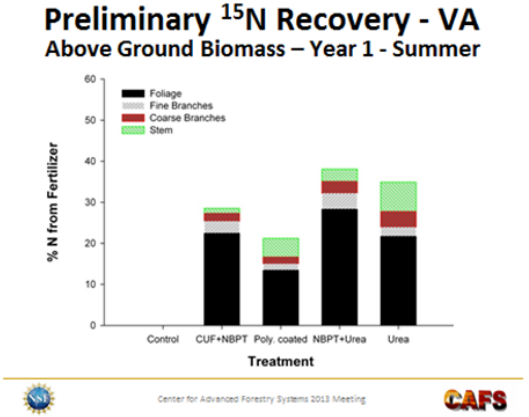
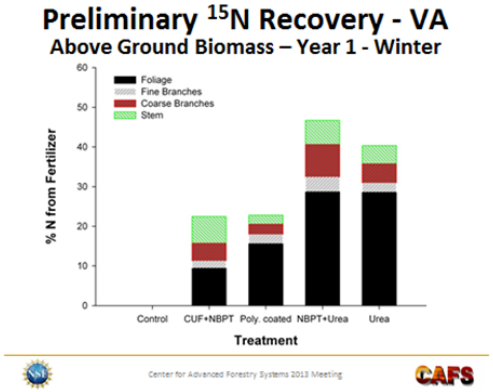
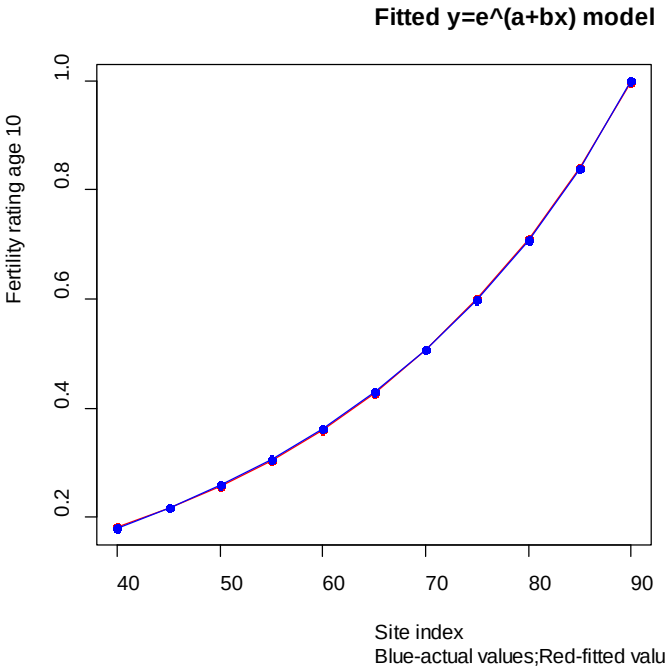
PINEMAP Year 2 Final Progress Report: Milestones and Work Plan Progress
March 2013

Aim 1	
Milestone	**Progress**
Assessment of Tier III treatment effects	• Preliminary leaf gas exchange data from the Oklahoma site indicate a reduction in net photosynthesis and stomatal conductance in the rainfall exclusion plots, but no effect of fertilization. • Preliminary soil CO_2 efflux data from the Oklahoma site indicate a suppression due to fertilization. • At the Georgia Tier III experiment, fertilization increased peak LAI from 1.7 to 2.1. At peak LAI, IPAR increased from 70% to 80% with fertilization. • At the Georgia site, rainfall exclusion reduced leaf light-saturated photosynthesis, stomatal conductance, and predawn water potential in both growing and dormant seasons. No interactive effects of rainfall manipulation and fertilization treatment on leaf-level physiology were observed. During the growing season, photosynthesis was reduced on average by 10% and leaf conductance by 19% in response to rainfall exclusion. During the non-growing season, net photosynthesis and stomatal conductance were reduced on average by 9% and 15%, respectively, by the rainfall exclusion treatment. • At the all 4 Tier III sites, sap flow was measured from November 2012 through February 2013 and average daily sap flux density (Js) and average daily canopy stomatal conductance (Gs) were averaged by month. At the Georgia site, an interactive effect of rainfall manipulation treatment and fertilization treatment was detected for Js and Gs. Average Js was reduced from 44 to 35 g m^{-2} s^{-1} by rainfall exclusion only in fertilized plots. Fertilization reduced Gs from 84 to 61 mmol m^{-2} s^{-1} only in the rainfall exclusion treatment. These results indicate greater sensitivity to nutrient and water availability at the whole plant level. • At the Virginia Tier III site, throughfall is being measured to determine the proportion of total rainfall that is being affected in the rainfall exclusion plots. • At the Florida Tier III site, basal area growth from year one (pre-treatment) to year two was significantly greater for plots that had received fertilizer application. However, there was no apparent impact of fertilization on height growth. The throughfall exclusion treatment did not significantly affect basal area or height growth. The two treatments having received fertilization demonstrate higher rates of mean daily transpiration, though this relationship was not statistically significant.

Assessment of climate, soil, and management impacts on soil GHG flux	Three measurement cycles (March-June, July-October, and October-January) have been completed. Sf ranged from 3.4 umol m^{-2} s^{-1} in March to greater than 15 umol m^{-2} s^{-1} in July. The +LR treatments increased Sf by 15% (p=0.04) compared to -LR treatments. Clone had no effect on Sf and there was no clone x LR interaction; however, there was a strong clone x season interaction (p=0.008), where Sf was 17% greater in the BC clone in July. The root exclusion pipe significantly reduced Sf and the response magnitude varied with season. The Ra/Sf was greater in the summer (0.32) than in the spring (0.13) or fall (0.22). There were no clone, LR, or clone x LR effects on Ra. Similarly, clone had no effect on Rh; however, +LR increased Rh 25% (p=0.0001). These early results suggest that genotype and management can alter Sf, Ra, and Rh.
Regionalize estimates of WUE for application in 3-PG and WaSSI	Monthly WUE values were derived for the period 2007-2009 for mid-rotation and young stands at the Parker Track site, and 2001-2008 for the Duke Forest site. It appears that WUE had little variation across the year, but WUE varied across stand age. Younger stand has lower values (1.97) than mid rotation (2.34) at the Parker Track site.
Initial C and nutrient baselines estimated from existing Tier I data	Data from the Tier 1 sites has been included in the TerraC system and is being used by the Aim 3 group to model carbon and nutrient content in the Tier I sites with a range of models.
Regional C, nutrient, H2O baselines and responses to management from measured Tier II data	Field data was collected on carbon and nutrient content in the first set of Tier II sites using the protocols developed by Aim 1. Carbon efflux measurements that separate heterotrophic and autotrophic respiration are scheduled to begin in Tier II sites in 2013 based on the established protocol.
Work Plan Task	**Progress**
Develop standardized methods for baseline C inventory, baseline soil characterization, and baseline ecophysiology measures	Data quality control and processing for sap flux data has been standardized across PINEMAP sites and researchers using a program developed by Aim 1 members in the open source language R (R Foundation for Statistical Computing, Vienna, Austria). This program is being beta-tested by select research groups in the US and Australia for eventual public distribution.
Develop standardized methods for separating soil heterotrophic and autotrophic respiration	The protocol has been finalized and posted on the PINEMAP website. The approach used by Heim et al. was adopted with minor modification. The first set of cores to separate Ra and Rh were installed March/April 2013.

Collect soil baseline data on Tier III sites	• All Tier III sites: near-surface wireless soil moisture probes have been installed. Much effort has been made to collect consistent and reliable data. • GA Site – TDR cables were installed at 2m and 3 m depths in each plot. Preliminary measurements were taken to allow proper calibration for soil moisture estimates. • Oklahoma site – TDR rods were installed at 5 locations in each plot to depths 0-12, 0-40, and 0-80 cm. • Florida site- TIG welding rods with RiserBond Instruments 1205CX TDR cable fault locator tested in order to implement deep profile soil moisture system based on GA and OK design. Wired soil moisture probes were installed in throughfall exclusion plot to assess the effect of troughs on within plot microsite soil conditions. Probes were placed at multiple locations with respect to distance from tree row (in tree row, directly under trough, in gap between two troughs on same structure), multiple locations with respect to trough height (high end approaching 5 ft, low end approaching 3 ft), and multiple depths (0-10cm, 10-20cm).
Install studies to measure N fertilizer uptake efficiency using 15N labeled fertilizer at Tier II and Tier III sites	Tree, understory, forest floor and soil samples were collected at the end of year 2 in the installations installed in 2011 and at the end of year 1 for the studies installed in 2012. Nitrogen uptake from the different fertilizers is being analyzed. Results from the site in Virginia adjacent to the Tier III site indicate that between 20% and 50% of the applied N was recovered in the overstory trees after one year following fertilization in the winter and between 20 to 40% was recovered in the overstory trees after one year following fertilization in the summer.  

Install studies to measure N_2O and CH_4 emissions following N fertilization	A PINEMAP undergraduate will continue trace gas sampling at the GA Tier III Site over the summer as part of a PINEMAP Internship Program project.
Develop improved method to evaluate fertility rating (FR) in 3-PG	An equation has been developed to predict FR based on the site index of the stand. This predicted FR value is currently being tested in the 3PG model for sites included in the Tier II dataset. 
Develop improved method to evaluate stomatal response functions to update 3-PG	• Initial sap flux data from Tier III site in Virginia (May 2012-Feb 2013) indicates little difference in monthly mean daytime water use of treatments. However, an interaction between the effects of fertilization and throughfall displacement on J_S and G_C may form as stands increase leaf area over coming years (see Aim 1 annual report research story on this topic). • Future analyses will employ hierarchical modeling techniques using a Bayesian state-space framework[1] to quantify differences between half-hourly responses to light, atmospheric water demand and soil moisture.

Ongoing measures of carbon, nutrient pools and fluxes, and water flux at Tier III sites (i.e., soil respiration, soil nutrient availability, leaf level PD and respiration, etc.)	Forest floor and soil samples were collected at all four Tier III sites and analyses are underway. Soil moisture is being monitored. Trace gases and CO_2 soil efflux are being measured. Litter traps were installed and crown and foliar attributes are being assessed and sap flow is being monitored. A study of through fall as a proportion of total rainfall was installed at the VA Tier III site. In addition the activities listed in the November report, manual dendrometer bands were installed on sap flux trees at all four Tier III sites and the installation of root exclusion cores for separating autotrophic and heterotropic respiration are underway.
Identify subset of Tier II sites for additional ecophysiology measures	• Northern subregion Tier 2b sites have been selected • Three Tier II sites have been identified within the UGA/Auburn sub-region for more intensive ecophysiological measures.
Wood samples for O and C isotope analysis from Tier II sites	Half of the sites have been selected where tree cores were collected for 13C/14C analysis to determine water use efficiency. Field work to collect the remainder of the tree cores will be completed in 2013.
Collect baseline data at Tier II sites to evaluate treatment effects on C and nutrient pools and fluxes	Measurements (standing live and dead stem survey, non-planted tree/shrub survey, coarse woody debris) and samples (soil, forest floor, understory vegetation) have been collected from a subset of the Tier II sites and the samples are in various stages of being processed.
Collect additional data on water and carbon fluxes at subset of Tier II sites previously identified	Northern subregion Tier 2b sites have been selected. Setting up of root exclusion collars and temperature and moisture probes is underway.

Aim 2	
Milestone	**Progress**
Improved process and hybrid models parameterized from network measurements	
Work Plan Task	**Progress**
Start evaluation of initial growth and yield fitting using Tier 1 data.	
Preliminary assessment of potential effects of climate change on loblolly water/C manuscript submitted	
Evaluation of Ames RT LAI product	
Initial modeling of Tier I sites using 3-PG, 3-PGS, and CASA (latter two using Landsat data)	
Initial empirical LAI modeling	
Incorporate climate variables in growth and yield components	
Assessment of Tier I big leaf modeling completed; models reparameterized	
Climate scenarios added to Ames System Regional baseline big leaf models runs using Landsat LAI (3-PGS and CASA)	
Improved process model (3-PG) parameterization from network measurements	
Completed prototype of growth and yield components; start of scale-up	
Modeling soil C—forest dynamics (G-Day Model)	

Aim 3	
Milestone	**Progress**
Version 1 of genetic deployment tool with provenance information	1) Texas A&M: Analysis of the data has been conducted with a focus on age 15 height and diameter measurements and planted tree volume. Mean minimum temperature of the coldest month (MMIN) and aridity index (AI) were used as independent variables. The modeling efforts provided robust support for current and future seed deployment guidelines at the provenance level. Moreover, with focus primarily upon the climate at the seed source as a common evolutionary background, additional gains could be made from taking advantage of the considerable tree-to-tree genetic variation. Change in climate between provenance and the test site as the sole controlled parameter with other environmental factors assumed constant (e.g. site preparation, fertility, drainage) leaves room for further improvement of future loblolly pine productivity through application of better silvicultural methods, targeted seedling deployment supported by continued breeding and progeny testing and the integration of the two efforts. 2) NC State University: Growth (height at age 8) and climate data were analyzed for 19 field test sites of the Plantation Selection Seed Source Study using multiple regression approaches. Main effects and higher order terms were fit to growth data to develop prediction models under climate change scenarios for the Southeast. A model with 19 predictors explained about 68% of the variation in height growth. Cross-validation showed that the predictive power of models was low, indicating that the problem is ill-conditioned due to co-linearity in the climate variables. In order to find parsimonious models that are stable, different approaches for model selection and parameter estimation were explored, namely the stepwise method combined with ordinary least squares (OLS), ridge regression, and LASSO regression. The predictive accuracies of these approaches were compared through cross-validation. Although a formal hypothesis test reveled significant differences between OLS and LASSO, and between ridge and LASSO; the three models perform similarly and explained 22% of variation in height. A hypothetical climate scenario was created from historical data, assuming a 5% decrease in precipitation, 2% increase in maximum temperatures, and an increase of 2° C in minimum temperatures. The results suggested that local seed sources perform very well in the Georgia-Florida coastal plains, and their estimated growth decreases as the seed sources are moved to the north. On the other hand, South Carolina seed sources exhibited a more robust performance relative to local seeds, specifically in North Carolina. We observed a rapid decline in performance of Virginia seed sources under the climate change scenarios when they were moved to southern regions. The models

	developed can be used as quantitative tools to predict the norm of reaction of seed sources under climatic (minimum temperatures) change scenarios. Larger data from older genetic field trials that represent a wider geographic area should be used to further refine the models. 3) University of Florida: Analysis of provenance progeny trials with 15 year height has been conducted with two sets of climate data, PRISM and SECC, using a multiple regression approach. The multicolinearity of the climate data was dealt with by first using LASSO, a Bayesian variable selector, to identify the most significant climate parameters. With the PRISM data, the most significant parameters are site mean winter monthly temperature, site mean coldest monthly temperature, site mean annual precipitation, provenance mean coldest monthly temperature, and provenance longitude. These explain 52% of the variation in height. With the SECC data, the same 5 climate variables were significant and an additional one, site mean annual radiation. These six variables also explained 52% of the variation in height. To test the stability of the models, the height for Atlantic Coastal and Florida provenances was predicted based on climate variables across the SE. Overall, the ACP shows increased growth in the north with the tallest trees in central GA, AL and AR. The predictions in SC are more variable. Somewhat unexpectedly, the Florida provenance shows a similar pattern with better growth north but extends further south into FL. These preliminary results need validating.
Determine appropriate genome reduction methods for genotyping by sequencing	1) The University of Florida is in the process of GBS of the CCLONES population using Agilent's SureSelect target enrichment in collaboration with a USDA funded planting breeding training grant. In all 850 individuals are being sequenced at 14,729 target loci. Libraries and selection is 80% complete. 2) NC State University has collected 1600 tissue samples from the PSSSS test site in Screven County, GA, and completed DNA extraction and quantitation of those samples. Library construction for sequencing of PstI-MspI double-digest restriction fragments is underway. In parallel, software development efforts are underway to create a pipeline for expedient analysis of the sequencing reads, including calling SNP haplotypes based on comparison to the loblolly pine reference genome sequence and haplotype-based analysis of the genomic basis of phenotypic variation measured at the Screven County GA test site. 3) At Texas A&M University, we applied the Agilent SureSelect Target Enrichment method to capture unigene-based targeted genomic sequences in loblolly pine (*Pinus taeda* L.). We used 35,386 out of 35,550 unigenes that were assembled by Dr. Chun Liang (Miami University, Oxford, Ohio) and available on http://bioinfolab.muohio.edu/txid3352v1 to design 647,634 oligonucleotide hybridization probes (baits). To make this approach more affordable for population studies, it is important to be able to use multiple barcoded individuals in a single hybridization reaction. Two single (A and B) and two

	multiplexed (C and D) DNA libraries were constructed and sequenced to test two multiplexed strategies: A and B were non-multiplexed samples representing DNA of the haploid megagametophyte and embryo from a single seed, respectively, while C and D were multiplexed pools composed of four and eight indexed individual DNA samples of megagametophytes, embryos or needles from two and seven individual trees, respectively. Each library was hybridized to the same number of probes. After capturing the targeted sequences, all samples were sequenced on an Illumina Hiseq2000 using paired-end sequencing (2×100bp). A and B were pooled and sequenced in lane 1, while C and D were sequenced in lanes 2 and 3, respectively. We obtained 70M, 275M and 234M reads (one direction) from lanes 1, 2 and 3, respectively. After filtering, high quality reads were mapped to the original unigenes and to the draft loblolly pine reference genome assembly (v0.9, provided by the PineRefSeq project; http://pinegenome.org/pinerefseq) using BWA and SAMtools. With the same mapping parameters, 56% of the reads obtained for non-multiplexed samples were mapped to unigenes, while 40% and 44% for C and D pools, respectively. 0.97% (including 762 unigenes) of the total unigene length were uncovered for non-multiplexed A and B samples, while 0.703% (including 534 unigenes) and 0.611% (including 438unigenes) for four-multiplexed C pool and eight-multiplexed D pool, respectively. 97% and 93% of the reads in non-multiplexed samples and multiplexed pools were mapped to the draft loblolly pine reference genome assembly, respectively. SNP detection was done with each pool using SAMtools. 568,422; 2,370,705 and 2,810,893 SNPs were detected in the non-multiplexed, four multiplexed and eight multiplexed pools, respectively, with minimum read depth of 10 and 30% cutoff threshold. The SNP densities are 0.16337 SNPs/kb, 0.328SNPs/kb, 0.396SNPs/kb. The numbers of genotyped SNPs decrease in four-multiplexed and eight-multiplexed pools to 169,769 and 34,627 SNPs with read depth of at least 8 reads per each individual tree in the pools. The conclusions are: 1) Multiplexing strategies worked well for capturing targeted sequences and SNP discovery. 2) Higher multiplexing level reduces the coverage of each sample, but still provides a high number of SNPs for efficient genotyping. 3) Sequencing depth for each sample can be increased by decreasing the number of targeted genes.

Comparison of methods	No additional comparative analysis was carried out in this quarter – additional analyses and comparisons will be conducted after collection of the first complete datasets are available.
Work Plan Task	**Progress**
Develop mixed model analysis for URF	In order to handle colinearity, and develop parsimonious, stable prediction models, NC State University employed variable reduction methods, such as LASSO and Ridge Regression and compared the subset of models with OLS regression. The predictive power of the best models is much lower than the proportion of variation explained by the OLS regression models, indicating that current models have relative low power to predict plantation yields forward into the future.
Continue Phenotyping for: insect and disease resistance and response to fertilizer	NC State University had originally planned to measure a set of clonally-replicated progeny tests derived from advanced-generation parents to obtain data relevant to these objectives, but the drought of the past few years slowed growth, and the tests were not considered to have grown sufficiently to yield reliable phenotypes.
Reduction of Genome Complexity for generating molecular markers	NC State University – preliminary experiments have been conducted to test the automated size-selection procedure and evaluate its effects on the library preparation workflow and on the quality of the resulting data. Occasional contamination of the size-selected fraction with high-molecular-weight DNA has been observed; it is not yet clear if this is due to a problem with the size-selection procedure or if it is an artifact of the nature of the samples submitted for size selection. The first set of libraries made using this procedure have been sequenced, but the data have not yet been analyzed, so firm conclusions regarding the benefit of the procedure cannot yet be drawn.

Aim 4	
Milestone	**Progress**
Assess policies & programs that may affect C mitigation in planted pine forests	The paper by Escobedo et al. on carbon hotspots and management drivers has been published in 2013 issue of *Journal of Environmental Management* (Vol 114, Pages 293-302).
Regional market impacts based on business-as-usual assumptions	We added welfare calculations to the regional timber market model (SRTS).
NPV analysis & regional market impacts of adaptation strategies	An economic framework has been developed and will be applied as soon as we have the information about predicted pine productivity change and carbon accounting under climate change from other Aims.
Document landowner adoption of mitigation and adaptation strategies	Survey data have been estimated and analyzed; manuscripts reporting the results are being drafted.
Work Plan Task	**Progress**
Literature review and summary of ecosystem functions, goods and services	Nilesh T., F. Escobedo, W. Cropper: We are currently reviewing literature on the use of genetic algorithm for its use as an optimization tool for in ecosystem management. This tool will be used to optimize different ecosystem services outputs/production functions and assess trade-offs between different level of ecosystem service provision. We are also doing literature review to develop various scenarios and management goals that can be used for optimization analyses. F. Escobedo and R. Cademus (MS student working for a separate project): We used Florida FIA data, the literature, a simplified water yield mass balance model based on McLaughlin et al. (2012), and an ecosystem service provision level classification framework to examine, in a spatially explicit manner, output levels of carbon sequestration, timber production and water yield provision and their interactions (i.e. synergies vs. tradeoffs) in slash pine ecosystems in north Florida. Literature on ecosystem service "tradeoffs" and "synergies" was compiled as well as on the effect of biophysical drivers (e.g. age, basal area, tenure, silvicultural treatments, disturbance regime) on these interactions.
Develop and validate herbaceous richness model	We finished developing and validating our species richness model. The results are published in a 2013 issue of Forests (Vol 4(1), Pages 122-136). This richness model was used to predict species richness using Forest Inventory and Analysis data. This will allow us to assess trade-offs between different ecosystem services (i.e. timber, carbon and "diversity").

Complete the assessment of implications of carbon sequestration on economic rents for southern forestland owners	We have completed the first draft of a manuscript in which we developed an economic model that incorporate the effect of fluctuating carbon prices, conversion factors to forest products, and proportion of wood that permanently sequester carbon on optimal harvest decision of southern pines. The paper has been submitted to the *Journal of Forest Economics*.
Conduct trade-off analysis and optimization	We prepared data for our trade-off analysis using our species richness predictive model. Now we have data on carbon, timber and species richness for each Florida FIA plots and can begin our trade-off analysis upon finalization of our genetic algorithm. Currently we are identifying different management scenarios for optimization. We are also setting up genetic algorithm using R statistical software.
Complete SPB infestation modeling	We have made good progress on modeling the impact of climate change and forest management adaptation activities on SPB infestations. The compilation of SPB, climate, and adaptation data has been completed; preliminary modeling results have been generated.
Assess economic impact of SPB outbreaks using the SRTS model	This is in progress and we wait for colleagues to provide the data on predicted climate change.
Complete wildfire data in the South for modeling	Fire forecasts have been developed for ecoregion by state areas using climate forecasts.
Complete survey instrument	Grebner and Khanal have developed a draft survey instrument for forest landowners. It is currently under review. Monroe and Adams continued analysis of their attitudes and perceptions of climate change survey to Extension professionals. Adams and Kreye completed implementation of a regional survey on the willingness to pay for forest-based water quality program, and data are being analyzed and have been presented to stakeholders.
Complete LCA of long-duration wood products	A paper has been submitted to Bioenergy Research.

Aim 5	
Milestone	**Progress**
Report of teachers' attitudes concerning forest management	Further detailed analysis on factors predicting teachers' use of forestry field trips was conducted. A paper is currently in review for Natural Science Education.
Report of research on climate change education strategies	Data were collected in July on climate change education strategies to determine whether connecting carbon lessons to climate change affects student interest and knowledge gain, whether student's attitudes about climate change are influenced by their perception of their parents' opinions of climate change, and whether a discussion or a role play is more effective in getting students to discuss the variety of opinions about climate change. Stephanie Hall is finishing data analysis and drafting her thesis, and is scheduled to graduate in spring 2013.
Web-based course in multidisciplinary research for graduate students completed	The second offering of the course began January 2013 and ends April 2013. Nineteen students are participating in the course. Ten PINEMAP co-PIs and staff are leading weekly webinars and discussions; the course introduces graduate students to the diversity of disciplines that contribute to better understanding climate and forests in the South.
Undergraduate research internships completed	Undergraduate internships were completed in December with the end of the undergraduate distance course, *Effective Communications Skills*. Five of six interns participated in the course, and completely went through the full internship program. The second year of the internship program began with the identification of 12 best undergraduate applicants and graduate mentors to the 2013 program. These applicants were notified in February. As of March, placements for the summer internship are in the process of being finalized.
Undergraduate teaching and communication distance course completed	The undergraduate distance-delivered course ended in December 2012. Five of six interns participated in and completed the course.
Work Plan Task	**Progress**
Undergraduate Intern Program	
Conduct undergraduate communication and teaching distance course on education	The course was completed December 14, 2012. Five of the six interns that participated in the course successfully completed it.

Promote 2013 summer undergraduate internship program	The 2013 PINEMAP Undergraduate Fellowship Program was promoted from November 2012 through January 31, 2013. Announcements were distributed through relevant organizational and college listservs, and the position was posted on a variety of natural resources and ecology job boards.
Deliver inquiry-based educational presentations	The five students in the course delivered 54 presentations at 16 public secondary schools in the classrooms of 29 teachers to a total of 1,060 students.
Obtain evaluation input from students and faculty on future graduate student interactions and next course offering	Evaluation data were collected in April and May 2012 and the course was discussed during the annual PINEMAP meeting in Atlanta. A compilation and summary report has been shared with all instructors and the course organizing team for 2013.
Evaluate goals, objectives, structure, and format of summer internship program and modify as necessary	Goals and objectives remain unchanged. Intern pay is split between the summer internship and fall course to incentivize continuing through the internship past the summer.
Conduct follow-up evaluation with teachers, mentors, and interns and modify as necessary	Completed. Additional opportunities and requirements for interaction between participants will be implemented for the 2013 summer fellowships.
Conduct selection process for winners of intern micro-grant program	Completed March 2013. Placements are being finalized.
Conduct selection process for winners of undergraduate internship program	Completed March 2013. Placements are being finalized with official offers made and accepted by mid-March.
PLT Secondary Module	
Develop and revise activities, based on advisory committee feedback	Complete. We held our final advisory committee conference call regarding activity developed. We have incorporated all the feedback provided by this group. The final module draft was completed and contains 13 activities, divided into 5 sections (see table on pages 20-21). The final draft was returned to the group, with a summary of the changes that were made to respond to their feedback. We invited all members to be on the advisory committee from another year January 2013-2014 to provide guidance on formative evaluation and training tasks. Four members agreed, and we recruited two new members. We will hold 3 conference calls during the year, with the first one scheduled in March 2013.
Identify experts to review activities	Complete. Experts were identified through each aim, along with a few external experts from CORRIM, USFS, and the National Renewable Energy Laboratory. We have received 25 reviews from this group and are incorporating their comments into the new draft of the materials.
Develop supplemental resources (videos, web site, etc.)	In progress. We have drafted early ideas about the website and potential videos.

Launch needs assessment with high school science teachers	An online needs assessment survey was launched in April 2012 with 4 email lists of teachers and 9 contacts who forwarded the survey link to their email lists. A total of 732 teachers completed the survey by 6/13/12.
Research report on climate change education strategies	In progress. Stephanie Hall is finishing data analysis and drafting her thesis, and is scheduled to graduate in spring 2013.
Begin plans for formative evaluation	In progress. Plans are being finalized to recruit 40 high school teachers to use 2-4 activities with their students and report on their experience.
Develop formative evaluation tools	In progress. Christine (Jie) Li (UF) developed a draft teacher evaluation form that we will modify for each activity. Christine will also be developing tools to collect student data regarding knowledge, skills, attitudes, and behaviors for her dissertation research.
Develop training workshop for teachers (online and in person)	In progress. We have discussed early ideas for the online training materials and contacted several people who might be able to help complete this work. We are planning a May 24 in-service teaching training on UF Campus with several partners (CPET, Florida Climate Institute, LEEF).

Aim 6	
Milestone	**Progress**
Implement and strengthen forestry Extension/climatologist partnership	• Heather Dinon, Ryan Boyles and Leslie Boby attended the annual meeting of the Southeast Climate Consortium (SECC). At the meeting Leslie presented an overview of PINEMAP extension. Heather and Ryan are members of the SECC as well. The SECC meeting provided an opportunity to network with and engage more climatologists and other researchers and extension personnel in PINEMAP work. • Aim 6 is partnering with Melissa Griffin and Pam Knox to develop climate-related information for fact sheets on climate and forestry interactions, including topics of: 1) climate oscillations, 2) weather and climate, 3) climate change, 4) drought, 5) climate overview, and 6) extreme events. • Pam Knox and Ryan Boyles served as reviewers of the climate components of the Project Learning Tree modules during February/March 2013. • Melissa Griffin, Heather Dinon Aldridge, and Pam Knox are also planning to present at the PINEMAP 1890s workshop in Huntsville during May 2013. Barry Keim and John Nielsen-Gammon have been confirmed as speakers at the Western Gulf Workshop during May 2013.
Audience/Needs Assessments for Extension programs	• For the Texas FRESH (Forest Resources, Ecosystem Services and Health) Survey: it has been completed, the data has been analyzed, and the draft report has been sent out for review. • Aim 6 members conducted a survey for forestry professionals (consulting foresters, extension foresters, and others) to examine needs for continuing education as well as perceptions of climate and climate change. Hilary Cole is conducting research on the survey data to identify which demographic variables influence climate change attitudes, and whether climate change attitudes influence management actions. • February 2013: Joshua Idassi conducted a telephone inquiry on the 1890 Agroforestry consortium leadership about planning a joint PINEMAP training of their specialists and associates on the Climate Change basics. A planning conference call with PINEMAP AIMS 6 team was held to set a tentative agenda for the workshop to be held on May 15-17 in Huntsville, Alabama. A team of speakers from AIM 6 together with a panel of climatologists from three states will provide educational materials through presentations, discussions and hands-on activities.
Extension programs delivered	A workshop is planned for May 15-17, 2013, in Huntsville, Alabama and will include extension specialists from 1890's Universities in the Southeast. The focus of the workshop will be climate science, climate change, forestry and climate tools and PINEMAP developments. 25-30 people are expected to attend. A cyber workshop is planned for summer 2013, planning is ongoing.

State extension and climatologist teams organized	Aim 6 members continue to work with other state climatologists and to engage them for workshops, consultation and webinars.
Decision Support System	A prototype DSS website is available at: http://hatteras.meas.ncsu.edu/pinemap/pinemap_intro.php During Jan/Feb 2013, DSS developers gathered potential research results from aim teams that could be used within the DSS. Aim 6 is also working diligently to provide a layout and design which is useful for our DSS audience which includes professional foresters, specialized practitioners, and landowners. In particular, the group is developing a list of decisions that these stakeholders are trying to make by using results from the survey of professional foresters and by using internal knowledge of Aim 6. Eric Taylor has also been getting feedback on the DSS layout and design from a pilot group of about 12 professional foresters in the western Gulf region. This group plans to pilot test the DSS this summer. DSS developers are working with the DSS subcommittee to determine how aim team research results can fit into the stakeholder decisions. We will prioritize 3-4 items that can be developed comprehensively by the end of the project. Data from TerraC will be feed into the DSS using an interface that Brandon Hoover developed. Careful consideration of the data use agreement is being performed during this process. Also, example code has been developed to display TerraC datasets on maps and time series graphs.
Work Plan Task	**Progress**
Audience assessment—develop several "baseline" survey instruments that establish the existing knowledge levels, needs, beliefs, interests, attitudes, learning preferences, etc. regarding climate variability and forest interactions for various groups	• The audience assessment survey- "Professional Foresters survey for continuing education needs," was launched at the end of January 2013, closed March 1, 2013 and is currently being analyzed. • Poster and abstract on "Climate Change Attitudes of Southeastern Forestry Professisonals" will be presented at Annual Pinemap Meeting Authors: H.L. Cole, M.A. Megalos, W.Hubbard, L. Boby • Abstract on "Climate Change Attitudes of Southeastern Forestry Professisonals" will be presented at SAF National Meeting, October, 2013 Authors: H.L. Cole, M.A. Megalos,W.Hubbard, L. Boby • Poster and abstract on "Climate drivers of wildfire size in North Carolina: Establishment and quantification of Scale-threshold and cross-scale interaction 1907-2012" will be presented at PINEMAP Annual Meeting; Authors: R.E. Burnett and M.A. Megalos

Strengthen relationships with education, research, and stakeholders: State/regional advisory planning meetings	Martha Monroe, Leslie Boby, Bill Hubbard and Wendy-Lin Bartels are working with two other AFRI funded CAP grant projects to develop a leadership academy for extension agents on climate science, climate change, and their respective resource (forestry, livestock, and vegetable production). This program was first initiated through Bill Hubbard's presentation on PINEMAP to Dr. Joan Dusky (Associate Dean for Extension, Agricultural programs, University of Florida). Dr. Dusky requested ours (and others) help to develop training for extension agents on these areas. Many of us met in late January in Tifton, Georgia to define objectives, goals and general training guidelines for the "academy." The ideas were put together and sent to Dr. Dusky- who will contact other state extension Deans to generate interest. The project would include training agents from at least three southeastern states (Georgia, Florida and Alabama), and eventually all of the states. Shelby Krantz, a graduate student of Martha Monroe, is filming, editing, and developing a short film about southern forest landowners' management attitudes and strategies. This video will be used in extension work- at workshops, panels, over webinars, and in focus groups. Since the video will feature a diverse mixture of landowners, this video will be used to help generate peer-to-peer comparisons for extension work (as in, most landowners should see an approximate peer).
Creation of regional advisory panels	Invitations to a webinar meeting about PINEMAP's regional advisory panel were sent to more than 20 state level extension foresters and 1890s University extension foresters earlier this year. About 10 foresters attended this initial meeting and expressed interest in evaluating PINEMAP extension products and plans.
External outputs (fact sheets, web-based climate education modules, complete analysis and submit articles on SE Extension perceptions of climate change, eXtension, etc.)	• Three factsheets have been through the peer-reviewed process and are ready for production. Factsheets will be printed for distribution and added to the eXtension website. • Two training workshops are currently in planning stages: the first is a 'cyber-workshop,' planned for summer 2013 and the other one is Huntsville, AL in mid-May. • A workshop is planned for May 15-17, 2013, in Huntsville, Alabama and will include extension specialists from 1890's Universities in the Southeast. The focus of the workshop will be climate science, climate change, forestry and climate tools and PINEMAP developments. 25-30 people are expected to attend. • An academy on climate science, climate change, and resource management and impacts from climate change is being organized for fall 2013 and will include extension agents from at least three southeastern states.

Administrative activities	Aim 6 continues to have regular monthly web conferencing meetings, as well as additional meetings with different members of the Aim, dependent on project. In general, AIM 6 members consult each other almost daily and at least weekly, to work on joint projects.