historic drought (1961-2012) impacts on US forests, results will be compared to field experiments from PINEMAP.

Regional Modeling: Community Land Model

The DAYCENT regional modeling has been replaced with regional modeling using the Community Land Model (CLM) Version 4.5. The CLM is the land model in the Community Earth System Model. We are using the version that includes the CENTURY model as the soil biogeochemistry model, which is also the same soil model in the DAYCENT model that was previously associated with this task. We are running the CLM at the 1 x 1 degree spatial resolution because that is the spatial scale of climate inputs.

Region wide parameterization (soils, weather, etc.)

We created a PINEMAP grid that replaces the global grid in the CLM. The PINEMAP grid was used to resample the global input datasets that describe soil physical properties. Currently, we are using the default parameterization for a needleleaf evergreen temperate tree to represent a loblolly tree (future plans to parameterize as loblolly). The weather inputs used output from Community Climate System Model (a precursor to the CESM) RCP 8.5 scenario simulation. This includes historical output (1850-2005) including historical data on forcing agents (CO₂, land-use, N deposition, solar) and future output (2006-2100) based on the RCP 8.5 scenario.

Simulate SOC stocks, calibrate model

To create a map of initial soil organic carbon stocks, we ran the CLM for 1000 years using climate from 1850-1880 and other forcings from 1850 (CO₂, N deposition, and land-cover) until equilibrium. The CLM was used with default parameterizations, except for modifying tree annual mortality rate from 2% to 1% to better match the lower mortality in planted pine. We modified simulated harvest to removing all tree boles at harvest and replanting. From the equilibrium 1850 initial conditions, we simulated 1850 to 1970 where vegetation was replaced with needle leaf evergreen trees and harvested every 25 years. Next we simulated from 1970 to 2100 with harvests every 25 years and no wildfire.

Baseline runs and model refinement

We have model output from 1970 to 2100 from RCP 8.5. Key variables in the output are the change carbon (vegetation and soil) stocks over each 25 year harvest cycle and average NPP, GPP, NEP, and R_H over each cycle. We will not refine the CLM with respiration data because it is difficult to perfectly match environmental conditions at the time that the respiration data was collected. However, we do plan to compare model-simulated to observed R_H to better understand if the model captures the general patterns in the observed R_H .

Forecasting

We have simulated the RCP 8.5 forecast and plan to simulate the RCP 4.5 forecast. Since the CLM requires sub-daily weather inputs, daily MACA output cannot be used, though it is important to note the CCSM input data used in the CLM is the same data MACA uses for the downscaled CCSM data. Since the other models (G&Y, 3PG, and WaSSI) will also use CCSM data as one of the MACA inputs, we can directly compare the CLM output to the output from other model simulations that use the CCSM MACA inputs.

Output to DSS

The final CLM simulations are still being processed before delivery to the DSS.

Regional modeling: SRTS

WaSSI and 3-PG baseline input

We have previously worked out the protocol and code to implement growth changes by age, region, and age class and done test runs with WaSSI. As discussed at the spring meeting we are working with 3-PG to refine protocols in anticipation of new runs. Bob Teskey et al. have created the 3-PG+ model with an accompanying algorithm to estimate FR, the 3-PG soil fertility factor that serves to mimic an index of site productivity. David Arthur Sampson created an original version code set (3-PGs) of the 3-PG model using 3-PG+ as the starting point. The 3-PGs base model was parameterized using the VPI FMC stand data set (using the Santosh FR algorithm) and validated using the FBRC IMPAC control sites.

Test runs

In anticipation of data becoming available in the last phases of the project we have moved our student support funding to a research associate position.

Aim 3 (Genetics) Milestones and Deliverables

Genotyping

Collect more phenotypic data on ADEPT2

Mengmeng Lu and an undergraduate intern spent three weeks collecting tissue samples and data from the ADEPT2 clonal trial planted near Saucier MS in May and June, 2014. Phenotypic data available now include specific leaf area, branch angle, crown width, total height, growth height, diameter, and number of fusiform rust galls. Measurements of carbon isotope discrimination and stomata density are underway on foliage to examine the relationship between water use efficiency and growth in the field. These phenotypic measurements will be used in conjunction with genotypes obtained from the same cloned individuals to test for associations.

Genotyping experiments underway at VT, NCSU, TAMU, and UF

The Texas A&M group is waiting for sequencing results from the first test of Nimblegen hybrid capture reagents to confirm the utility of that method before moving forward with more genotyping of the ADEPT2 clonal population, and the group at Virginia Tech is waiting for sequencing results from GBS libraries prepared from the Appomattox County, Virginia test site of the PSSSS test series. NC State is preparing to grow seedlings from two sets of about 40 parents that were used in large partial-diallel mating designs to create about 250 full-sib families. The phenotypic data from those progeny tests are in hand, and the seedlings will be used for RNA-seq experiments to test the hypothesis that gene expression levels can be used to model genetic variation in family mean performance.

Seed deployment tool for DSS

Version 1 Seed deployment tool

North Carolina State University: Additional analysis of variation among families within seed sources, using maximum and minimum annual temperature and total precipitation as climate variables, shows that 40% to 60% of the variation

in family performance relative to locally-adapted checklot families can be explained by three climate factors. The predictive power of these models will be tested by cross-validation to evaluate the stability of the models, and additional climate factors will be tested to assess which models have the best predictive power. If this method is successful with the PSSSS data, it can be extended to include other progeny test data to evaluate the approach across a more diverse set of germplasm from the current breeding population.

Texas A&M University has used a multinomial logit regression approach to develop a Categorical Universal Response Function (CURF) to delineate potential deployment zones for loblolly pine (*Pinus taeda* L.) using 15 year measurements from the Western Gulf Forest Tree Improvement Program (WGFTIP) Geographic Seed Source Study (GSSS). The CURF uses performance categories for the response variable, and the model assigns a probability score of a given seed source's response falling into each of these categories. Minimum temperature of the coldest month, summer precipitation, and variation measures of these two metrics for both the seed source provenance and the test location were used as independent variables. Planted tree volume, accounting for both survival and growth (a proxy for timber yield) was used as the response variable. Even with this limited number of environmental input variables, model performance was good, with the AUC score ranging from 0.785 to 0.808, depending on the parameters included and the evaluation criteria. The models developed with the CURF approach can be readily implemented in a Decision Support System as they 1) suggest sets of adapted families from which foresters can choose based on local knowledge, 2) can be easily expanded to include other variables, and 3) can be applied to outputs from projected climate scenarios to extrapolate into the future.

Final seed deployment tool

The Aim 3 Group will be working with the Deployment Decision Support Group to produce an interactive web application to produce 'heat-maps' showing historic and projected values for climate variables identified as important in our analysis.

Determine appropriate genome reduction methods for genotyping by sequencing

North Carolina State University: The relatively low yield of marker loci from the double-digest GBS method should still be useful for construction of kinship matrices based on Identity-By-Descent using reference-genome-based haplotypes, and these matrices will be incorporated into genetic analysis of the PSSSS data to assess the added value obtained from more precise measures of relationships. We are working in collaboration with Trudy Mackay's research group in the Genetics Program at NC State to re-assess the potential value of RNA-seq measurements of gene expression as predictors of phenotypic variation, based on unpublished results they have recently obtained in *Drosophila* lines derived from wild populations. Independent analysis of public data on gene expression levels and phenotypic variation in the mouse Collaborative Cross has confirmed the observation that genetic variation in levels of gene expression can be used to train a statistical model with some power to predict phenotypic variation, so a pilot experiment to determine the scale and power of an RNA-seq experiment on the PSSSS population is being planned.

Texas A&M University: Genotyping using Nimblegen SeqCap EZ System with the exon annotation based probes is underway. 20 samples have been sequenced in two lanes using Hiseq-2500 as a test. 158million and 170million reads were produced, respectively. The reads are currently being analyzed.

New markers for genotypes in ADEPT2, CCLONES, and PSSSS populations

Virginia Tech is using GBS to genotype ~1000 progeny of the PSSSS trial at Appomattox, VA, which will complement ongoing work at NC State that involves genotyping the same families at more southern sites. This will allow for testing of predictions based on genome-wide data across two different points in the climate space in which loblolly pine is planted.

Phenotypes for adaptive traits in ADEPT2 & CCLONES

In collaboration with Dana Nelson (USFS), Virginia Tech researchers are measuring cold hardiness for the ADEPT2 population at Saucier, MS. We will begin with a preliminary test in late fall and assuming genetic variation in this trait exists, we will proceed to a full replicated test in winter.

Aim 4 (Economics & Policy) Milestones and Deliverables

NPV and regional market impacts of altered disturbance risks

We have completed two publications in which we assessed the impacts of climate change on the economics of loblolly pine and slash pine. Both articles have been accepted for publications by the Journal of Agricultural and Applied Economics and Journal of Environmental Management.

Wildfire forecasts under varying climate and socio-economic scenarios have been developed. Using county level wildfire, socioeconomic and downscaled climate, we estimated a model using a three-stage heckman to account for the irregular missing observations. Forecasts were then generated on an annual basis for 9 climate/socio scenarios. A Monte Carlo analysis will be used to develop an uncertainty profile for each year's forecast for each ecoregion. The mean, median and confidence interval data will be available for use in a DSS or stand level NPV calculations. The analysis accounts for uncertainty in both wildfire recording and in climate forecasts.

We are building a GAMS-based bioeconomic model of invasive beetle impacts for southern loblolly pine forests. The model will link climate change-related factors to stand-level optimal rotations and regional markets for wood products.

Bioeconomic modeling of nontimber market ecosystem services

Using FIA data, we are employing data envelopment analysis to determine the efficiency of forest plots in the provision of ecosystem services. We are considering forest plots in Florida as a decision making units with inputs (for example, number of trees per ha, stand development, and site productivity) and outputs (timber production, species richness and carbon sequestration). This nonparametric approach would compare the efficiency of each forest plot with the most efficient plot given the existing conditions. Furthermore, the performance of each plot would be evaluated assuming changes in precipitation, temperatures and forest productivity.

Daniel Taylor-Rodriguez and Salvador A. Gezan (working with Co-PI Escobedo) completed "Ecosystem Service Interaction Analysis and Management-Ecological Driver Predictive Models using objective Bayes Procedures". This statistical analysis developed predictive models based on several FIA-based management and ecological factors that contains 2-way ecosystem service interactions among these variables. Interactions between aboveground carbon, herbaceous richness, net timber volume and saw timber volume were analyzed. Factors or drivers influencing these interactions were predicted and identified.

Assess tradeoffs between regional C sequestration, forest products, & maintenance of ecosystem services

We are finalizing an analysis on the effect of drivers on ecosystem service interactions in subtropical forests using a genetic algorithm. The manuscript used FIA plot-level data from Florida to develop an automated method that spatially identify pine-dominated stands that provide optimal level of ecosystem services and tests what climate change proxies (e.g. forest management activities, ecological/anthropogenic disturbance) significantly affect diversity, timber production, and carbon stores.

Aim 5 (Education) Milestones and Deliverables

PLT Secondary module

Design and test summative evaluation tools

We are making progress on a summative evaluation plan. A teacher self-efficacy tool was pilot tested during a teacher workshop in June 2014. A student knowledge test was pilot tested by high school students during a 4-H event.

Conduct regional workshops

We have two workshops planned. The first one is a 6-hour workshop in Asheboro, North Carolina on September 19. Given the short length of the workshop, we are not inviting researchers to give presentations at this event. The second training will be held in Little Rock, Arkansas November 13-15. As the agenda develops, we can invite specific presenters who may be interested in helping with a portion of the training.

Print module, revise website

The module, designed with input from 140 people, is currently being printed, and we are in the process of revising the website and online module materials. Through educator training opportunities, the team has reached more than 65 teachers to date.

Undergraduate fellowship program

Researchers mentor Undergraduate fellows

Twelve graduate students from seven of PINEMAP's collaborating universities agreed to participate in the 2014 undergraduate fellowship program, including completion of the Effectivce Communication Skills course and delivery of 107 presentations on forest resources at 25 secondary schools in the southeastern US, reaching a total of 2629 students.

Train 3rd cohort Undergraduate fellows

Twelve undergraduate students from seven universities across the southeastern US and Puerto Rico participated in research activities of three of PINEMAP disciplinary areas (Silviculture, Genetics, and Education) and learned about conducting forest resources research.

Aim 6 (Extension) Milestones and Deliverables

Extension outreach

The PINEMAP Extension program has two broad audiences: corporate and non-corporate planted pine landowners. The corporate effort centers around the outreach activities of the numerous regional forestry research cooperatives associated with PINEMAP, while the non-corporate effort is carried out primarily through traditional cooperative Extension channels. However, in many areas the two areas overlap and are synergistic. Based on a comprehensive needs assessment including surveys, phone calls, and in-person workshops, we have finalized outreach plans for both audiences to guide activities in the final phase of the project.

Conceptualization of "one-stop" web presence

The "one-stop" website is in the early design stages, currently, we have a draft framework. The initial iteration of website organization, as well as a selection of topics and features to be covered have been started.

Revive Regional Advisory Panels

Multiple advisors have been solicited for feedback on the DSS and outreach materials at two meetings (one foresters and one extension foresters). Additional meetings are scheduled for December 2014, January 2015 and February 2015.

Facilitate development of presentations; publicize, test, evaluate

Over the past year, we have produced 14 webinars for professional foresters presented by PINEMAP researchers and other professionals. We worked closely with them to guarantee the quality and relevance of their presentations. 739 people viewed the webinars for an average attendance of 53 per webinar.

Landowner fact sheets

More than 9 landowner factsheets have been completed since last year and more than 12 are in progress.

Professional Development webinars

14 PINEMAP webinars have been watched by 739 total viewers (professional foresters, targeted audience) and archived for further viewing.

Adaptive silvicultural training

Aim 6 personnel developed two workshops specifically on silvicultural training that trained a total of 300 foresters and landowners. About 45 other extension foresters were trained in adaptive forest management at 3 other workshops.

Facilitate development of presentations; publicize, test, evaluate

Aim 6 members facilitated development of presentations for the webinar series over the past year by guiding speakers and providing feedback on content and flow.

Decision Support System

Regional modeling output

A web interface has been developed to download the Multivariate Adaptive Constructed Analogs (MACA) dataset averaged over HUC12 regions. MACA was created using a statistical downscaling method with 20 global climate models from IPCC's 5th Assessment Report and two different emission scenarios across a baseline period (1950-2005) and future period (2006-2100). This state-of-the-art climate projection dataset provides the best data available for PINEMAP's modeling simulations. Unfortunately, processing and aggregation of the datasets to the appropriate spatial scale, and integration with the PINEMAP soils dataset, is very time intensive, both in terms of computer processing and project personnel. This has led to delays in the production of input datasets and subsequent regional modeling.

When complete, modelers can download CSV files for each requested time period (baseline, future), region (huc, state, PINEMAP), model, parameter, time step (daily, monthly, annual), and emission scenario (RCP 4.5, RCP 8.5, or both). Once the data begin processing, the user will be emailed a link to check the status of their request, and a subsequent email will be sent with a link to download the data.

Available parameters include the six standard outputs from MACA (min/max temperature, precipitation, wind speed, specific humidity, and solar radiation) at a daily time step as well as aggregated to monthly and annual time steps. Other calculated parameters are also available, which include monthly average mean temperature, frost days per month, growing season days, and summer dryness index. After downloading this data, the modelers will run it through their models and create output for the DSS.

Assess tools/information for market change inclusion: ecosystem services, timber yields, bioenergy

Identified individuals to provide feedback and much of the work will be done small pieces at a time through webinar meetings.

Regional model integration

The DSS team has been working closely with Evan Brooks to identify meaningful modeling outputs. We will continue this conversation during Fall 2014.

Beta testing of version 1

Identified testers and connected Ryan Boyles with those potential testers and established times/meeting for connection during Fall 2014.

Finalize overall design, time steps for backend model runs to generate data, risk/uncertainty visuals, determine min. and max. change for maps, create shopping cart for "data export"

The DSS team is refining a 3-panel display for the climate data tools. We are also ready to begin analyzing the MACA downscaled climate dataset. For this analysis, we will be generating multi-model means and +/-2 standard deviations for all variables across 20-year time periods (e.g. 2021-2040, 2041-2060, etc.). Feedback on these will be obtained from the beta testers and DSS subcommittee.

Version 1 of climate risk and opportunity tools

The multi-model means and +/- 2 standard deviation outputs will be displayed as a climate tool on the DSS using the 3-panel display described above.

Website design, look/feel, language

Initial website has been designed, and a second iteration of the website was completed. Aim 6 provided feedback on the look, feel and language of the website and also solicited feedback from other foresters.

DSS training; climate tools; seed deployment

The DSS will be rolled out at three Society of American Foresters (SAF) meetings across the PINEMAP region (SC, GA, and TX) during January 2015.

Broad Impacts

In a project of this scope, many broad impacts are built into our work plan. However, additional impacts arise that are not anticipated. Examples include the following:

Aim 2 (Modeling)

Both carbon and water resources are essential to the sustainability of the South. Our modeling studies provide insights of tradeoffs of among ecosystem services (water supply, timber supply, climate moderation). Climate change adaptation and mitigation measures must consider all the likely impacts on ecosystems and local economics.

Aim 3 (Genetics)

The NCSU Cooperative Tree Improvement Program is also part of the Integrated Biomass Supply System (IBSS) project funded at University of Tennessee-Knoxville under the bioenergy component of NIFA'S CAP program. The IBSS research conducted by NCSU CTIP is focused on chemical and physical properties of loblolly pine biomass, with a strong focus on wood. These properties are relevant to PINEMAP objectives because they affect the market for southern pine forest products, including solid wood products, pulp and paper as well as potential bioenergy markets that may develop.

Close ties are maintained between PINEMAP researchers and the PineRefSeq CAP, also funded by the bioenergy component of the CAP program, to fully exploit the value of the draft loblolly pine genome sequence for the breeding and genetic analysis objectives of the IBSS and PINEMAP research efforts. Texas A&M University applied the results of the draft loblolly pine reference genome assembly and annotation from PineRefSeq team for designing the capture probes used in the Nimblegen hybrid-capture sequencing experiment now being analyzed. The SNPs discovered from the captured exome sequences will be a supplement for the current pool of molecular markers which could be used in screening for better-adapted genotypes.

The application of the multinomial logit regression approach to the development of environmental models to guide assisted migration appears to have broader application to other areas such as the ecophysiological modeling of invasive plant movement.

Aim 5 (Education)

One offshoot of the Education Aim work is the opportunity for John Kidd to pursue dissertation research on the PINEMAP Undergraduate Fellowship Program and similar research experiences for undergraduates. John plans to conduct a meta-analysis of natural resource REUs including the Fellowship Program. This analysis would categorize, define, and describe current summer undergraduate research experiences and/or internships within the natural resource discipline. There may be a possibility for opening up any evaluations of the fellowship program to other natural resource REUs that currently do not have evaluations in place.

We have been able to involve many people representing a variety of expertise areas in our module development process through the advisory committee, expert review, pilot test, and incorporating student projects into undergraduate environmental education courses. These connections have provided opportunities to introduce PINEMAP research and to build relationships that will help us distribute and train educators to use the final module.

We have built a strong relationship with the University of Florida Center for Precollegiate Education and Training. This relationship has allowed us to test activities and evaluation tools, to present about climate change and forest topics, and to co-produce the Climate Change Symposium.

Aim 6 (Extension)

One important broad impact of the Extension team's work for PINEMAP has been collaborations with other similar projects, which focus on different natural resource sectors. PINEMAP's Aim 6 partnered with an animal livestock and climate change project (Animal Agriculture and Climate Change Project) as well as an agriculture and climate change project (Southeast Climate Extension), in order to collectively train about 100 extension agents on climate science/change and tools for their resource areas. This successful collaboration, called Southern Region Extension Climate Academy was first started after Martha Monroe presented results from her PINEMAP funded survey on

Southeastern Extension Agents' perceptions on climate change to extension directors from the southeast. After that, one extension director approached Martha as well as Bill Hubbard to discuss how best to train agents on these topics. From there, other partners were brought in to assist. One important focus of the academy has been to create a cohort of trained agents who can share ideas within their sectors and with their statewide colleagues. Within the forestry sector group, about 22 foresters have agreed to continue to share ideas and work together jointly on some projects as well- goals that are compatible with PINEMAP's larger goals.

Conversations and planning are underway regarding post-PINEMAP continuation of outreach programming. Much of this effort will likely involve the Southeast Regional Climate Hub, which is directed by PINEMAP co-PI Dr. Steve McNulty.

Training

As of August 2014, 57 graduate students, 39 undergraduate students, 14 postdoctoral research associates, and 22 professional and technical staff have been trained under the PINEMAP project. Names and roles of these individuals are listed in Appendix B.

Concluding Statement

The southern pine ecosystem is one of the most economically and ecologically important forest ecosystems in North America. The PINEMAP project is integrating key research, education, and outreach networks to create and disseminate the knowledge that enables landowners to harness planted pine forest productivity to mitigate atmospheric CO₂, more efficiently use nitrogen and other fertilizers, and adapt forest management approaches to increase resilience in the face of climate variability and change. In the fourth year of the project, we produced key products and results that will support these outcomes as described below.

Our focus on integration across disciplinary groups positions us to deliver the real-world outcomes embedded in our mission:

- Increased carbon sequestration from silvicultural and genetic enhancement of productivity and efficiency of fertilizer use, and resilience to climate variability and disturbance.
- Engaged and literate public with the capacity to make informed, practical decisions related to climate, forest ecosystems, and forest management.
- Public policy that supports sustainable management of planted pine under future climate scenarios.
- Enhanced capacity for regional, interdisciplinary collaboration among climate and forest scientists and Extension and education professionals.
- Enhanced connections between corporate and non-corporate forest landowners and forestry and climate researchers and education and outreach professionals.
- A more robust and resilient forest-based economy in the Southeast U.S.

Appendix A: Team Outputs

Products

Peer-reviewed publications

Aim 1 (Silviculture and Physiology) Peer-reviewed publications

Akers, M.K., M. Kane, D. Zhao, R.O. Teskey, and R.F. Daniels. 2013. Effects of planting density and cultural intensity on stand and crown attributes of mid-rotation loblolly pine plantations. *Forest Ecology and Management* 310: 468-475.

Albaugh, T.J., L.C. Kiser, T.R. Fox, H.L. Allen, R.A. Rubilar, and J.L. Stape. 2014. Ecosystem nutrient retention following fertilization of *Pinus taeda*. *Forest Science*. In press. <http://dx.doi.org/10.5849/forsci.13-159>

Albaugh, T.J., T.R. Fox, C.E. Blinn, H.L. Allen, R.A. Rubiliar, and J.L. Stape. 2013. Developing a new foliar-nutrient-based method to predict response to competing vegetation control in *Pinus taeda*. *Southern Journal of Applied Forestry* 37:196-201. <http://dx.doi.org/10.5849/sjaf.12-025>

Albaugh, J.M., T.J. Albaugh, R.R. Heiderman, Z. Leggett, J.L. Stape, K. King, K.P. O'Neill, J.S. King. 2014. Evaluating changes in switchgrass physiology, biomass, and light-use efficiency under artificial shade to estimate yields if intercropped with *Pinus taeda* L. *Agroforestry Systems* 88:489-503. <http://dx.doi.org/10.1007/s10457-014-9708-3>

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Products: Peer-reviewed publications

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Aim 2 (Modeling) Peer-reviewed publications

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Products: Peer-reviewed publications

Susaeta A., Carter, D., Adams, D. 2014. Sustainability of forest management under changing climatic conditions in the southern United States: adaptation strategies, economic rents and carbon sequestration. *Journal of Environmental Management* 139: 80-87.

Susaeta, A., Chang, S.J., Carter, D., Lal, P. 2014. Economics of carbon sequestration under fluctuating economic environment, forest management and technological changes: an application to forest stands in the southern United States. *Journal of Forest Economics* 20(1): 47-64.

Wear, D.N., E. Dixon, R.C. Abt, N. Singh. 2014. Projecting potential adoption of genetically modified Eucalyptus plantations. 52pp. Submitted to USDA Animal and Plant Health Inspection Service (APHIS) in response to Aborgen request for certification. *Forest Science*. Submitted.

Aim 5 (Education) Peer-reviewed publications

McCabe, S.M., J.F. Munsell, and J.R. Seiler. 2014. Forest Field Trips among High School Science Teachers in the Southern Piedmont. *Natural Sciences Education*. <http://dx.doi.org/10.4195/nse2013.01.0001>

Monroe, M. C., J. Ireland, and T. A. Martin. 2014. Innovations in Integrated Graduate Education. *Journal of Forestry*. Submitted.

Monroe, M. C., R. R. Plate, D. C. Adams, and D. J. Wojcik. 2014. Harnessing homophily to improve climate change education. *Environmental Education Research*. <http://dx.doi.org/10.1080/13504622.2014.910497>

Plate, R. and M. Monroe. 2014. A structure for assessing systems thinking. *The Creative Learning Exchange*, 23(1): 1-6. <http://clexchange.org/ftp/newsletter/CLEx23.1.pdf#page=1>

Aim 6 (Extension) Peer-reviewed publications

Burnett, R.E., Megalos, M.A., Vuola, A.J., Adams, D.C., and M.C. Monroe. 2014. North Carolina Cooperative Extension professionals' climate change perceptions, willingness, and perceived barriers to programming: An educational needs assessment. *Journal of Extension* 52(1). Available at <http://www.joe.org/joe/2014february/rb1.php>.

Krantz, S., Monroe, M., & Bartels, W. 2014. Creating Extension Programs for Change: Forest Landowners and Climate Change Communication. *Journal of Applied Environmental Education and Communication* 12(4): 272-279.

Morris, H.L., C. Megalos, M.A., Vuola, A.J., Adams, D.C., Monroe, M.C. 2014. Cooperative Extension and Climate change: Successful Program Delivery. *Journal of Extension* 52 (2).

Wojcik, D. J., M. C. Monroe, D. C. Adams, and R. R. Plate. 2014. Message in a Bottleneck? Attitudes and Perceptions of Climate Change in the Cooperative Extension Service in the Southeastern United States. *Journal of Human Sciences and Extension* 2(1): 51-70.

Products: Theses/Dissertations

Aim 1 (Silviculture/Ecophysiology) Theses/Dissertations

Clark, J.E. 2013. Physiology and growth of a 6-year-old loblolly pine (*Pinus taeda* L.) plantation in response to rainfall exclusion and fertilization treatments. M.S. Thesis, Auburn University, Auburn, AL. (Samuelson)

Clark, Z.S. 2014. Non-planted vegetation attributes and developmental patterns in loblolly pine plantations under varying cultural intensity and stand density. M.S. Thesis, The University of Georgia, Athens, GA. (Kane)

Heim, B.C. 2014. V. M.S. Thesis, Virginia Tech, Blacksburg, Va. (Seiler and Strahm)

Montecinos, P. 2013. Impact of fertilization and weed control on growth of loblolly, shortleaf, white and Virginia pine. M.F. Thesis. Virginia Tech, Blacksburg, VA. (Fox)

Nichols, L.K. 2013. Relationships among soil properties and soil CO₂ efflux in a loblolly pine-switchgrass intercropped system. M.S. Thesis, Virginia Tech, Blacksburg, VA. (Fox and Strahm)

Werner, A.E. 2013. Nitrogen release, tree uptake and ecosystem retention in a mid-rotation loblolly pine plantation following fertilization with 15N enriched enhanced efficiency fertilizers M.S. Thesis, Virginia Tech, Blacksburg, VA.(Fox)

Wightman, M. 2014. The impact of fertilization and throughfall reduction on *Pinus taeda* water relations and growth. M.S. Thesis, University of Florida, Gainesville, FL. (Martin)

Wilson, E. 2014. The drought response of physiological and structural traits in loblolly pine (*P. taeda* L.) clones with a focus on mesophyll conductance to CO₂. M.S. Thesis, Texas A&M University, College Station, TX. (West and Vogel)

Yanez, M.A. 2014. Management intensity effects on growth and physiological responses of loblolly pine varieties and families growing in the Virginia Piedmont and North Carolina Coastal Plain of the United States. Ph.D. Dissertation, Virginia Tech, Blacksburg, VA (Fox and Seiler)

Zhai, L. 2013. Finding Ideotypes by Examining Interactions among Silvicultural Intensity, Genotype, and Environment for Full-Sib Loblolly Pine Families. M.S. Thesis, Texas A&M University, College Station, TX. (Vogel)

Aim 4 (Economics and Policy) Theses/Dissertations

Joshi, O. 2013. Woody biomass and bioenergy opportunities in Mississippi. Doctor of Philosophy Dissertation. Mississippi State University. 118 p.

Aim 5 (Education) Theses/Dissertations

Hall, Stephanie. May 2013. Addressing climate change through biology concepts: Insights for educators. University of Florida Masters Thesis.

Aim 6 (Extension) Theses/Dissertations

Krantz, Shelby. Message Framing To Affect Forest Landowners' Intention To Adapt To Climate Change (Master's Thesis), January 2014. University of Florida, School of Forest Resources

Morris (Cole) H.L. 2013 Climate Change Attitudes of Southeast Forestry Professionals: Implications for Outreach. Master of Science Thesis, May 10, 2014, NC State University, <http://www.lib.ncsu.edu/resolver/1840.16/9225>

Burnett, R. E. 2014. Climate Predictors of Wildfire Size in North Carolina, 1979-2006: A Quantile Regression Approach. Master of Science Thesis, NC State University, <http://ww.live.ncsu.edu/resolver/1840.16/9399>

Products: Audio/video products

Aim 2 (Modeling) Audio/video products

Krantz, S. (Producer). 2014. PINEMAP Focus on Research: Focus on Water. Video from the Southeastern Forests and Climate Change: A Project Learning Tree Secondary Environmental Education Module.

<https://www.youtube.com/watch?v=-qFvYSG4r9E&index=13&list=PLgM-uU3vOAbIVCkFxqkwGNQPkRL0Rs7gl>

Aim 5 (Education) Audio/video products

Krantz, S. (Producer). 2013. PINEMAP Focus on Research: Modeling Climate and Tree Growth. Video from the Southeastern Forests and Climate Change: A Project Learning Tree Secondary Environmental Education Module.

<https://www.youtube.com/watch?v=EpIbkFw8nrs&list=PLgM-uU3vOAbIVCkFxqkwGNQPkRL0Rs7gl&index=12>

Krantz, S. (Producer). 2014. PINEMAP Focus on Research: Focus on Water. Video from the Southeastern Forests and Climate Change: A Project Learning Tree Secondary Environmental Education Module.

<https://www.youtube.com/watch?v=-qFvYSG4r9E&index=13&list=PLgM-uU3vOAbIVCkFxqkwGNQPkRL0Rs7gl>

Krantz, S. (Producer). 2014. PINEMAP Focus on Research: Drought, Fertilization and Tree Growth. Video from the Southeastern Forests and Climate Change: A Project Learning Tree Secondary Environmental Education Module.

<https://www.youtube.com/watch?v=QPfvctc47EA&index=14&list=PLgM-uU3vOAbIVCkFxqkwGNQPkRL0Rs7gl>

Aim 6 (Extension) Audio/video products

Forest Landowners Discuss Changes they've Witnessed- May 2014, Leslie Boby, Bill Hubbard and Shelby Krantz.

<https://www.youtube.com/watch?v=5E8xuC9KPTI&list=PLHu4PGejzrIw-WSdG8Jlb7h8R-mCRjXrm&index=1>

Managing for Resilient Forests, February 2014, Shelby Krantz.

<https://www.youtube.com/watch?v=bV7jlAGuhaA&list=PLHu4PGejzrIw-WSdG8Jlb7h8R-mCRjXrm&index=2>

Products: *Other publications*

Aim 3 (Genetics) Other publications

Byram, T.D., T.E. Koralewski and E.M. Raley. 2013. A climate change response function for loblolly pine (*Pinus taeda* L.) from the Western Gulf region of the United States. In: Proceedings of the 32nd Southern Forest Tree Improvement Conference. Advancing the Value of Forest Plantations. June 10-13, 2013, Clemson, SC, USA. <http://www.sftic.org> , p 36

Byram, T., T. Koralewski, G. Peter, J. Zhang, F. Isik, A. Farjat. 2013. Using Historical Progeny Tests to Optimize Pine Breeding and Deployment Strategies. PINEMAP (Pine Integrated Network: Education, Mitigation, and Adaptation Project) Year 2 Annual Report | March 2012-February 2013 "Mapping the future of southern pine management in a changing world". Pp. 28-29 http://www.pinemap.org/reports/annual-reports/PINEMAP_Year_2_Annual_Report_FINAL.pdf

Chhatre, V.E., M.F.R. Resende Jr., P.R. Munoz, G.F. Peter, J.M Davis, M.M. Kirst, C.S. Echt, K.V. Krutovsky, C. Dana Nelson, 2013. Multiple pedigrees allow construction of a densely populated reference linkage map in loblolly pine (*Pinus taeda* L.). In: Proceedings 32nd Southern Forest Tree Improvement Conference, Edited by Michael W. Cunningham, p. 53, June 10-13, 2013. Clemson, SC, USA (<http://www.sftic.org/f/2013%2032nd%20SFTIC%20Proceedings.pdf#page=67>)

Farjat, A., F. Isik, R. Whetten, S. McKeand, 2013. Modeling climate change effects on the growth of loblolly pine seed sources in the southeastern United States. In: Proceedings of the 32nd Southern Forest Tree Improvement Conference; 10-13 June 2013, Clemson South Carolina, USA. <http://www.sftic.org>, pp 24-26.

Krutovsky K., Byram T., Whetten R., Wheeler N., Neale D., Lu M., Koralewski T., Loopstra C. PINEMAP + PineRefSeq = Future Forests. PINEMAP (Pine Integrated Network: Education, Mitigation, and Adaptation Project) Year 2 Annual Report | March 2012-February 2013 "Mapping the future of southern pine management in a changing world". 2013. P. 26-27 (http://www.pinemap.org/reports/annual-reports/PINEMAP_Year_2_Annual_Report_FINAL.pdf)

McKeand, S. E., J. B. Jett, and T. Byram. 2014. Good wood. *Forest Landowners* 73(2): 14-19.

Steiger, J.J., B.P. Bullock, R.C. Abt, R.W. Whetten, 2013. Impacts of different levels of genetic homogeneity on juvenile stem characteristics and potential stand-level value in loblolly pine. In: Proceedings of the 32nd Southern Forest Tree Improvement Conference; 10-13 June 2013, Clemson South Carolina, USA. <http://www.sftic.org>, pp 27-29.

Wheeler, N.C., R. Whetten, 2013. The pine reference genome sequence and applied tree breeding. In: Proceedings of the 32nd Southern Forest Tree Improvement Conference; 10-13 June 2013, Clemson South Carolina, USA. <http://www.sftic.org>, pp 80-84.

Whetten R., Krutovsky K., Holliday J. Comparing Genotyping Technologies for Efficiency and Cost-effectiveness. PINEMAP (Pine Integrated Network: Education, Mitigation, and Adaptation Project) Year 2 Annual Report | March 2012-February 2013 "Mapping the future of southern pine management in a changing world". 2013. P. 30-31 (http://www.pinemap.org/reports/annual-reports/PINEMAP_Year_2_Annual_Report_FINAL.pdf)

Whetten R., Krutovsky K., Holliday J. Comparing Genotyping Technologies for Efficiency and Cost-effectiveness. PINEMAP Press (the Pine Integrated Network: Education, Mitigation, and Adaptation Project newsletter). 2012. №1: P. 6 (http://www.pinemap.org/publications/quarterly-newsletter-pinemap-press/Issue_1_Fall_2012.pdf)

Aim 4 (Economics and Policy) Other publications

Abt, R. 2013. Contributor to "Biomass Boom: Threat or Opportunity for Southern Forests". *BIOENERGY Connections* Vol. 2.3, UC Berkeley, Energy Biosciences Institute, Chris Woolston Lead Author.

Products: Other publications

Abt, R.C., C.S. Galik, R.W. Gonzalez. 2013. An Initial Assessment of Economics, Carbon Scores, and Market Impacts of Selected Woody Biomass Feedstock Biomass Systems. 22p. Electric Power Research Institute.

Jose Soto, Francisco J. Escobedo, Damian C. Adams. 2014. An Overview of Carbon Markets for Florida Forest Landowners. FOR319. Gainesville: EDIS/University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/FR387>

Jose Soto, Damian C. Adams, Francisco J. Escobedo. 2014. Florida Forest Landowner Preferences for Carbon Offset Program Characteristics. Gainesville: EDIS/University of Florida Institute of Food and Agricultural Sciences. In Press.

Khanal, P. N. and D.L. Grebner. 2012. A preliminary framework for evaluating the willingness of nonindustrial private forestland owners to practice optimum carbon sequestration regimes in Mississippi. In conference proceeding of Southern Forest Economists’ Workshop (SOFEW), 2012. Retrieved from /sofew.cfr.msstate.edu/.

Schultz, E.B., T.G. Matney, and D.L. Grebner. 2013. A Tree Biomass and Carbon Estimation System. Proceedings of the 15th Biennial Southern Silviculture Research Conference, Hot Springs, AR. Editor: Guldin, J., e-Gen. Tech. Rep. SRS-GTR- 175. Asheville, NC: USDA, Forest Service, Southern Research Station.

Aim 5 (Education) Other publications

Monroe, M. C., & Oxarart, A. (Eds.). 2014. *Southeastern forests and climate change: A Project Learning Tree secondary environmental education module*. Gainesville, FL: University of Florida and American Forest Foundation.

Aim 6 (Extension) Other publications

Forest Ecosystem Values Tool

The Forest Ecosystem Values Tool, funded in part by PINEMAP and hosted at texasforestinfo.com, is an online application that provides estimated economic values for certain ecosystem services and benefits provided by forests for forest practitioners and landowners. To date, there have been 166 unique users to use the tool.

Fact sheets: published

<i>To Plant or Not to Plant: New Timber Stand Drought Risk Assessment</i>	Eric Taylor and Sean Burns
<i>Drought and Southern Forests: The Importance of Forest Health and Resilience</i>	Rachel Burnett, Heather Dinon, Ryan Boyles, Mark Megalos, Eric Taylor, and Sean Burns
Climate Communication Series V3: <i>Obstacles to Delivering Climate Variability Programming to Traditional Audiences</i>	Mark Megalos, Martha C. Monroe, and Claire Layman Bode
Climate Communication Series V2: <i>Communicating through Climate Change Challenges</i>	Claire Layman Bode, Martha C. Monroe, and Mark Megalos
Climate Communication Series V1: <i>Challenges in Communicating Climate Change to Extension Audiences</i>	Martha C. Monroe, Claire Layman Bode, Mark Megalos
<i>Southern Pine Plantations and the Carbon they store: Important Information for the Forest Landowner</i>	Adam Maggard and Leslie Boby
<i>The Role of Woodlands in Climate Regulation</i>	Eric Taylor and Sean Burns
<i>The Role of Woodlands in the Bio-based Industry: Woody Biomass for Power and Products</i>	Eric Taylor and Sean Burns
<i>Climate Change Attitudes of Southeastern Foresters</i>	Leslie Boby, William Hubbard, and Shafkat Khan

Fact sheets: in development

<i>Assessing Forest Vulnerability</i>	Mark Megalos and Heather Dinon
<i>Climate Change and Forestry</i>	Leslie Boby and Heather Dinon

Products: Other publications

<i>Climate Change in the Southeastern United States: Opportunities for Adaptation and Mitigation</i>	Anslei Foster and Joshua Idassi
<i>Climate Oscillations: Impacts to Forestry</i>	Heather Dinon and Ryan Boyles
<i>Frequently Asked Questions about Climate Projections</i>	Heather Dinon and Ryan Boyles
<i>Glossary of Climate Terms</i>	Mark Megalos and Heather Dinon
<i>Herbicide Use Considerations</i>	Eric Taylor and Sean Burns
<i>Interpreting Uncertainty of Climate Model Projections</i>	Heather Dinon and Ryan Boyles
<i>Introduction to Weather and Climate</i>	Heather Dinon and Ryan Boyles
<i>Minimizing Forest Insect / Disease Risk: A Practical Landowner Guide</i>	Mark Megalos
<i>Misconceptions about Global Warming and Climate Change</i>	Heather Dinon and Ryan Boyles
<i>Thinning Recommendation Key</i>	Eric Taylor
<i>Drought and Southern Forests: Management Practices</i>	Eric Taylor and Mark Megalos
<i>Water Cycle in Forested Lands with Emphasis on Silvopasture Systems</i>	Shareika Williams and Gwendolyn Boyd
<i>What's Under the Umbrella that is Climate?</i>	Heather Dinon and Ryan Boyles
<i>Seedling Selection Tool Factsheet</i>	Eric Taylor
<i>Forest Resiliency Workbook</i>	Eric Taylor
<i>Woodlands Risk Assessment</i>	Eric Taylor and James Henderson

Events/Activities: Presentations

Aim 1 (Silviculture/Ecophysiology) Presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Akers, M.K.	PINEMAP Update: PMRC 2014 Annual Meeting	Presentation (Meeting)	July 17, 2014	2014 PMRC Annual Advisory Committee Meeting, Athens, GA
Ausmus, C.J., A.O. Maggard, R.E. Will, D.S. Wilson, T.C. Hennessey, and C.R. Meek	Response of soil CO ₂ efflux in a mid-rotation loblolly pine (<i>Pinus taeda</i> L.) exposed to extreme drought conditions	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Bartkowiak, S.M. and L.J. Samuelson	Interactive Effects of Throughfall Exclusion and Nutrient Availability on Sap Flux and Hydraulic Properties of 7-Year-Old Loblolly Pine	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Bartkowiak, S.M., and L.J. Samuelson	Potential impacts of climate change on transpiration and hydraulic properties of 7-year-old loblolly pine.	Poster Presentation	August 5-9, 2013	98th Ecological Society of America Meeting
Clark, Z., M. Kane, D. Zhao, D. Markewitz, and M. Akers	Effects of site, stand density, cultural intensity and site preparation techniques on non-planted vegetation attributes and developmental patterns in loblolly pine (<i>Pinus taeda</i>) plantations.	Presentation (Meeting)	July 2013	2013 PMRC Annual Advisory Committee Meeting, Athens, GA
Clark, Z., M. Kane, D. Zhao, D. Markewitz, and M. Akers	Effects of site, stand density, cultural intensity and site preparation techniques on non-planted vegetation attributes and developmental patterns in loblolly pine (<i>Pinus taeda</i>) plantations.	Presentation (Meeting)	January 2014	Southeastern Society of American Foresters Annual Meeting, Panama City Beach, FL
Clark, Z., M. Kane, D. Zhao, D. Markewitz, and M. Akers	Effects of stand density, management intensity, and site preparation technique on non-planted vegetation growth and developmental patterns in loblolly pine plantations	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Domec JC, Noormets A, King JS, McNulty SG, Sun G, Palmroth S, Swenson J, Oren R.	Reduced hydraulic redistribution under future climate will affect root water uptake and ecosystem carbon balance across divergent forest ecosystems	Presentation (Meeting)	May 14-15, 2013	DOE TES/SBR Joint Investigators Meeting
Domec JC, A Noormets JS King, SG McNulty, and G Sun	Convergence of the effect of root hydraulic functioning and root hydraulic redistribution on ecosystem carbon balance and drought-induced vegetation mortality across divergent forest ecosystems	invited presentation (meeting)	May 14-15, 2013	DOE TES/SBR Joint Investigators Meeting.
Domec JC, Noormets A, Stout A, King JS, Radecki A, Sun G, McNulty SG, Miao G, Zietlow DR, Ward EJ.	Aquaporin-mediated reduction in root hydraulic conductivity impacts whole stand water use and carbon assimilation: Scaling and modeling the effect of sea level rise from roots to the ecosystem.	poster presentation	May 6-7, 2014	DOE TES/SBR PI meeting, Potomac, MD
Domec JC, Noormets A, Stout A, King JS, Radecki A, Sun G, McNulty SG, Miao G, Zietlow DR, Ward EJ	Aquaporin-mediated reduction in root hydraulic conductivity impacts whole stand water use and carbon assimilation: Scaling and modeling the effect of sea level rise from roots to the ecosystem.	oral presentation	April 7-10, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE, Raleigh, NC
Gonzalez-Benecke, C.A.	Physiological processes predicting growth for slash pine	oral presentation	September 17-18	17 th annual meeting Forest Biology Research Cooperative, Perry, Florida
Gonzalez-Benecke, C.A.	Predicting climate change impacts on slash pine productivity in SE United States using physiological process based model 3-PG	oral presentation	July 28-30, 2014	3 rd International Conference on Earth Science & Climate Change, San Francisco, California
He, D., Vogel, J.G., Jokela E.J., Ruan, H., Hockaday W.C., and E.A.G. Schuur.	The effect of genetic selection and fertilization on the chemical characteristics of soil organic matter in managed loblolly pine forests as determined with nuclear magnetic resonance (NMR)	Presentation (Meeting)	Nov. 11th, 2013	Soil Science Society of America Meeting, Tampa Bay, FL.
Laviner, A. and T.R. Fox	Litter Decomposition and Nitrogen Fluxes Following Fertilization and Rainfall Exclusion Treatments	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Lin, W., A. Noormets, J.C. Domec, J. King, G. Sun, and	Isotopic estimates of water use efficiency: a high-throughput a-cellulose extraction method for softwood and its application	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA

Events/Activities: Presentations

S. McNulty				
Lin, W., A. Noormets, J.C. Domec, J. King, G. Sun, and S. McNulty	Seasonality of soil respiration partitioning coefficient at different Tier II sites	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Maggard, A.O., C.R. Meek, R.E. Will, D.S. Wilson, and T.C. Hennessey.	Drought and carbon stress mortality in loblolly pine (<i>Pinus taeda</i> L.).	Poster Presentation	October 24-26, 2013.	Society of American Foresters Annual Meeting. Charleston, SC.
Maggard, A.O., R.E. Will, C.R. Meek, C. Ausmus, and D.S. Wilson	Physiological mechanisms related to drought mortality of mid-rotation loblolly pine (<i>Pinus taeda</i> L.)	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Maier, C.A.	Ecophysiological differences in tree carbon gain and water use for two fast growing loblolly pine ideotypes that differ in carbon allocation.	Presentation Meeting	September 17-18, 2013	17 th annual meeting Forest Biology Research Cooperative, Perry, Florida
Maier, C.A., D. McInnis, and K.H. Johnsen	Partitioning root and heterotrophic respiration from soil CO ₂ efflux in two loblolly pine clones that differ in growth efficiency and carbon allocation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Maier, C.A., K.H. Johnsen, P. Dougherty, T. Albaugh, and S. Patterson	Ecophysiological differences in tree carbon gain and water use for two fast growing loblolly pine ideotypes that differ in carbon allocation	Presentation Meeting	December 9-12, 2013	American Geophysical Union, San Francisco, CA
Martin, T.A.	PINEMAP Outcome Themes: CO ₂ mitigation through productivity and resilience	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
McCarthy, H.R., R. Oren, D. Kim, P. Torngern, K.H. Johnsen, and C.A. Maier	Harvesting Duke FACE: improving estimates of productivity and biomass under elevated CO ₂ .	Presentation (Meeting)	December 9-12, 2013	American Geophysical Union, San Francisco, CA
McElligott, K.M., J.R. Seiler, and B.D. Strahm	Fertilization and Throughfall Reduction Effects on Soil Respiration as Mediated by Extracellular Enzyme Activity and Litter Decomposition	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Meek, C.R., R.E. Will, D.S. Wilson, and J. Vogel	Fertilization decreases soil CO ₂ efflux of mid-rotation loblolly pine (<i>Pinus taeda</i> L.) stands in southeastern Oklahoma	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Noormets A., S.G. McNulty, G. Sun, J.C. Domec, M.G. Gavazzi, and J.S. King	The effect of management on forest carbon fluxes	Presentation (meeting)	December 9-13, 2013	AGU Fall Meeting, San Francisco, CA
Noormets A., J.C. Domec, G. Sun, M. Gavazzi, S. McNulty, J.S. King, and I. Thompson	Soil carbon budget and sustainability of timber production on the coastal plain.	Invited presentation (meeting)	November 14, 2013	Weyerhaeuser Catchlight Energy Sustainability Studies Meeting, New Bern, NC
Noormets A	Carbon and water cycling in loblolly pine. (Field tour for Southern University Global Sustainability Initiative's summer interns. Instructor: E. Reyes from ECU.)	Field tour	July 24, 2014	US-NC2 research site at Parker Tract, Washington County, NC
Noormets A, Gavazzi M, Domec JC, Sun G, Zietlow DR	Field trip to Parker Tract Eddy Flux Water and Carbon Flux Study. (part of: International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond, ASABE, Raleigh, NC.	Field trip	April 10, 2014	US-NC2 research site at Parker Tract, Washington County, NC
Pell, C.J. and L.J. Samuelson	Long-term interactive effects of throughfall exclusion and fertilization on physiology of loblolly pine (<i>Pinus taeda</i> L.)	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Qi, J. and D. Markewitz.	Effect of Drier Summers on Deep Soil Carbon and Hydrology	Interactive Webinar	September 13, 2013	PINEMAP Internal Webinar Series

Events/Activities: *Presentations*

Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	November 3-6, 2013	Soil Science Society of America Annual Meeting Tampa, FL
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	February 24-25, 2014	Soil Science Society of Georgia Annual Meeting, Athens, GA
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon and Hydrology	Poster Presentation	February 19-21, 2014	Symposium of Warnell School of Forestry and Natural Resources, UGA
Qi, J. and D. Markewitz.	Drier Summers: Effects on Deep Soil Carbon	Poster Presentation	July 16-17, 2014	PMRC Annual Meeting Athens, GA
Qi, J. and D. Markewitz.	Effects of Drier summers on Deep Soil Carbon	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Qi, J. and D. Markewitz	Effect of Wetting/Drying Cycles on Deep Soil Carbon in a Southeastern US Loblolly Pine Plantation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Subedi, S. and T.R. Fox	Baseline Fertility Rating Assessment in the 3-PG Model for Loblolly Pine Plantations Across the Southeastern United States	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Teskey, R.	Scenarios for PINEMAP Simulations	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Thompson I., A. Noormets, M. Gavazzi, and Z. Legget	Root decomposition study	Presentation	August 27, 2013	Weyerhaeuser-NCSU Co-operators Meeting
Vogel, J.G., Jokela E.J., He D., Hockaday W.C., and E.A.G. Schuur	The effect of fertilization levels and genetic deployment on soil organic matter chemistry and turnover in managed loblolly pine forests	Poster	Dec. 10th, 2013	American Geophysical Union Meeting, San Francisco, CA.
Ward, E.J	Sap Flux Sensor Networks at Tier 3 Sites	Interactive Webinar	February 15, 2013	PINEMAP Internal Webinar Series
Ward, E.J.	Tier 3 Sap Flux Data Processing Protocols and Programs.	Interactive webinar	May 28, 2013	PINEMAP Internal Webinar
Ward, E.J., J.-C. Domec, G. Sun, S. McNulty, J.S. King and A. Noormets	Sap Flux Measurements at Virginia Tier III Site.	Poster	April 24-26, 2013.	PINEMAP 2013 Annual Meeting. Athens, GA.
Ward, E.J., J.C. Domec, G. Sun, S. McNulty, J. King, and A. Noormets	Transpiration and Canopy Conductance at the Virginia Tier 3 Site	Poster Presentation	April 24-26, 2013	PINEMAP 2013 Annual Meeting, Athens, GA
Ward, E.J., J.-C. Domec, G. Sun, S. McNulty, J.S. King and A. Noormets	Transpiration and Canopy Conductance of Loblolly Pine with Fertilization and Throughfall Exclusion.	Poster	June 5, 2013	North Carolina State Univ. Postdoc Research Symposium. Raleigh, NC.
Ward, E.J., J.-C. Domec, G. Sun, S. McNulty, J.S. King and A. Noormets	Transpiration and Canopy Conductance of Loblolly Pine with Fertilization and Throughfall Exclusion.	Poster	August 9, 2013	Ecological Society of America Annual Meeting. Minneapolis, MN.
Ward, E.J.	Pine Integrated Network: Education, Mitigation, and Adaptation Project (PINEMAP)	Presentation (Seminar)	November 14, 2013	Triangle Climate & Landscape Researchers, Raleigh, NC
Ward, E.J., D.M. Bell, J.S. Clark, H.R. McCarthy, H.-S. Kim, J.-C. Domec, A. Noormets, S. McNulty, G. Sun, and R. Oren	Stomatal conductance at Duke FACE: Leveraging lessons from 11 years of scaled sap flux measurement for region-wide analyses.	Poster Presentation	December 9, 2013	American Geophysical Union, Fall Meeting, San Francisco, CA
Ward E.J., Domec JC, Sun G, McNulty SG, King JS, Noormets A.	Transpiration and Canopy Conductance of Loblolly Pine with Fertilization and Throughfall Exclusion: Early Results from PINEMAP.	oral presentation	April 7, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE,

Events/Activities: Presentations

				Raleigh, NC
Ward, E.J.	Cross-site Integration of Sap Flux Data.	Oral Presentation	May 15 2014	PINEMAP Annual Meeting, Athens, GA
Wightman, M., T. Martin, and C. Gonzalez	The Impact of Fertilization and Throughfall Exclusion on loblolly pine (<i>Pinus taeda</i>) Growth and Water Use	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Will, R.E.,	Mid-rotation Management Under Extreme Stressors.	Presentation (Meeting)	Dec. 12 2013.	Western Gulf Silvicultural Technology Exchange. Shreveport, LA
Wilson, E., Vogel J.G. and J.B. West.	The effects of water stress on variability in mesophyll conductance of loblolly pine (<i>Pinus taeda</i> L.) leaves	Poster Presentation	August 9 th , 2013	Ecological Society of America Meeting
Wilson, E., Vogel J.G. and J.B. West	Variability of mesophyll conductance to CO ₂ and coordination of physiological traits in loblolly pine (<i>P. taeda</i> , L.)	Oral Presentation	May 22nd, 2014	Ecological Integration Symposium, College Station, TX
Wilson, E.	Drought Stress and Loblolly Pine Leaf Physiology: Using Carbon Stable Isotope Analysis to Examine Water Use Efficiency and Mesophyll Conductance	Interactive Webinar	September 13, 2013	PINEMAP Internal Webinar Series
Wilson, E.S., J.B. West, J.G. Vogel, A. Volder, M. Wigley, and J.C. Domec	The drought response of physiological and structural traits in loblolly pine (<i>P. taeda</i> L.) clones with a focus on mesophyll conductance to CO ₂	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, and R.O. Teskey	Effects of throughfall exclusion and fertilization on soil CO ₂ efflux in a loblolly pine (<i>Pinus taeda</i>) plantation	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Yang, J., C.M. Luedtke, M.K. Akers, M. McGuire, Doug P. Aubrey and R.O. Teskey	Effects of throughfall exclusion and fertilization on soil CO ₂ efflux and its components in a loblolly pine (<i>Pinus taeda</i>) plantation	oral presentation	Aug 10-15, 2014	99th Ecological Society of America Meeting
Zhang, Y., West J.B., Will R.E. and J.G. Vogel.	Effects of fertilization and drought on substrate decomposition and inorganic nitrogen concentration in a managed loblolly pine forest	Poster Presentation	Dec. 10 th 2013	American Geophysical Union Meeting, San Francisco, CA
Zhang, Y., J. Vogel, and J. West	Effect of climate change and forest management on wood mass loss in a southeastern US loblolly pine forest	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Zhao, D., M. Kane, R. Teskey, T.R. Fox, T.J. Albaugh, H.L. Allen, J. Stape, R. Rubilar	Maximum Response of loblolly pine plantations to increased culture	oral presentation	July 17, 2014	PMRC Advisory Committee Meeting, Athens, GA
Zietlow D, Noormets A, King JS, Sun G.	Energy and Water Balance of Contrasting Land uses of Forested Wetlands in North Carolina's Lower Atlantic Coastal Plain	oral presentation	April 7-10, 2014	International Symposium: Evapotranspiration: Challenges in Measurement and Modeling from Leaf to the Landscape Scale and Beyond. ASABE, Raleigh, NC

Aim 2 (Modeling) presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Ahlswede, B.J. and R.Q. Thomas	Biophysical Climate Effects of Sub-biomes within the Temperate Forest: Implications for Plantation Forestry and Urban Expansion in the Southeastern United States	Poster	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Gopalakrishnan, R., V.A. Thomas, J. Coulston, and R.H. Wynne	Producing a canopy height map over a large region using heterogeneous lidar datasets	Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA

Events/Activities: Presentations

Ross, C.W., S. Grunwald, S. Gerber, L. Kobziar, and E.A.G. Schuur	Modeling the effects of climate change on terrestrial carbon pools across the Southeastern U.S.	Poster	January 6-9, 2014	NIFA Climate Change Project Directors Meeting, Gainesville, FL.
Ross, C.W., S. Grunwald, L. Kobziar, and S. Gerber	Using DayCent to model ecosystem dynamics in managed pine	Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Wynne, R.	Regional model upscaling	Poster Presentation	January 6-9, 2014	NIFA Climate Change Project Directors Meeting, Gainesville, FL.
Sun, G., P. Caldwell, Steve McNulty, Erika Cohen, and Jennifer Moore Myers.	WaSSI: Modeling Impacts of Global Change on Ecosystem Services.	Poster	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Sun, G., S. McNulty, and Y. Liu	Interactions of Climate, Carbon, and Water in the Southeastern Forests	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Sun, G., P. Caldwell, S. McNulty	From Forests to Faucets: Water Supply Functions of Forests	Presentation	Oct 6-11, 2014	2014 IUFRO Conference, Salt Lake City, UT

Aim 3 (Genetics) presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Byram, T.	Valuing the family tree: Open-pollinated vs. control-pollinated families	Presentation (Meeting)	April 25-26, 2014 (Meeting)	2014 Four State Forestry Conference, Texarkana, TX
Casola, C.	How forest genomics at Texas A&M can impact the breeding program	Presentation (Meeting)	May 6-7, 2014	WGFTIP Contact Representatives Meeting, Jasper, TX
Casola, C.	Using genomics to study pine tree adaptation and phenotypic variation	Presentation (Meeting)	March 25-26, 2014	WGFTIP Executive Committee Meeting, Shreveport, LA
Dasgupta, M. G., V. Dharanishanthi, and K.V. Krutovsky	Development of Genetic Markers in Eucalypt Species by Target Enrichment and Exome Sequencing	Poster Presentation	January 11-15, 2014	Plant and Animal Genome XXII. The International Conference on the Status of Plant and Animal Genome Research, San Diego, CA
Farjat, A., F. Isik, R. Whetten, and S. McKeand	Modeling the Growth of Loblolly Pine in the Southeastern United States	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Farjat, A., F. Isik, R. Whetten, and S. McKeand	Modeling Climate Change Effects on the Growth of Loblolly Pine Seed Sources in the Southeastern United States	Presentation (Meeting)	May 22 – 23, 2013	NCSU Cooperative Tree Improvement Program Advisory Board Meeting, Raleigh NC.
Farjat, A., F. Isik, S. McKeand, and R. Whetten	Modeling Growth Performance of Loblolly Pine Families Under Differing Climate Conditions	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Farjat, A., F. Isik, R. Whetten, S. McKeand	Modeling climate change effects on the growth of loblolly pine seed sources in the southeastern United States.	Presentation (Meeting)	June 10 – 13, 2013	32nd Southern Forest Tree Improvement Conference, Clemson SC.
Koralewski, T.E., T.D. Byram, and E.M. Raley	A climate change response function for loblolly pine (<i>Pinus taeda</i> L.) from the Western Gulf region of the United States	Presentation (Conference)	February 4-7, 2013	Breeding for Value in a Changing World, sponsored by the Breeding and Genetic Resources of Southern US and Mexican Pines, IUFRO Working Group 2.02.20. Jacksonville, Florida
Koralewski, T.E., H.-H. Wang, and T.D. Byram	In search of optimal strategies for delineating assisted migration guidelines as applied to loblolly pine families from the Western Gulf region of the USA	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Krutovsky, K.V.	High-throughput genome-wide genotyping and targeted sequencing in loblolly pine (<i>Pinus taeda</i> L.)	Presentation (Meeting)	June 7-9, 2013	Second meeting of the Alpine Forest Genomics Network (AForGeN), Neukirchen am Großvenediger, Salzburg, Austria

Events/Activities: Presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Krutovsky, K.V.	The <i>Pinus sibirica</i> and <i>Larix sibirica</i> genome projects	Presentation (Summit)	June 14-17, 2013	The 2013 Conifer Genome Sequencing Summit in Björkliden, Lapland, Sweden
Krutovsky, K.V.	Forest tree genomics for understanding local adaptation and population responses to changing climate	Invited presentation (Colloquium)	December 10, 2013	Ecology, Conservation and Biodiversity Colloquium, University of Marburg, Germany
Krutovsky, K.V.	Innovative approaches for <i>de novo</i> sequencing of large complex genomes.	Presentation (training workshop)	July 19-21, 2013	Scientific Training School "Genomic Sequencing and Data Analysis", Novosibirsk, Russia (http://conf.nsc.ru/seq2013)
Krutovsky, K.V.	Targeted and complete genome <i>de novo</i> sequencing in conifer trees with giant and complex genomes	Presentation (Conference)	July 21-25, 2013	"High-Throughput Sequencing in Genomics" (HSG-2013), Novosibirsk, Russia (http://conf.nsc.ru/files/conferences/HSG/183699/%D1%82%D0%B5%D0%B7%D0%B8%D1%81%D1%8B%20HSG_end.pdf)
Krutovsky, K.V., V.E. Chhatre, M. Lu, T.D. Byram, J.L. Wegrzyn, D.B. Neale, and C. Loopstra	High-Throughput Genome-Wide Genotyping, Targeted Sequencing and Association Mapping of Adaptive and Breeding Traits in Loblolly Pine (<i>Pinus taeda</i> L.) Populations	Presentation (Conference)	January 11-15, 2014	Plant and Animal Genome XXII. The International Conference on the Status of Plant and Animal Genome Research, San Diego, CA
Lu, M., C. Loopstra, and K.V. Krutovsky	Genome Target Sequencing in Loblolly Pine (<i>Pinus taeda</i> L.) using Different Multiplexing Strategies	Presentation (Symposium)	May 15-16, 2013	The Molecular and Environmental Plant Sciences (MEPS) symposium "Plant signaling systems – from cells to environment", Texas A&M University, College Station, TX
Lu, M., K. Krutovsky, C.D. Nelson, T. Byram, and C. Loopstra	Phenotyping environmental adaptation and stress mitigation traits in the clonal loblolly pine association mapping population ADEPT2	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Lu, M., K. Krutovsky, C.D. Nelson, T. Byram, T. Koralewsky, and C. Loopstra	Genetics of Adaptation and Stress Mitigation Traits in the Clonal Loblolly Pine (<i>Pinus taeda</i> L.) Association Mapping Population	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
McKeand, S., J. Steiger, J. Andrews, D. Barker, R. Whetten, T. Brooks, F. Isik.	And they're off! - Fourth-cycle of loblolly pine breeding has begun in the NCSU Cooperative Tree Improvement Program	Presentation (Meeting)	June 10 -13, 2013	32nd Southern Forest Tree Improvement Conference, Clemson SC.
Taylor, E.	Impact of faster growth on a thinning decision support tool	Presentation (Meeting)	May 6-7, 2014	WGFTIP Contact Representatives Meeting, Jasper TX
Townsend, L., R. Whetten.	Identifying Genetic Variation in Site Adaptability in Loblolly Pine	Poster Presentation (best poster award)	June 10 – 13, 2013	32nd Southern Forest Tree Improvement Conference, Clemson, SC.
Townsend, L., R. Whetten	High-throughput sample collection and DNA extraction methods for tree breeding	Presentation (Meeting)	May 22 – 23, 2013	NCSU Cooperative Tree Improvement Program Advisory Board Meeting, Raleigh NC
Townsend, L. and R. Whetten	Identifying Genetic Variation in Loblolly Pine	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Vogel, J	Can silviculture and genetic deployment affect the sensitivity of managed pine stands to disturbance?	Presentation (Meeting)	May 6-7, 2014	WGFTIP Contact Representatives Meeting, Jasper, TX
Wheeler, N.C., R. Whetten	The pine reference genome sequence and applied tree breeding	Presentation (Meeting)	June 10 – 13, 2013	32nd Southern Forest Tree Improvement Conference, Clemson, SC.

Events/Activities: *Presentations*

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Whetten, R., W. Kohlway, L. Townsend	Impacts of cost-effective high-throughput genotyping of loblolly pine on applied tree breeding programs	Presentation (Meeting) (best oral presentation award)	June 10 – 13, 2013	32nd Southern Forest Tree Improvement Conference, Clemson SC.
Whetten, R.W.	PINEMAP research and applied tree breeding	Presentation (Meeting)	May 22 – 23, 2013	NCSU Cooperative Tree Improvement Program Advisory Board Meeting, Raleigh NC
Whetten, R.W.	Testing gene expression patterns as predictors of pine family performance	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Zhang, J., S.A. Gezan, and G.F. Peter	Integrating Climate and Genetic Effects of Loblolly Pine by Universal Response Functions	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA

Aim 4 (Economics and Policy) presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Abt, K.L., R.C. Abt, C.S. Galik, K.E. Skog, and A.L. Stephenson	Effect of policies on wood pellet production and forests	Presentation	July 28, 2014	Annual Meeting of the Southern Forest Resource Assessment Consortium, Durham, NC
Abt, R.C.	SRTS Model: Updates and Applications.	Presentation	August 8, 2013	Annual Meeting of the NCSU Southern Forest Assessment Consortium, Durham, NC.
Abt, K.L.	Modeling timber demand for use in SRTS.	Presentation	August 8, 2013	Annual Meeting of the NCSU Southern Forest Assessment Consortium, Durham, NC.
Abt, R.C. (presenter, invited), K.L. Abt, C. Galik, F.W. Cabbage.	Bioenergy Demand and the Southern Forest Resource.	Presentation	May 14, 2013	Packard Foundation. Washington DC
Abt, R.C.	Expectations and sustainability.	Presentation	May 14, 2013	Packard Foundation. Washington DC.
Abt, R.C. (presenter, invited), T. Adams, S. Houston, M. Luppold.	SC Forest Resource Projections: a 20/15 program assessment.	Presentation	October 2013	South Carolina Forestry Association. Asheville, NC.
Abt, R.C. (presenter), K.L. Abt, C. Galik.	Bioenergy Demand and the Southern Forest Resource.	Presentation	September 20, 2013	Energy Biosciences Institute, University of Illinois. Urbana-Champaign, IL.
Adams, D.	PINEMAP Outcome Themes: Public Policy and Economy	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
An, H., J. Gan, and K. Clifton	Impact of Climate Conditions and Adaptation on Southern Pine Beetle Infestations	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Escobedo, F.J.	Using regional forest inventory data to analyze ecosystem service tradeoffs and synergies	Presentation	August 26, 2014	8th Forest Vegetation Management IUFRO meeting, Halmstad Sweden
Gan, J.	Why should we buy US made forest products: economic and environmental perspectives	Presentation (Meeting)	April 9, 2014	Texas Society of American Foresters Annual Meeting, Athens, Texas
Gan, J., A. Jarrett, C. Johnson Gaither	Propensity of landowners to purchase wildfire insurance: Implications for adaptation to wildfire risk under climate variability	Presentation (Conference)	May 28, 2014	International Conference on Social Sciences, Honolulu, HI

Events/Activities: *Presentations*

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Gan, J.	Transnational leakage of forest conservation: Implications for REDD and offshore outsourcing	Presentation (Keynote, Conference)	July 16, 2014	IUFRO Second Global Forum on Ecological Economics in Forestry, Nanjing, China
Grebner, D.L., Grala, R.K., Henderson, J.E., and O. Joshi	An approach and framework for assessing the use of woody biomass as a bioenergy feedstock in the United States West Gulf Coast Region.	Presentation (Conference)	May 19-23, 2014	International Symposium of International Union of Forestry Research Organizations (IUFRO), Joint Units 4.05.00 and 3.08.00. Sopron, Hungary
Grebner, D.L., Grala, R.K., and O. Joshi	Current status of woody biomass research in the United States Mid-South	Presentation (Conference)	October 6-9, 2013	Forest Biomass Conference in Mierzęcin, Poland.
Grebner, D.L., Grala, R.K., and O. Joshi	Current status of woody biomass research in the United States Mid-South	Presentation (Conference)	January 29, 2014	Seminar Series, Northern Arizona University, Flagstaff, AZ
Henderson, J., J. Gordon, S. Dicke, G. Hughes, J. Kushla, B. Self, C. Siegert, D. Grebner, and P. Khanal	Climate Change Related Extreme Weather Events and Risk Management Options for Family Forests.	Presentation (Conference)	July 20-24, 2014	99th Annual Meeting and Professional Improvement Conference of the National Association of County Agricultural Agents, Mobile, AL
Khanal, P. and D.L. Grebner	Factors affecting NIPF willingness to sequester forest carbon in the South	Presentation (Conference)	March 7, 2014	International Society of Forest Resource Economics Annual Meeting, St. Louis, MO
Khanal, P. and D.L. Grebner	Non-industrial private forest landowner obstacles to forest carbon sequestration in the Southern United States	Presentation (Conference)	March 16-18, 2014	Southeastern Natural Resources Graduate Student Research Symposium, Mississippi State University, MS
Khanal, P. and D.L. Grebner	Non-Industrial Private Forest Landowner obstacles to Forest Carbon Sequestration in the Southern United States	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Prestemon, J.P (presenter), U. Shankar, A. Xiu, K. Talgo, D. Yang, E. Dixon IV, and K.L. Abt.	Human and Lightning Wildfire Projections for the Southeastern U.S.: 2015-2060.	Presentation (Conference)	March 17, 2014.	International Society for Forest Resource Economics, St. Louis, MO.
Prestemon, J.P (presenter), U. Shankar, A. Xiu, K. Talgo, D. Yang, E. Dixon IV, and K.L. Abt.	Wildfire and Climate Change in the South.	Presentation (Conference)	October 21, 2013.	Forestry and Environmental Resources Departmental Seminar, NCSU, Raleigh, NC.

Aim 5 (Education) presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Kidd, J. B., J. R. Seiler, M. C. Monroe, S. Sriharan	Undergraduates using climate and forest ecosystem issues to engage secondary school students	Poster Presentation	October 23-27, 2013	Society of American Foresters National Convention, North Charleston, SC
Kidd, J. B.	Evaluation of an innovative research experience for undergraduates: The PINEMAP Undergraduate Fellowship Program	Poster Presentation	March 3, 2014	Connections 2014 Conference, Blacksburg, VA
Kidd, J. B., J. R. Seiler, M. C. Monroe, S. Sriharan	Two years in: reflections on the PINEMAP undergraduate fellowship program	Presentation	March 15, 2014	Biennial Conference on Undergraduate Education in Natural Resources (BCUENR) Conference, Auburn, AL

Events/Activities: *Presentations*

Krantz, S.	Engaging Audiences through Video	Roundtable Presentation	October 11, 2013	North American Association for Environmental Education (NAAEE) conference, Baltimore MD
Krantz, S.	Video as a Research Tool	Roundtable Presentation	October 9, 2013	North American Association for Environmental Education (NAAEE) Research Symposium, Baltimore MD
Kunkle, K.	Evaluating Websites in Environmental Education and Extension	Poster Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL
Kunkle, K. and M. Monroe	Evaluating Web Tools in Environmental Education and Extension	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Kunkle, K. and M. Monroe	Applying a Motivated Reasoning Framework to Mitigate Cultural Conflict in Climate Change Education	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Li, J.	Formative Evaluation as a Tool for Bridging the Research-Practice Gap	Roundtable Presentation	October 9, 2013	North American Association for Environmental Education (NAAEE) Research Symposium, Baltimore MD
Li, J. and M. Monroe	Effective Climate Change Education: Making Hope Happen	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Li, J. and M. Monroe	Evaluating the Effectiveness of PLT Secondary Module	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Li, J. and M. Monroe	Assessing Teens' Misconceptions about Climate Change	Poster Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL
Monroe, M. C., and J. Li	Climate Change Mitigation & Adaptation	Presentation	July 18, 2013	University of Florida Center for Precollegiate Education and Training, Gainesville, FL
Monroe, M. and J. Li	Climate Change in the Classroom	Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL
Monroe, M., K. Kunkle, T. Ritchie, and S. Krantz	PLT Secondary Module: Southeastern Forests and Climate Change	Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL
Monroe, M. C., A. Oxarart, J. Li, T. Ritchie, K. Kunkle	Module Activities on Forest Management and Life Cycle Analysis (6, 50-minute classes)	Presentation	November 12-19, 2013	Santa Fe High School, Alachua, FL
Monroe, M.C.	PINEMAP's Required Graduate Course: An innovation in integrated education	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Monroe, M.C.	PINEMAP Outcome Themes: Engaged and Literate Public	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Monroe, M.C.	Southeastern Forests and Climate Change: A PLT Secondary Module	Webinar	April 16, 2014	Climate Educators Professional Development, Will Steger Foundation, Minnesota
Monroe, M. C.	Southeastern Forests and Climate Change: A PLT Secondary Module	Webinar	June 5, 2014	Climate Science Initiative, Association of NR Extension Professionals (CSI-ANREP)
Monroe, M. C.	Southeastern Forests and Climate Change: A PLT Secondary Module	Presentation	Sept 4, 2014	Southern Region Extension Climate Academy (SRECA), Forests Sector
Monroe, M. C., A. Oxarart, and J. Li	Designing appropriate teacher in-service training	Presentation	May 20, 2014	Association of NR Extension Professionals (ANREP), Sacramento CA
Kunkle, K., J. Li, M. Monroe, and T. Ritchie	Evaluating websites and webtools in Extension education	Presentation	May 21, 2014	Association of NR Extension Professionals (ANREP), Sacramento CA
Oxarart, A. and M. Monroe	EE at UF's SFRC: Engaging Activities on Complex Issues	Poster Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL
Ritchie, T.	Using Systems Thinking to Improve Student Achievement in Environmental Education	Poster Presentation	March 22, 2014	League of Environmental Educators in Florida (LEEF) Conference, Altoona, FL

Events/Activities: *Presentations*

Monroe, M. C.	Developing educational programs to complement large research projects	Presentation	Oct 31, 2013	Guest speaker, University of Minnesota - Duluth
Ritchie, T. and M. Monroe	Can Using Systems Thinking Improve Student Success with Climate Change Education?	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Seiler, J., J. Kidd, M. Monroe, A. Oxarart, K. Kunkle, J. Li, and S. Krantz	Integrating Education and Research: All Team PINEMAP	Webinar	December 6, 2013	PINEMAP Internal Webinar Series

Aim 6 (Extension) presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Boby, L.A., Dinon Aldridge, H. and Knox, P.	Climate Science and PINEMAP information	Informal presentation	September 18, 2013	Birmingham, AL Society of American Foresters Chapter Meeting
Boby, L. A.	Southern Regional Extension Forestry and PINEMAP Update	Presentation	October 16, 2013	Southern Group of State Foresters Services, Utilization and Marketing Committee Meeting, Lexington, KY
Boby, L.A., Rashash, D. and Megalos, M.	Perceptions of Climate Change: Six Americas in the general Public and Extension Agents	Presentation	January 21, 2014	1890 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC
Boby, L.A.	PINEMAP/ Project Learning Tree Activity	Presentation	January 23, 2014	1890 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC
Boby, L.A. and Risse, M.		Presentation	February 18, 2014	American Meteorological Society Meeting Atlanta, GA
Boby, L.A. and Monroe, M.	Climate Change And Biomass Outreach- What's new- What's Needed	Presentation	February 27, 2014	Southern Regional Extension Forestry Unit Leaders Meeting, Athens, GA
Boby, L.A., Dwivedi, P., Teskey, R., Markewitz, D., McGuire, M., Kane, M. and Akers, M.	Pine Integrated Network: Education, Mitigation and Adaptation Project	Poster	February 28, 2014	University of Georgia Sustainability Forum, Athens, GA
Boby, L., W. Hubbard, and H. C. Morris	Southern Foresters' Perceptions on Climate Change and Implications for Extension	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Boyles, R.	Climate Change and Coastal NC	Presentation	Sept. 17, 2013	New River, NC Roundtable
Boyles, R.	Climate change in NC	Presentation	November 8, 2013	NCCU Climate Change Symposium
Boyles, R.	Climate change and agriculture	Presentation	November 16, 2013	CFSA Sustainable Agriculture Conference
Boyles, R. and Dinon-Aldridge, H.	Climate Change Basics: Climate 101	Presentation	January 21, 2014	1890 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC

Events/Activities: *Presentations*

Boyles, R.	How Climate Forecasts are Made	Presentation	February 7, 2014	Farming Adaptation Conference
Boyles, R.	PINEMAP's Decision Support System	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Boyles, R.	PINEMAP Climate Scenarios and Projection Datasets	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Boyles, R., Dinon Aldridge, H., Davis, C.	DSS and seed deployment tool	Presentation / Web Demo	May 15, 2014	PINEMAP Annual Meeting, Athens, GA
Boyles, R.	Climate Models, Downscaling, and Usage	Presentation	August 15, 2014	USDA Southern Region IPM and SE Regional Climate Hub
Boyd, G.	Integrating Climate Change into your Extension Programming	Presentation	January 23, 2014	1890 Land Grant and PINEMAP Climate Change Workshop Wilmington, NC
Davis, C.	Fire Weather Monitoring and Predictability in the Southeast	Presentation	March 13, 2014	Piedmont Chapter of the Society of American Foresters
Davis, C.	Teaching the Basic Weather Processes unit of the S-290 (Intermediate Wildland Fire Behavior) training course	Presentation	September 16, 2013	S-290 Training for NC Forest Service
Dinon Aldridge, H.	PINEMAP's Decision Support System: An Integration Vehicle	Webinar	September 6, 2013	PINEMAP ATP meeting
Dinon Aldridge, H., Adams, D., Boyles, R., Gan, J., Grebner, D., Ireland, J., Martin, T., Susaeta, A., Taylor, E., Teskey, B.	PINEMAP's Risk Assessment Tool	Webinar	October 4, 2013	PINEMAP ATP meeting
Dinon Aldridge, H.	PINEMAP DSS development process	Webinar	October 18, 2013	Aim 4 in-person meeting
Dinon Aldridge, H., Crimmins, M.	Climate Science Resources and Partnerships	Presentation (Meeting)	October 29, 2013	ANREP National Extension Climate Science Initiative Conference
Dinon Aldridge, H., Knox, P.	Part I: Trends in the Southeast and Their Impacts on Trees and Foresters and Part II: What People are Saying About Global Warming and Climate Change?	Webinar	November 21, 2013	PINEMAP Professional Development Webinar Series: Climate Science and the South: An Overview
Dinon Aldridge, H.	Frequently Asked Questions about Climate Change	Presentation	January 21, 2014	1890 Land Grant and PINEMAP Climate Change Workshop Wilmington, NC
Dinon Aldridge, H., Boyles, R.	PINEMAP Gridded Data: THREDDS Data Server & Climate Model Data	Webinar	February 7, 2014	PINEMAP ATP Meeting

Events/Activities: *Presentations*

Dinon Aldridge, H.	Weather and Climate in NC	Webinar	February 21, 2014	NIDIS/CoCoRaHS webinar
Dinon Aldridge, H., Boyles, R., Davis, C.	DSS Progress Updates	Webinar	April 21, 2014	PINEMAP DSS subcommittee meeting
Dinon Aldridge, H., Boyles, R., Davis, C.	DSS Tool Demo	Presentation	April 28-29, 2014	Carolinas Climate Resilience Conference
Dinon Aldridge, H., Bobby, L., Li, J., Megalos, M., Monroe, M.	Assessing Misconceptions about Global Warming and Climate Change in the Southeast US	Poster Presentation	May 19, 2014	ANREP Conference 2014
Dinon Aldridge, H., Boyles, R., Davis, C., Peter, G.	PINEMAP's Decision Support System	Presentation	September 4, 2014	SRECA meeting
Dinon Aldridge, H., Peter, G., Boyles, R., Davis, C.,	PINEMAP DSS Seed Deployment Tool Demo	Presentation / Web Demo	September 4, 2014	SRECA meeting
Dwivedi, P. and Bobby, L.A.	Pine Integrated Network: Education, Mitigation and Adaptation Project	Presentation	February 28, 2014	University of Georgia Sustainability Forum, Athens, GA
Hubbard, W.G.	Updates on the PINEMAP project	Presentation	October 2, 2013	Arkansas Forestry Association Meeting, Little Rock AR
Hubbard, W.G.	Southern Regional Extension Forestry Updates	Presentation	March 25, 2014	Clemson Society of American Foresters Meeting, Clemson SC
Idassi, J., G. Boyd, L. Bobby, M. Megalos, H. Dinon Aldridge, M. Monroe, and W. Hubbard	1890 Land Grant Institutions and PINEMAP Climate Change Workshops	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Keim, B.	Extreme Events in Changing Climate	Presentation (Meeting)	December 12, 2013	Western Gulf Silvicultural Technology Exchange
Knox, P.	Climate Change -- Weather Patterns and Effects on Trees	Presentation (Meeting)	August 22, 2013	GA Arborist Association Summer Conference
Knox, P.	Our Changing Weather and Its Impacts on Horticultural and Arboricultural Operations	Presentation (Meeting)	January 23, 2014	Georgia Green Industry Association Wintergreen Meeting
Knox, P., Bobby, L., and Risse, M.	From Drought to Floods (2012 to 2013): Agriculture, Livestock and Forestry Tools and Resources for a Variable Climate	Presentation (Meeting)	January 24, 2014	Georgia Winter School for Extension Agents at Rock Eagle Conference Center
Knox, P.	Weather 101: Understanding and Responding to Severe Weather	Presentation (Meeting)	February 17, 2014	Southern Chapter of the International Society of Arboriculture's 72nd Annual Conference and Trade Show

Events/Activities: *Presentations*

Knox, P.	Environmental Change Agents	Presentation (Meeting)	August 21, 2014	9 th Annual Georgia Environmental Conference
Krantz, S.	Engaging audiences through Video: Communicating science effectively	Workshop	March 22, 2014	League of Environmental Educators in Florida 2014 Conference, Altoona, FL
Krantz, S.	Engaging audiences through Video: Communicating with forest Landowners Effectively	Presentation	May, 2014	Association of Natural Resource Extension Professionals 2014 Conference
Krantz, S. and M. Monroe	Message Framing Matters: Communicating Climate Change with Forest Landowners	Poster Presentation	May 14-16, 2014	PINEMAP Annual Meeting, Athens, GA
Martin, T.A.	PINEMAP Stakeholder Needs Assessment: Research Priorities	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Martin, T.A. and W. Hubbard	PINEMAP Stakeholder Needs Assessment: Research Delivery Mechanisms and PINEMAP Outreach Plans	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA
Megalos, M.	Forestry and Climate Science/Change Resources for Extension Agents and Educators	Presentation	January 23, 2014	1890 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC
Megalos, M., Bobby, L., Idassi, J., Boyd, G. and Rashash, D.	Outcomes, Expectations and Next Steps for Utilizing Climate Science Information	Presentation	January 23, 2014	1890 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC
Monroe, M, C. Powers and C. Layman	Climate Communication	Presentation	October 29, 2013	National Agent In-service Training on Climate Science, Sponsored by the Association of Natural Resource Professionals, Cloquet, MN
Monroe, M.C. and C. Layman	Audience Analysis	Presentation	October 29, 2013	National Agent In-service Training on Climate Science, Sponsored by the Association of Natural Resource Professionals, Cloquet, MN
Morris (Cole), H.L., M. Megalos, W. Hubbard, L.Boby	2013 Climate Change Attitudes of Southeast Forestry Professionals: Implications for Outreach	Presentation	October 10, 2013	Society of American Foresters Annual Meeting, Charleston, SC
Morris (Cole), H.L.	2013 Climate Change Attitudes of Southeast Forestry Professionals: Implications for Outreach	Presentation	January 2014	NC State University Marine Earth and Atmospheric Sciences- Forestry and Environmental Resources Joint Graduate Symposium, Raleigh, NC
Nielsen-Gammon, J.	Climate Prediction Made Difficult	Presentation (Meeting)	December 12, 2013	Western Gulf Silvicultural Technology Exchange

Events/Activities: *Presentations*

Taylor, E.L., Burns, S., Boby L.A., Markewitz, D.	PINEMAP Professional Development Series: An Introduction to Soils – Getting Grounded	Webinar	October 16, 2013	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Taylor, E.L., Burns, S., Boby, L.A.	PINEMAP Professional Development Series: Soil Mapping – An Overview	Webinar	October 17, 2013	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Taylor, E.L., Burns, S., Boby, L.A., Jokela, E.	PINEMAP Professional Development Series: Expected Responses – Management Implications	Webinar	October 18, 2013	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Dinon Aldridge, H., Taylor, E.L., Burns, S., Boby, L.A	PINEMAP Professional Development Series: Climate Science and the South – An Overview	Webinar	November 21, 2013	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Taylor, E.L., Burns, S., Boby, L.A.	PINEMAP Professional Development Series: The Connection Between Water Stress and Plant Productivity	Webinar	February 19, 2014	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Taylor, E.L., Burns, S., Boby, L.A., Martin, T.	PINEMAP Professional Development Series: Biology and Ecology of Temperature – Managing for Temperature and Water	Webinar	February 20, 2014	PINEMAP sponsored webinar aimed at professional foresters & resource managers
Taylor, E.L.	Climate Change Made Difficult	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	Hurricanes in a Changing Climate	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	Climate Resources	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	Nutrient Cycling and Nutrient Deficiencies in Production Forests	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	Tree Physiological Responses to Extreme Stress	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	Stand Establishment	Prerecorded lecture	March 31, 2014	Recorded at Western Gulf Silvicultural Technology Exchange and hosted at forestrywebinars/.net
Taylor, E.L.	PINEMAP Outcome Themes: Enhanced Capacity and Enhanced Connections	Presentation	May 14, 2014	PINEMAP Annual Meeting, Athens, GA

Events/Activities: Trainings, workshops, and courses

Aim 1 (Silviculture/Ecophysiology) Trainings, workshops, and courses

NREM 3101 visited the Oklahoma Tier III site for an afternoon to learn about carbon cycling and global change (May 26, 2014).

Aim 2 (Modeling) Trainings, workshops, and courses

CW Ross conducted a CENTURY/DayCent training workshop from August 18-22, 2014 at Ft. Collins, Colorado.

Aim 3 (Genetics) Trainings, workshops, and courses

Krutovsky, K.V. served as Instructor and Lecturer at the School of Young Scientists "Genome Sequencing and Data Analysis", organized by the Institute of Chemical Biology and Fundamental Medicine, Siberian Branch, Russian Academy of Science, July 19-21, 2013, Novosibirsk, Russia; <http://conf.nsc.ru/seq2013/en>; presented a lecture on “Innovative approaches for de novo sequencing of large complex genomes”, <http://conf.nsc.ru/seq2013>)

The NCSU Cooperative Tree Improvement Program conducted a Tree Improvement Short Course in Birmingham AL, Nov 5 – 7, 2013. S. McKeand, F. Isik, and R. Whetten presented lectures on strategies for tree breeding, including sections on geographic variation in loblolly pine, breeding for site adaptability and resilience, and analysis of performance data from multi-site progeny trials.

Aim 5 (Education) Trainings, workshops, and courses

Martha Monroe, Annie Oxarart, Jie Li, Tracey Ritchie, and Kristen Kunkle presented a workshop on June 25, 2014 entitled “Teacher Training, Southeastern Forests and Climate Change at the Center for PreCollegiate Education and Teaching (CPET) at the University of Florida.

Aim 6 (Extension) Trainings, workshops, and courses

The Western Gulf Silvicultural Technology Exchange

The Western Gulf Silvicultural Technology Exchange (WGSTE) is a biennial workshop focused on disseminating new knowledge, tools, and strategies about pine-based silviculture to industrial and large-scale silviculturists working primarily in the Western Gulf region of the U.S. This event is crucial due to the unique climate conditions of the region and the concomitant impact to forest health and resilience. In other words, the effects of climate and climate variability on southern forests are particularly hard-hitting here. PINEMAP is sensitive to the greater urgency of adaptive silvicultural strategies in the Western Gulf region. PINEMAP has established a permanent committee to guide this effort consisting of not only PINEMAP members, but also, non-PINEMAP funded universities and agencies in the Western Gulf including the Louisiana State University AgCenter, Stephen F. Austin College of Forestry, and Louisiana Tech School of Forestry. To date, PINEMAP information has reached 72 silviculturists through the WGSTE representing 9 million acres – 5 of those million in pine.

Professional Development Webinar Series

The Professional Development Webinar Series is an ongoing, monthly series of webinars that debuted in November 2012 using the Forestry Webinars portal (www.forestrywebinars.net). This effort primarily targets large-scale forest managers and natural resource professionals such as forestry consultants and state forestry agency personnel. The series packages and delivers new knowledge and tools developed by PINEMAP in such a way that the audience can confidently incorporate these into their daily business and, as a result, improve the resilience, productivity, carbon sequestration, and nutrient management of their forest lands. Combined survey results show that participants feel satisfied with the amount of information covered in the webinars (Figure 18.1). **To date, there have been 14 webinars with a total of 739 viewers.**

Adaptive Silvicultural Training: State Forestry Agency Training

PINEMAP is driving efforts in adaptive silvicultural training for state agency foresters. The key goal is to inform foresters of the latest research and tools so they can transfer information to their clients (primarily small-scale family forest landowners) and positively impact forest health, resilience, and productivity. To date, the program has been tested with the Texas A&M Forest Service. Sixteen foresters participated in the initial training program and have already incorporated the new strategies into their forest management plans and used new decision-support tools to guide landowners. Plans are in place to conduct four trainings of this type across the region in 2014.

1890's Extension Agents and Specialists PINEMAP Training Workshop, Huntsville, AL, May 17-19, 2013

Events/Activities: *Trainings, workshops, and courses*

This workshop was organized by PINEMAP's Aim 6 extension team and was designed to train and inform extension specialists and agents from 1890's Universities on climate science as well as PINEMAP information and resources. The training included about 30 people as well as Aim 6's Martha Monroe, Bill Hubbard, Mark Megalos, Heather Dinon Aldridge, Leslie Boby and Joshua Idassi. Presentations included basic climate science, resources for learning and teaching about climate science, PINEMAP resources and tools available to utilize.

2014 Land Grant and PINEMAP Climate Change Workshop, Wilmington, NC, January 21-23, 2014

Members of PINEMAP's Aim 6 extension team organized a workshop on climate science, forestry, agriculture and coastal resources for a group consisting of North Carolina Cooperative Extension Service agents and then other extension agents from 1890's Universities, as well as a few agents from the non-profit forestry extension organization- Federation of Southern Cooperatives. 25 people attended to listen to talks on audience analysis, climate science and then forestry specific resources. Aim 6 members that were present included Ryan Boyles, Heather Dinon Aldridge, Leslie Boby, Mark Megalos, Gwen Boyd and Joshua Idassi.

Southern Region Extension Climate Academy, Athens, GA, September 3-5, 2014

The SRECA program was first initiated in August 2013, when the Extension leadership in the Southern region asked the coordinators from three USDA/NIFA-funded regional climate projects to coordinate a regional professional development program. SRECA was designed to help Extension professionals who bring a variety of perspectives on climate change become leaders and facilitators in their state for appropriate and relevant programming in climate variability and change. The Academy enabled individuals to work in small groups to develop resources or programs and report experiences to the entire group through web-based workshops over the next year. SRECA aims to improve Extension response and programming in four target areas: Crops, Livestock, Forestry, and Coastal areas. Through new relationships built with professionals in similar arenas across the region, participants have and will continue to exchange ideas and enhance their programs. Twenty five foresters attended the forestry sector meeting, out of 120 attendees.

Aim 1 (Silviculture & Ecophysiology) Experiments, surveys, and data collection

Title	Time frame	Description
Tier I Legacy Experiments	Ongoing	The Tier I legacy network consists of hundreds of existing silviculture experiments and growth-and-yield plots that blanket the region and provide extensive, spatially explicit information on regional variability and productivity. Industry/university cooperative research installations to include in the Tier I legacy experiments have been identified and archived data from these sites has been uploaded into the TerraC database.
Tier II Active Experiments	Ongoing	The Tier II active experiments network consists of 127 sites distributed throughout the Southeast. These sites were selected to represent the range of climate, geology, and soil conditions in the Southeast and span a range of plantation ages (5 to more than 25 years) covering a progression of stand development. Principle treatments represented in the network include planting density, thinning, fertilization, and competition control. Sampling on all or a subset of locations in this network include biomass and carbon inventory; soil sampling; tree canopy light interception measurements; wood core sampling for ¹³ C/ ¹⁸ O analysis to determine water use efficiency; and assessments of soil carbon emissions, nitrous oxide emissions, and nitrogen uptake efficiency. Data collection from Tier II sites is ongoing.
Tier III Throughfall Exclusion x Fertilization Experiments	Ongoing	<p>The Tier III throughfall exclusion x fertilization network is made up of four research sites situated at the edges of the native range of loblolly pine. The four sites, located in McCurtain County, Oklahoma; Taylor County, Florida; Taliaferro County, Georgia; and Buckingham County, Virginia, capture the current range-wide variability of climate, precipitation, and productivity (Figure 3). The research sites range in planting date from 2003 to 2008, are unthinned, and were planted with a mix of genetic sources appropriate for each region. Treatments at the four Tier III sites consist of a factorial experiment:</p> <ul style="list-style-type: none"> • Control (no treatment) • Fertilizer: fertilizer additions to achieve “optimum” nutrition • Throughfall exclusion: panels installed in understory to divert 30% of throughfall off the plot • Fertilizer + throughfall exclusion: combined fertilizer and throughfall exclusion treatment <p>Researchers at each Tier III site are measuring tree and stand growth, above and below ground carbon, changes in soil nutrient and water availability, whole-tree water use, leaf area development and canopy light capture, and soil carbon dioxide (CO₂) efflux (partitioned into autotrophic and heterotrophic respiration).</p>

Aim 5 (Education) Experiments, surveys, and data collection

Undergraduate Fellowship Program Attitudes Survey

The objective of this survey research is to identify changes in undergraduate student attitudes toward research as a result of participating in a full time summer research internship. Three cohorts of students (n = 30) have come through the PINEMAP Undergraduate Fellowship Program from 2012-2014. The survey was presented in a pre- and post-experience format, and it consisted of 24 Likert-type items (1 represented “strongly disagree” and 5 represented “strongly agree”) that integrated 17 items from the “Attitudes Toward Research” (ATR) Scale and 7 scientific-method oriented items. A preliminary Wilcoxon signed-rank analysis of data from 2012-2013 cohorts identified no significant differences for each factor (research use, negative attributes of research, positive attributes of research, and research understanding). These data will be reevaluated when post-experience responses from the third cohort are available.

Formative Evaluation of Secondary Education Module: Teacher Feedback

Objectives: To test the usefulness and effectiveness of this module, the evaluation and research team based at the University of Florida’s School of Forest Resources and Conservation conducted a formative evaluation during fall 2013. The formative evaluation plan was developed and revised with input from the Education Advisory Committee (n=5) and designed to answer the following questions:

- a. What are teachers’ perceptions of the secondary teaching module?
- b. How can the activities be improved?
- c. What are teachers’ perceptions of the online training resources and secondary teaching? module website?

Procedure and Instruments: After approval from the Institutional Review Board at University of Florida, an invitation was sent through several email lists to recruit pilot testers. From the 123 applicants, 64 teachers were accepted to represent

regional and grade-level diversity. Twenty-eight teachers (46.4% high schools and 53.6% middle school) agreed to use two activities and complete the online teacher evaluation form. Thirty-six high school teachers agreed to use four activities, complete the online teacher evaluation form, and involve their students in pre- and post-activity surveys. Teacher evaluation forms were developed, reviewed by 10 experts, revised, and pilot tested with 2 teachers. Student pre- and post-tests were developed, reviewed by 9 experts, revised, and pilot tested with 89 students who participated in the University of Florida's Center for Precollegiate Education and Training Student Science Training Program over the summer of 2013.

Results: Forty-four pilot testers completed their evaluation forms by January 24, 2014, and about half (53%) of the teachers used the activities in environmental science and advanced placement (AP) environmental science classes. About 15% used the activities for middle school integrated science classes and 14% used the activities in biology and AP biology classes. The remaining teachers (8%) used the activities in courses such as earth science, land resources, economics, and ecology. The pilot testers were from Florida (45%), Kentucky (16%), Virginia (14%), Arkansas (11%), North Carolina (9%), and Georgia (5%). Although the activities are designed for high school students, we involved middle school teachers in the pilot test and asked them if the materials could be adapted for their students.

Pilot testers provided positive comments about the organization and detail of the materials and online supplemental resources. About 90% of high school teachers said the activity they pilot tested was ready for classroom use. On average, high school teachers agreed that their students were able to meet the activity's stated objectives ($Mean=4.27$, $SD=0.78$ on a scale of 1 to 5, with 5 = strongly agree) and the activity procedure was appropriate for their students ($Mean=4.27$, $SD=0.80$). As expected, data from middle school teachers suggests that the activities were a little more challenging ($Mean=3.76$, $SD=1.2$) and the students were slightly less able to meet stated objectives ($Mean=3.91$, $SD=0.90$) as compared to high school students. Pilot testers indicated that the online training resources and module website effectively prepared them to use these activities ($Mean=4.58$, $SD=0.58$) and built their confidence to teach about climate science topics ($Mean=4.54$, $SD=0.56$). The results of the formative evaluation suggest that these activities are written in an appropriate tone and provide sufficient background information for teachers to effectively use them in their classrooms.

Recommendations: Teachers provided many excellent suggestions for improving the materials. After reviewing the teachers' feedback and recommendations on all the activities, the module development team is focusing on the following overall changes:

- a. Include a section that offers an adaptation of each activity for middle school students or basic high school classes.
- b. Provide multiple-choice questions to allow teachers to develop a student quiz and include writing prompts for assessments on each activity.
- c. Add comments from teachers about their classroom experience and suggestions for using the materials to both the printed document and website.

Many pilot testers indicated that they would like to implement the lessons with future classes and were very pleased with the formative evaluation process. After the PINEMAP education team completes revisions and updates the website, we will begin plans for regional teacher workshops.

To test the usefulness and effectiveness of the secondary module, Southeastern Forests and Climate Change, the team conducted a formative evaluation during fall 2013 to answer questions about how teachers perceive the module and how the activities can be improved. From the 123 applicants, 64 teachers were accepted to represent regional and grade-level diversity. Twenty-eight teachers (46.4% high schools and 53.6% middle school) agreed to use two activities and complete the online teacher evaluation form. Thirty-six high school teachers agreed to use four activities, complete the online teacher evaluation form, and involve their students in pre- and post-activity surveys. Forty-four pilot testers completed their evaluation forms by January 24, 2014, and about half (53%) of the teachers used the activities in environmental science and advanced placement (AP) environmental science classes. Participating teachers were from Florida (45%), Kentucky (16%), Virginia (14%), Arkansas (11%), North Carolina (9%), and Georgia (5%). The team obtained excellent and useful feedback from these teachers and their students which enabled us to make systematic revisions to the module (e.g., adding modifications for younger students) and editing the activities to increase clarity. We also added systems thinking connections to each activity to increase visibility for this important skill. Experts reviewed all changes to the materials to assure that no misconceptions were introduced in the revision process.

Appendix B: Training

These tables provide a comprehensive list of undergraduate and graduate students, postdocs, and technical/research personnel trained under this project, as well as their role in the project.

Project Administration/Management Training

Last name	First name	Position	University	Role
Bartels	Wendy-Lin	Assistant Research Scientist	UF	Conducting social network analysis, team science, and integration research; assisting with meeting planning and strategic project management.
Ireland	Jessica	Project Coordinator	UF	Coordinates project-wide activities; maintains the project web site and intranet site; organizes and coordinates project meetings; manages and oversees interim and annual reporting; and coordinates project communications.

Aim 1 (Silviculture/ Ecophysiology) Training

Last name	First name	Position	University	Role
Akers	Madison	Research Staff	UGA	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Georgia Tier III site
Albaugh	Tim	Research Staff	NCSU	Evaluating impacts of weed control and fertilization on loblolly pine using the 3-PG model
Alvarez	Jose	Postdoc	NCSU	Evaluating changes in loblolly pine leaf area due to silvicultural treatments as a component of the 3-PG model
Ausmus	Casey	M.S. Student	OSU	Research focus: determine the effects of fertilizer and water availability on tree physiological processes
Baggett	Brittany	Undergraduate Intern	Univ. of W. FL	2013 Undergraduate Fellow; working with Adam Maggard at OSU
Barron	Stephan	Undergraduate Intern	Auburn	2014 undergraduate fellow; working with Stan Bartkowiak and Lisa Samuelson. Focus area: Sap flow and leaf/stand level physiology.
Bartkowiak	Stan	Ph.D. Student	Auburn	Research focus: measuring sap flux at the Georgia Tier III site
Barros	Bruce	M.S. Student	UGA	Research focus: Transpiration predictions with 3-PG model (Tier III)
Bass	Allison	Undergraduate Intern	UNC Wilmington/ NCSU	2014 undergraduate fellow; working with Wen Lin, and Michael Gavazzi. Focus area: Soil carbon dynamics
Brown	Robert	M.S. Student	UGA	Research focus: estimate proportion of heterotrophic respiration vs. autotrophic respiration of forest soils.
Clark	Joe	M.S. Student	Auburn	Research focus: assessing relationships among intercepted radiation, LAI, photosynthetic capacity, phenology, and productivity in loblolly pine
Clark	Zach	M.S. Student	UGA	Research focus: assessing developmental pattern of understory vegetation on Tier II installations
Cucinella	Josh	Research Staff	UF	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Florida Tier III site
Diamond	Amanda	Undergraduate Intern	VT	2013 Undergraduate Fellow; working with Madison Akers at UGA
Faison	Andrew	Undergraduate Intern	VSU	2012 Undergraduate Fellow; assisted Jay Raymond at Virginia Tech with investigating the mechanisms nitrogen dynamics and uptake efficiencies of N containing fertilizers in loblolly

				pine plantations using stable isotope (15N) techniques.
Few	John	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Asko Noormets at NCSU
Fields	Anthony	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Maxwell Wightman at UF
Frye	Sam	Research Staff	VT	Assisting with soil CO ₂ efflux and N ₂ O measurements and installation and data collection on Tier II and III sites.
Gonzalez	Carlos	Research Associate	UF	Ecophysiology and Carbon Balance Modeling; support of tree transpiration measurements for Tier III; use of 3PG model to assess the effect of climate change in productivity of loblolly pine plantations in SE U.S.
Gregory	Bethany	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Andy Laviner at Virginia Tech with a study on environmental manipulation of fertilization, drought, and thinning in loblolly pine plantations.
Hancock	Amanda	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites.
He	Dongmei	Visiting Chinese PhD student	TAMU	Effect of soil aggregates on soil C stabilization in different families of loblolly pine
Heim	Brett	M.S. Student	VT	Research focus: separating heterotrophic and autotrophic respiration components of soil CO ₂ efflux
Heinemann	Bob	Research Coordinator	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Holeman	Randy	Research Specialist	OSU	Assists with site maintenance and data collection on Oklahoma Tier III site.
Ingwers	Miles	Ph.D. Student	UGA	
Jackson	Colin	Undergraduate Intern	OSU	2013 Undergraduate Fellow; working with Jay Raymond at VT
Jarvis	Rebecca	Undergraduate Intern	VT	2012 Undergraduate Fellow; assisted Wen Lin at North Carolina State University with quantifying the growth rate of loblolly pine, and analyze its sensitivity to temperature and precipitation dynamics.
K.C.	Dipesh	Postdoc	OSU	Tier III data inventory and TerraC database management
Kinnerly	Will	Undergraduate Intern	VT	2012 Undergraduate Fellow; helped Brett Heim at Virginia Tech with experimental manipulations of belowground metabolic activity in order to separate microbial respiration from plant respiration
Laguer Martinez	Doris	Undergraduate Intern	University of Puerto Rico	2014 Undergraduate Fellow; working with (Jill) Ji Qi at UGA; learned about forest soil carbon and hydrology
Laviner	Andy	Ph.D. Student	VT	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on VA Tier III site; research focus is water use efficiency in loblolly pine
Lewis	Wilson	Research Technician	UF	Assists with Tier III measurements and Tier II sample collection and lab processing
Lin	Wen	Ph.D. Student	NCSU	Research focus: water use efficiency in loblolly pine using 12C/13C ratios in wood
Luedtke	Cody	Ph.D. Student	UGA	Research focus: Soil CO ₂ efflux
Maggard	Adam	Ph.D. Student	OSU	Research focus: ecophysiology on Tier II and III sites
McConaghy	Scott	Undergraduate Intern	Kansas State	2013 Undergraduate Fellow; working with Yang Zhang at TAMU
McElligott	Kristin	Ph.D. Student	VT	Research focus: mechanisms controlling total soil CO ₂ efflux and heterotrophic and autotrophic soil respiration
Medsker	Teresa	M.S. Student	OSU	Research focus: belowground processes affected by fertilization and water availability
McConaghy	Scott	Undergraduate Intern	Kansas State	2013 Undergraduate Fellow; working with Yang Zhang at TAMU
Meek	Casey	Research Staff	OSU	Assisting with ecophysiological and process measurements at Tier II and III sites
Meeks	April	M.S. Student	NCSU	Incorporating competing vegetation in 3-PG model
Montecinos	P	M.F. Student	Auburn	Physiology and growth of a 6-year-old loblolly pine (<i>Pinus taeda</i> L.) plantation in response to rainfall exclusion and fertilization treatments
Nagel	Greg	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Nichols	L.K.	M.S. Student	VT	Relationships among soil properties and soil CO ₂ efflux in a loblolly pine-switchgrass intercropped system
Parisher	Josh	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation at Tier II sites
Pell	Charles	M.S. Student	Auburn	Research focus: ecophysiology at the Georgia Tier III site.

Pike	Jason	Research Staff	OSU	Assisting with installation, maintenance, and data collection on Tier III sites
Qi	Jill	Ph.D. Student	UGA	Research focus: soil water and deep soil carbon responses under rain throughfall treatment at Tier III sites
Raymond	Jay	Ph.D. Student	VT	Research focus is N uptake efficiency of enhanced efficiency N fertilizers using 15N stable isotopes
Rutemiller	Paul	Undergraduate Intern	VT	2013 Undergraduate Intern; working with Chris Maier at the USFS
Ryland	Rachel	Undergraduate Research Assistant	UGA	Received training in field sampling of trace gases at the Georgia Tier III installation and has been trained in laboratory techniques for soil gas analysis on the gas chromatograph
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Assists with processing soil samples from Tier2 soil respiration plots in the northern subregion, makes sapflow probes for Tier 3 installations, analyzes growth responses of trees at Tier 2 sites to historic drought events. /AN/
Sherrod	Charles Allen	Undergraduate Research Assistant	UGA	Received training in field sampling of soil at the Georgia Tier III installation and has been trained in laboratory techniques for soil sample preparation and analysis
Shrestha	Raj	Postdoc	VT	Soil greenhouse gas (CO ₂ , N ₂ O, CH ₄) flux across soil moisture and management gradients
Seyle	Jacob	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites.
Sherrod	Charles Allen	Undergraduate Research Assistant	UGA	Received training in field sampling of soil at the Georgia Tier III installation and has been trained in laboratory techniques for soil sample preparation and analysis
Stebler	Elaine	Research Staff	OSU	Coordinating baseline measurements on Tier II sites and overseeing installation and data collection on the Oklahoma Tier III site
Stokes	Tom	Research Staff	Auburn	Assisting with data collection on Tier II and III sites
Subedi	Santosh	Ph.D. Student	VT	Research focus: identifying an improved method to determine fertility rating for 3-PG
Thompson	Ian	Undergraduate Research Assistant	NCSU	Heterotrophic respiration, coarse woody decomposition, making sapflow probes for Tier 3 sites.
Vial	Sara	Undergraduate Research Assistant	VT / NCSU	2014 Undergraduate fellow, working with Wen Lin. Focus area: Radial growth and drought sensitivity in Tier2 sites.
Ward	Eric J.	Postdoc	NCSU	Measuring and modeling forest water and carbon cycles, including quantifying uncertainty in key processes; working with both Aim 1 and 2 to integrate data and models such as 3PG and WaSSI-C across scales; assisting with data collection and analysis of water fluxes at the Virginia Tier III site.
Werner	A.E.	M.S. Student	VT	Nitrogen release, tree uptake and ecosystem retention in a mid-rotation loblolly pine plantation following fertilization with 15N enriched enhanced efficiency fertilizers
Wightman	Maxwell	M.S. Student	UF	Research focus: Ecophysiology of drought response on FL Tier III site
Wigley	Madison	Undergraduate Research Assistant	TAMU	Carbon monitoring protocol implementation for Tier II sites
Wilson	Elizabeth	M.S. Student	TAMU	Research focus: understanding the effects of mesophyll conductance on isotopic signatures in leaves
Yancey	Fletcher	Research Technician	UF	Coordinates Tier III sap flux measurements and assists with Tier II sample collection and lab processing
Yanez	M.A.	Ph.D. Student	VT	Management intensity effects on growth and physiological responses of loblolly pine varieties and families growing in the Virginia Piedmont and North Carolina Coastal Plain of the United States
Yang	Jinyan	Ph.D. Student	UGA	Research focus: Heterotrophic and autotrophic components of soil respiration
Zhai	Lu	M.S. Student	TAMU	Research focus: Family and culture effects on ecosystem C and N dynamics
Zhang	Yang	Ph.D. Student	TAMU	Research focus: Carbon and nitrogen cycling response to drought at the OK Tier III site

Aim 2 (Modeling) Training

Last name	First name	Position	University	Role
Brooks	Evan	Postdoc	VT	Regional upscaling of growth and yield and 3-PG models for study timeframe and region, initial 3-PG parameter assessment.
Cook	Madison	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Jose Alvarez at NCSU.

Fang	Yuan	Ph.D. Student	NCSU	Using G'DAY model to address nitrogen use efficiency in pine plantations.
Gopalakrishnan	Ranjith	Ph.D. Student	VT	Research focus: Downloading and reformatting the NARCCAP scenarios for key climate variables from six models (GCM/RCM combinations).
Gyawali	Nabin	Ph.D. Student	VT	Modeling general response to silvicultural treatments in loblolly pine stands.
Henderson	Jesse	Research associate	NCSU	Leading initial stages of integration of SRTS with regional 3P-G and WaSSI data.
Ross	C. Wade	Ph.D. Student	UF	Research focus: Investigating the response of soil carbon dynamics to changes in climate and fire disturbance in southern pine ecosystems with a process based model.
Sabatia	Charles	Postdoc	VT	Investigated growth and yield response to climate and soils variables using Tier 1 data.
Thapa	Ram	Ph.D. Student	VT	Modeling mortality of loblolly pine (<i>Pinus taeda</i> L.) plantations.
Wang	Maggie	Ph.D. Student	UGA	Research focus: Working on a research proposal to predict C pool dynamics for alternative land use, management, and climate scenarios at the stand level. The proposal is to link 3-PG and Century to examine forest ecosystem carbon sequestration.
Ward	Eric	Postdoc	NCSU	Measuring and modeling forest water and carbon cycles, including quantifying uncertainty in key processes; working with both Aim 1 and 2 to integrate data and models such as 3-PG and WaSSI-C across scales; assisting with data collection and analysis of water fluxes at the Virginia Tier III site.

Aim 3 (Genetics) Training

Last name	First name	Position	University	Role
Bawa	Rajesh	Ph.D. Student	VT	Research focus: Conducting Phenotyping of adaptive traits (i.e., cold hardiness and bud phenology) in the loblolly pine progeny trials and working with universities across region to conduct genome-wide association mapping between these traits and the re-sequencing data.
Farjat	Alfredo	Ph.D. Student	NCSU	Research focus: Carrying out joint analysis of progeny test data and climate data for the Cooperative Tree Improvement Program.
Koralewski	Tomasz	Postdoc	TAMU	Building a location database for the progeny tests and the parents represented in those progeny tests that can be linked to climatic data, and performing URF analysis to optimize seedling deployment.
Lu	Mengmeng	Ph.D. Student	TAMU	Research focus: Evaluating efficiency of the Agilent SureSelect target gene enrichment system for Illumina GAI and HiSeq high-throughput sequencing instruments, based on capture probes designed using the Agilent eArray tool and the most recent and comprehensive unigene set consisting of 35,550 sequences representing individual genes expressed in loblolly pine.
Kohlway	Will	Undergraduate Research Assistant	NCSU	Working on pilot scale experiments to test genotyping-by-sequencing as a cost-effective means of genotyping the experimental populations.
Rusche	Ben	Undergraduate Research Assistant	NCSU	Working on pilot scale experiments to test genotyping-by-sequencing as a cost-effective means of genotyping the experimental populations.
Townsend	Laura	M.S. Student	NCSU	Research focus: Genetic variation in loblolly pine for adaptability to climate variables.
Zhang	Jianxing	Ph.D. Student	UF	Research focus: conducting analyses linking progeny test performance with climatic data and developing a database for the URF analysis to optimize seedling deployment.

Aim 4 (Economics and Policy) Training

Last name	First name	Position	University	Role
An	Hyunjin	Ph.D. Student	TAMU	Assessing climate change impact on southern pine beetle infestations and associated economic and carbon consequences.

Last name	First name	Position	University	Role
Dwivedi	Puneet	Postdoc	University of Illinois-Urbana Champaign	Working with Dr. Gan to assess impacts of climate change on southern pine beetle infestation and exploring life cycle impacts of different wood products produced using southern pines.
Khanal	Puskar	Ph.D. Student	MSU	Research focus: Evaluating forest management practices that enhance carbon sequestration in stands and developing a survey instrument to determine small forest landowner's willingness to implement these practices and identify potential incentives that increase carbon sequestration at the stand level.
Kreye	Melissa	Ph.D. Student	UF	Completed a literature review on the economic value of forest-based changes in water quality; conducted a meta-analysis of forest-based water quality values; and specified an econometric model that predicts willingness to pay for forest-based water quality. Using a benefit transfer method, she has applied the model to two representative sites.
Soto	Jose	Postdoc	UF	Modeling the impacts of invasive pine beetles and ecosystem service values as a function of changing climatic conditions, management, and policy.
Soto	Jose	Ph.D. Student	UF	Assessing and summarizing competing programs and policies that incentivize carbon sequestration at the local, state, national, and international level.
Soto	Justin	Undergraduate Intern	UF	2012 Undergraduate Fellow; assisted Melissa Kreye at University of Florida with assessment of the economic value of forest-based ecosystem services under alternative management and policy regimes.
Susaeta	Andres	Postdoc	UF	Primarily involved in developing a forest stand-level model to assess expected economic rents for forest landowners under hurricane risks associated with future climate change conditions.
Timilsina	Nilesh	Postdoc	UF	Assessing the interactions between different ecosystem services in pine flatwoods and optimizing modeling to maximize a particular ecosystem service and assess the tradeoff of the others.
Traboulsi	Mohamad	Ph.D. Student	UF	Integrating FIA plot data with hydrologic unit watersheds and subwatersheds in Florida. Watershed-level WASSI water yield outputs will then be integrated with FIA C, Timber and diversity data to identify watersheds with optimal provision levels and use/non-use values for water yield, C, timber and understory diversity.
Tucker	Joanna	Postdoc	UF	Assisting with analysis and manuscript preparation for a project involving the use of available USDA Forest Service FIA forest inventory data to estimate understory species richness (i.e. biodiversity).

Aim 5 (Education) Training

Last name	First name	Position	University	Role
Decker	Paul	Undergraduate Intern	VT	2012 Undergraduate Fellow; worked with Stephanie Hall at University of Florida to investigate how to teach high school students about controversial topics such as climate change.
Glover	Kristen	Undergraduate Intern	UF	2013 Undergraduate Fellow; working with Christine Li at UF
Krantz	Shelby	M.S. Student	UF	Produced videos for module website
Holmes	Tiara	Undergraduate Intern	VT	Assisted with video production for module website
Hall	Stephanie	M.S. Student	UF	Research focus: conducting research on how to best introduce potentially divisive and contested concepts in secondary

				school curricula; also helping to develop and pilot test activities for the PLT/PINEMAP Secondary Module.
Kidd	John	Research Staff	VT	Undergraduate Intern Program Coordinator. Developing the selection criteria, matching students, awarding proposals, developing the fall course, and working with local teachers to set up school presentations for the Undergraduate Internship Program.
Li	Jie (Christine)	Ph.D. Student	UF	Research focus: Assessing interest in climate change based on and hopefulness and relevance of solutions; teacher self-efficacy for teaching about climate; student self-efficacy for participating in climate change solutions.
Oxarart	Annie	Research Staff	UF	Environmental Education Program Coordinator. Working on the development of the PLT/PINEMAP Secondary Module, including assisting with the needs assessment, development and pilot testing of activities, and oversight of the Education Advisory Committee.
Plate	Richard	Postdoc	UF	Assisting with the development and evaluation of activities for the PLT/PINEMAP Secondary Module and analyzing needs assessment data; assisting with data analysis for the Extension climate perceptions survey.
Kunkle	Kristen	M.S. Student	UF	Research focus: conducting evaluation of module website and tools that convey pedagogical content knowledge about climate change to educators
Ritchie	Tracey	Ph.D. Student	UF	Research focus: Conducting summative evaluation and exploring ... TBD
Clifford	Margaret	M.S. Student	UF	Assisting with Extension program evaluation; assessing climate perspectives and program needs
Burja	Kristy	M.S. Student	UF	Assisting with materials development and evaluation
Cheek	Morgan	Undergraduate Intern	NCSU	2014 Undergraduate Fellow assisting with module production, evaluation, and research tasks
White	Ahnaia	Undergraduate Intern	VSU	2014 Undergraduate Fellow assisting with module production, evaluation, and research tasks
Hamill	Alyssa	Undergraduate Intern	VT	2014 Undergraduate Fellow; worked with John Kidd at Virginia Tech on a variety of projects related to undergraduate research experiences and secondary education.

Aim 6 (Extension) Training

Last name	First name	Position	University	Role
Boby	Leslie	Extension Staff	UGA/SREF	Assists with formation of regional Extension teams, and a PINEMAP Extension Advisory Board; participating in and presenting at research cooperative meetings; and facilitating internal and external PINEMAP research dissemination. Planned work includes developing and evaluating written and web-based (i.e. eXtension, webinars, etc.) educational materials and disseminating resources and materials to forestry stakeholders.
Burnett	Rachel	M.S. Student	NCSU	Assisting with reviewing factsheets and other PINEMAP-related publications; research focus: annual and decadal climate forcing of historical and current trends in fire regime in Southeast forests.
Cole	Hilary	M.S. Student	NCSU	Serves as a copy editor for factsheets and other PINEMAP-related publications, provides guidance with contextual examples for the climate education materials in collaboration with the State Climate Office of NC. Assists the SREF office with a region-wide Forest managers survey on Climate education needs that she will analyze as part of her Master's thesis.
Davis	Corey	Research Staff	NCSU	Environmental Meteorologist. Working with Heather Dinon Aldridge on DSS development.
Dinon Aldridge	Heather	Research Staff	NCSU	Applied Climatologist. Facilitates interaction between PINEMAP team members and state climatologists across the region through activities such as presentations in the internal webinar series and research cooperative meetings and weather/climate conferences. Other involvement includes development of the DSS, creation of fact sheets, and guidance on the best climate datasets for PINEMAP.
Foster	Anslei	M.S. Student	NCAT	Working on fact sheets and publications for PINEMAP.

Last name	First name	Position	University	Role
Hall	Megan	Research Assistant	NCSU	She is implementing contextual examples into the climate education materials for forestry in collaboration with PINEMAP colleagues.
Holmes	Tiara	Undergraduate Intern	VSU	2013 Undergraduate Fellow; working with Shelby Krantz at UF
Krantz	Shelby	M.S. Student	UF	Conducted focus groups, helped design the forest landowner Extension workshop, developed a pre/post survey and analyzed data to better understand perceptions on climate, willingness to change management strategies, and opportunities to make a meaningful difference.
Martin	Andrew	Undergraduate Research Assistant	NCSU	Developing a tool for forestry professionals across the southern US, which displays historical temperature, precipitation, and drought indices.
O'Connell	Charlie	Undergraduate Research Assistant	NCSU	Reviewed the climate education materials for forestry. Developed a tool for forestry professionals across the southern US which displays historical temperature, precipitation, and drought indices.
Temple	Christina	M.S. Student	NCSU	Drafted two fact sheets on adaptation related to forest pests and invasive species. Drafts were finalized by Hilary Cole and are undergoing developing a comprehensive list of climate education materials across the southern US.
Vuola	Aaron	M.S. Student	NCSU	Successfully defended his thesis on 3/30, graduated in May 2012 . Aaron has coauthored a peer-reviewed paper and commentary from his theses with current graduates Hilary Cole and Rachel Burnett as research notes and ultimately as refereed publications. Aaron's thesis research was featured in poster during an IUFRO Small-Scale Forestry Conference in Amherst, MA fall, 2012.
Wojcik	Deborah	Postdoc	UF	Assisted with survey development and data analysis for the Extension climate perceptions survey. Dr. Wojcik helped develop the Six Americas survey for SE Extension Professionals and is writing one article.