

#1: Please provide a figure that shows the major milestones and accomplishments that will be reached during each year of the project. Examples: when will the stakeholder group, executive committee, and advisory councils meet over the course of the project; when will the project manager be in place; when will work commence on the major project deliverables, what are the major milestones and deliverables for Years 1, 2, 3, 4, and 5.

We have developed two charts with different levels of detail and emphasis. The Major Milestone chart addresses the question posed, and the Tasks and Deliverables details our first cut at breaking the complex set of proposed Aims down into specific tasks and timelines. The Major Milestone chart indicates the timing of the administrative activities and deliverables as well as the milestones for each of the six project aims. In this chart a number of activities, such as extension program delivery and greenhouse gas monitoring, will occur continuously across much of the project. For these continuous activities a red square is included only at the end of each year to indicate completion during that year and to harmonize the chart with the more discrete milestones.

The more detailed Tasks and Deliverables chart shows a first cut at breaking down the Aims to specific tasks that we needed to develop the Milestone chart. In the Tasks and Deliverables chart, the green bars indicate the timing of the task and the red indicates a deliverable. No attempt has been made to develop a critical path or link tasks, even though many will be linked. If funded we will continue to develop more detailed work plans for all Aims, building linkages between appropriate tasks and establishing critical paths for close monitoring to insure project success.

#2: Measurable short and medium term outcomes that will result from the extension component of this project are described in the documents provided. Describe quantitatively the long-term outcomes that are expected to result (e.g., changes C, N, water footprints) and the impacts of those outcomes.

#5: Describe the suite of existing or novel approaches and management practices that lead to a net decrease in the carbon, nitrogen and water footprints or increased carbon sequestration with a focus on long-term sustainability

Summary: The mitigation goals set in the RFA (15% increase in C sequestration, 10% reduction in N and energy use by 2030) will be achieved through the adoption of altered forest management on a portion of the total southern pine plantation ownership. Table 1 shows a suite of management changes, and potential impacts and outcomes if these changes are adopted on a portion of the industrial and non-industrial ownership. These examples and postulated adoption rates give an idea of the magnitude of mitigation that can be achieved through various means. To fully demonstrate the feasibility of the scenarios in Table 1, we present a detailed analysis of southern pine land ownership patterns, industrial and non-industrial extension approaches, and descriptions of the altered management regimes and the assumptions associated with their application.

Questions two and five are addressed together, because our responses are highly related and intertwined. To better quantify and understand the potential for regional impacts on mitigation, it is important to understand the ownership structure of southern planted pine forests, the motivations of various land owners, the outreach strategies we propose to use with various land owners, and the success rate we intend to achieve. Taken together, this information enables us to describe potential long-term outcomes and impacts of this project.

1. Patterns of planted pine land ownership

According to the U.S. Forest Service Forest Inventory and Analysis unit, there are about 39 million acres of planted pine forest in the southern U.S. (Smith *et al.* 2009). The vast majority of the plantations are privately owned. This pattern is unique to the eastern U.S.; in the west, the pattern is reversed, where most forestland is owned by federal and other public agencies (Figure 1).

Public and private forest ownership in the conterminous United States

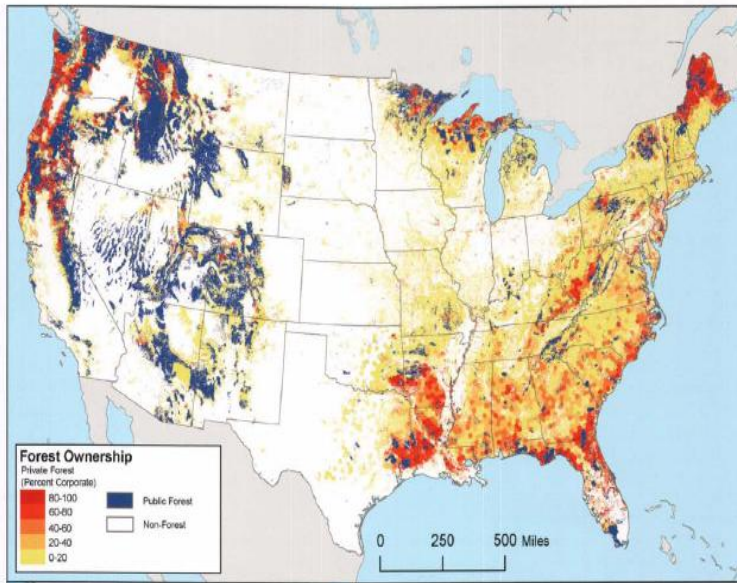


Figure 1. Spatial distribution of public, industrial/corporate private and non-industrial private (NIPF) forestland in the conterminous United States (Liknes *et al.* 2010). Note the predominance of private forestland ownership in the southern U.S.

Of southern pine plantations, about 21 million acres are owned by private corporate entities (Figure 2), including forest-based real estate investment trusts (“REITs”; *e.g.*, Plum Creek Timber, Rayonier, Weyerhaeuser), and Timber Investment Management Organizations (“TIMOs”; *e.g.*, Hancock, Molpus). This group represents the primary stakeholders for the industrial research cooperatives. Land ownership in this category is dominated by relatively few entities, each owning large amounts of pine land (*e.g.* Plum Creek Timber owns 3.6 million acres of forestland in the SE U.S.).

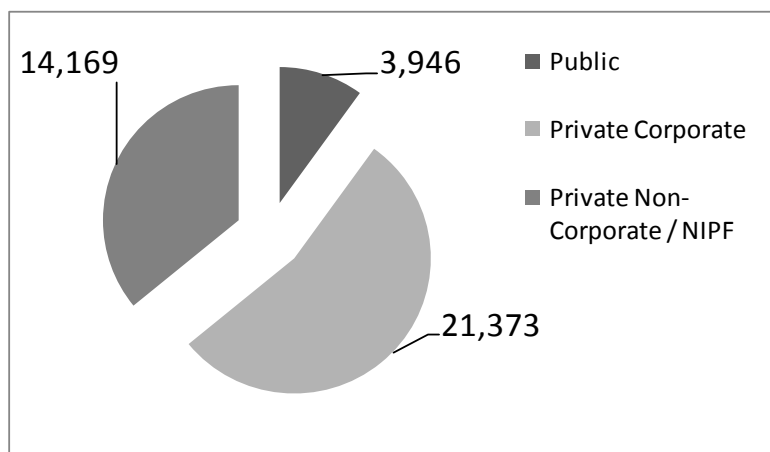


Figure 2. Distribution of planted pine forest (thousands of acres) in the southern United States by ownership class (Smith *et al.* 2009).

About 14 million acres of southern pine plantations are owned by non-industrial private forestland (“NIPF”) owners (Figure 2). In contrast to the industrial ownership category, NIPF owners are numerous and highly diverse in management philosophy and tract size (Figure 3), though planted pine tracts are not likely to fall into the less than 10 acre category. Across all forest types, half of the non-industrial southern forests are managed by 140,000 owners with more than 200 acres. An additional 15% of the southern private forest is owned by another 180,000 families who manage between 100 and 200 acres. This is less than 7% of the total number of southern NIPF landowners (Figure 3). While numerous research studies have attempted to characterize NIPF lands and owners based on tract size, landowner objective, values, demographics, etc., they have not focused on pine plantation owners. Thus, our assessments will target these owners and the results will be used to develop focused outreach efforts for them.

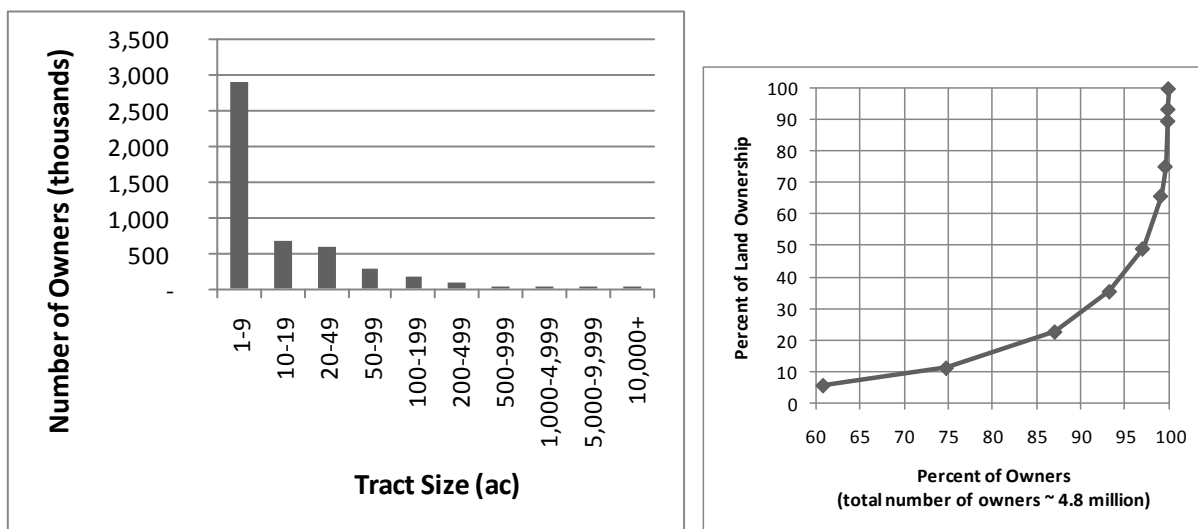


Figure 3. Distribution of non-industrial private forestland (NIPF) ownership by tract size (left) and cumulative percentage land ownership vs. cumulative percentage of owners (right) (Butler 2008).

2. Motivations of landowners

The larger the tract, the more important wood production becomes to the landowner, but even the largest non-industrial landowners also consider aesthetics, care for the land, intend to leave a legacy to the next generation, and believe they are good stewards (Butler 2008). Industrial landowners are motivated by the promise of financial gain and to a smaller extent, shareholder perceptions of being responsible community partners (e.g., Sustainable Forestry Initiative designation). A more detailed investigation of non-industrial landowner motives, values, and decision-making strategies will be pursued in Aim 4 with the intention of better matching our messages to landowners and of suggesting where incentive-based policies may be most useful.

3. “Extension” to various audiences

In our CAP, technology transfer will occur through both industrial cooperatives as “industrial extension programs,” and to NIPF landowners who are the primary target audience for “forestry extension programs.” Both classes of landowners will be important for securing the long-term mitigation outcomes of the project across the region. While the largest landowners represent the easiest audiences for meeting the carbon and nitrogen impact targets, we intend to use forestry extension programs to help reshape the assumptions and goals of southern pine forest management for all landowners. By increasing their awareness of climate change and forest management strategies to improve resilience, we can help them understand federal goals, incentive programs, and the role forests play across the landscape, even if they own a small tract. Two of the key components for effective technology transfer programs are access and trust. Organizations must have ready access to the clients being served and these clients must trust the organizations providing the information and the quality of the information provided to them. The breadth of our CAP co-PIs enables us to achieve the necessary level of trust for both industrial and NIPF landowners.

Industrial landowners: The existing industrial cooperative research programs participating in this CAP are directly supported by forest industry, providing the access and trust needed to efficiently and effectively reach ~ 21 million acres or one-half of the southern pine plantation lands in the South. Several of the co-PIs on this project spend more than 100 days each year directly working with their industrial cooperative members. We have a proven track record with industrial timberland owners and no other audience is better positioned to promote changes in practices that accomplish NIFA’s long-term outcomes in the region.

Technology transfer in the industrial cooperatives occurs through a range of approaches, including: recurring contact and advisory council meetings; workshops; field days and site visits; internal research reports; models and decision support tools; and one-on-one consulting by e-mail, telephone, and on-site visits. The well established access and trust inherent in the cooperative structure facilitates the effectiveness of these approaches, and also makes it possible to accurately assess outcomes from technology transfer. For example, the Forest Nutrition Cooperative at NC State University and Virginia Tech has been assessing the implementation of forest fertilization on member lands for forty years through surveys of cooperating members which have a 100% return rate (Albaugh *et al.* 2007). These records provide a high precision assessment of the efficacy of that particular cooperative’s technology transfer programs. The cooperatives participating in this CAP will follow similar procedures to quantify adoption of altered management regimes on member forestlands.

Diffusion from industrial audiences to others: Much of the research needed to increase the productivity and sustainability of southern pine plantations has been conducted by the industry supported cooperatives and first implemented by forest industry; however, the knowledge often quickly becomes available to non-industrial private landowners and family forest owners in the region via industry outreach activities, university cooperative extension and outreach efforts, state forestry agencies, and consulting foresters. These organizations are all active partners in this Climate Change CAP. They will use their traditional outlets for technology transfer to make the information available to the non-industrial private landowners in the region. The best

example of this is the use of genetically improved seedlings in the South. The bulk of the tree improvement work in the South was conducted by forest industry sponsored Tree Improvement Cooperatives. However high-quality genetically improved seedlings are now used by all landowners, including the smallest non-industrial forest landowners, to reforest their land.

One unique feature of forestry in the South that distinguishes it from traditional agriculture also greatly facilitates the transfer of information and technology to private landowners: Forest management activities are almost exclusively conducted by independent contractors who work for a large number of forest landowners in a region. These contractors prepare the land, plant the trees, control weeds, fertilize the forest, thin the forest and ultimately harvest the final products. The same contractors may work for a large industrial owner one day and the following day do the same work for a small non-industrial owner. We propose to take advantage of the existing contractor system and direct a portion of our extension and outreach efforts to training these contractors. By training only one contractor, we may reach dozens or even hundreds of small landowners. The feedback from these contractors will also be very helpful as we search for affordable ways to implement our management recommendations.

Non-industrial landowners: Extension specialists on the CAP have essentially three avenues for reaching private nonindustrial forest landowners: 1) traditional, direct contact with landowners via publicity and marketing efforts, one-on-one technical assistance visits, speaking engagements at state and county forestry association conferences, meetings, workshops, etc; 2) training an intermediate audience, such as field-based forestry and natural resource professionals and developing materials and programs for their use (for example county Extension agents, county/district agency foresters, consulting foresters and forestry contractors, Master Tree Farmer Program volunteer landowners, etc.) and; 3) newer, nontraditional forms of information dissemination, training and education such as eXtension, Moodle courses, webinars, and other Internet applications such as decision support systems (DSS) and web portals, etc. Each avenue has unique opportunities and challenges that will be assessed as we build our Extension outreach activities specifically designed to reach landowners and those who work with them. In addition, these avenues are not mutually exclusive and will benefit from providing complementary messages.

Direct Contact: The average NIPF landowner requires general information on forest management possibilities, importance of management, risks involved with management, and general economic consequence of each management possibility. We will help this audience understand the role forests play in carbon sequestration and the opportunities available for increased management. We intend to broaden our programs to recruit 20% more NIPFs into Extension programs than we are currently reaching by targeting large absentee landowners with basic information about responsible forest management and climate uncertainties.

Greater level of detail should be presented to state forestry association and county forest landowner associations landowners because this group is more experienced and involved with management decisions. State extension teams will prepare articles, factsheets, and conduct field days to reach this group. It is reasonable to assume that 80% of the NIPFs actively involved with state and county forest landowner associations will be informed of new strategies during this project, 20% will be willing to adopt at least one new project-related practice within the 5 year

project time frame, and 35% will adopt at least one new practice after the project period has ended.

Training Field Level Professionals and Developing Materials for Their Use: County Extension agents require a different kind of training, since they are expected to train others. Information regarding the potential of forests to mitigate climate change is important so that participants can understand the opportunities for change across landscape. They also must understand the various values and beliefs that are held by forest landowners and the non-climate motivators that may compel them to change management practices. Our outreach materials and training will be made available to all county Extension agents (model plans, brochures, publications, etc.) to conduct effective county level workshops.

As discussed earlier, it is also important to reach practicing consulting foresters and county foresters because each has numerous contacts with NIPFs that are willing and have the capacity to alter and/or implement climate/forest strategies. This group needs the highest level of quality and detailed training, which will require a dedicated effort and sufficient funds to develop. Extension and climate educators will conduct regional trainings for the consulting foresters through face-to-face and technology-assisted sessions (webinars, Moodle courses, eXtension options, etc). Each will thoroughly instruct participants on how to implement management options, compute the economic and financial aspects of each option, use the DSS that will be developed in our CAP, and provide each with a new set of outreach tools to disseminate to their clientele.

New Technologies: Both NIPF landowners and those we train to provide programs and information can be reached with new technologies that we will develop. Many of the tools developed above will be adapted for electronic dissemination, enabling smaller landowners, community leaders, decision-makers, and regional planners to access this information. These tools are outlined in the proposal. The immediate and emerging importance and value of these online efforts cannot be underestimated. According to Google Analytics, the Forest Encyclopedia Network coordinated by the Southern Regional Extension Forestry office receives tens of thousands of unique visitors per month (<http://forestencyclopedia.net>). Users report the information received on this site to be highly valuable in their decision-making (Ashton, Hubbard and Rauscher, 2009). Similarly, the Forestry & Natural Resources Webinar Series is reaching hundreds of county agents, county foresters, industry foresters, consulting foresters and others each year on a variety of topics. Users report substantial knowledge gain and cost savings as the result of these online activities. Incorporating climate and climate change into these established online sources will pay great dividends.

Receiving information once rarely changes behavior. By offering the same information through several channels and spokespersons, landowners will hear about new techniques and strategies that sound promising in uncertain climate futures. Receiving this message from consultants, colleagues, contractors, and neighbors will help people understand the relevance of this information. Reaching people who do not own land with electronic media may help citizens better understand the interplay between climate and forests and enable them to support policies and land-use decisions that affect forests.

4. Management practices to achieve mitigation outcomes and projected success rates

The mitigation goals set in the RFA (15% increase in C sequestration, 10% reduction in N and energy use by 2030) will be achieved through the adoption of altered forest management on a portion of the total southern pine plantation ownership. Table 1 shows a suite of management changes, and potential impacts and outcomes if these changes are adopted on a portion of the industrial and non-industrial ownership. It is important to note that these management changes are not mutually exclusive and are intended as examples: the efficacy of a much larger range of management approaches for mitigation will be explored in the CAP. These examples and postulated adoption rates give an idea of the order of magnitude of mitigation that can be achieved through various means.

Canadell and Raupach (2008) categorized the four primary strategies by which forest management can be used to mitigate atmospheric CO₂:

1. Increase carbon density (mass of carbon per unit land area) of existing forests at both stand and landscape scales
2. Increase forested land area through reforestation or afforestation
3. Expand the use of forest products that sustainably replace fossil fuel CO₂ emissions
4. Reduce emissions from deforestation and degradation

The forest management strategies that will be explored and assessed in the CAP will fall into all four categories, with likely emphasis on strategies which increase carbon density of existing forests, reduce degradation, and expand the use of longer-lived forest products.

Extended rotations: Extended rotation lengths increase forest system carbon sequestration in two ways. First, longer rotation lengths have larger trees that store more carbon just due to their increased age. Second, longer rotation length stands, when harvested, tend to produce greater proportions of longer-lived solid wood products which have much longer half-lives than products, such as paper, derived from smaller trees in shorter rotations. Research in our group has quantified the impacts of rotation length on *in situ* (forest ecosystem pools) and *ex situ* (product pools) forest carbon sequestration for slash pine management systems (Gonzalez-Benecke et al. 2010). These results, which will likely be similar to those for loblolly pine, show that longer-rotation, solid-wood management regimes incorporating multiple thinnings sequester 20% more carbon *in situ* and *ex situ* than shorter rotation management regimes focused on pulpwood production (Figure 4).

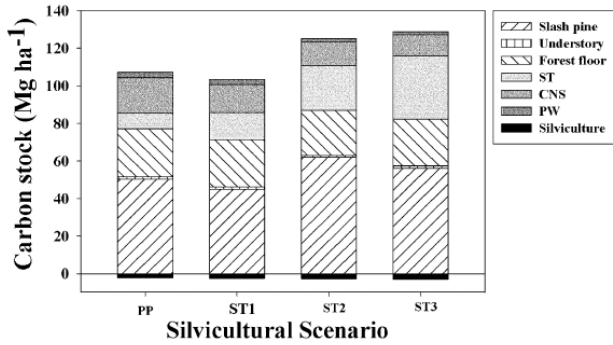


Fig. 2. Average carbon stock for slash pine plantations for first 5 rotations under different silvicultural scenarios.

Figure 4. Comparison of *in situ* and *ex situ* carbon stocks under 18-year pulpwood management (PP), 22-year rotation sawtimber management with one thinning (ST1), and 35-year rotation sawtimber management with one (ST2) and two (ST3) thinnings (Gonzalez-Benecke *et al.* 2010). *Ex situ* product pool classes specified in the key are sawtimber (ST), chip-n-saw (CNS) and pulpwood (PW).

Extension and outreach efforts will outline alternatives for landowners with established stands to extend their rotations. Continued declines in pine pulpwood markets are expected and will help provide an incentive to reach longer rotation ages, this particularly true for north Florida and coastal Georgia. Researchers together with the economics and policy team will provide financially viable alternatives to the industry and Extension team. To reach NIPF targets in this category, Extension and outreach foresters in the 10 state study region will need to influence decisions on 175,000 acres of private forests during the five year project. If the average plantation owner owns 100 acres, this translates to a reasonable target of increasing the rotation length of approximately 35 landowners per state per year for five years. We estimate that in coastal LA, FL, GA, and SC there is 6 million acres of densely stocked loblolly and slash pine stands initially planted for small diameter pulpwood markets. For conversion of low value stands, industry needs effectively silvicultural strategies that are economically attractive for optimizing yields of higher value solidwood products.

Substitution of wood for carbon and energy intensive building products: Wood in structural lumber or other building materials is a carbon sink, while concrete or steel building materials are a carbon source requiring substantial fossil fuel energy for their manufacture. For this reason, any substitution of wood for more carbon (and energy) intensive building materials will result in a net reduction in carbon emissions. Analysis by the CORRIM group, and others, has shown that this substitution effect, over the course of several rotations, can exceed the carbon storage in forest and wood products by several-fold (Figure 5; Perez-Garcia *et al.* 2005). Our analysis in Table 1 assumes that 25% of the additional solid wood produced from longer rotations will be used in place of steel or concrete, and therefore contribute to a substitution effect.

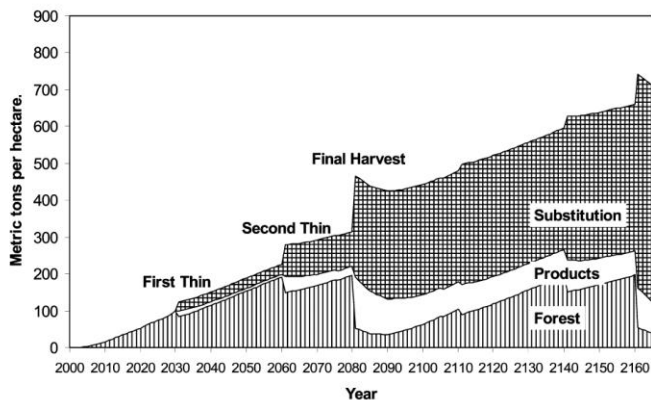


FIG. 2. Carbon in the forest and product pools with concrete substitution for the 80-year rotation.

Figure 5. An example of carbon accumulation in the forest (*in situ*), products (*ex situ*), and “accumulated” in an avoided emissions pool associated with substituting wood for more carbon intensive concrete building materials (Perez-Garcia *et al.* 2005). Note the large size of the substitution pool relative to the other pools.

Extension activities will include writing materials for policy makers and consumers about the wisdom of choosing solid wood and tree fiber-based products over non-renewable resources. The secondary education module will provide this information for educators; spin-off fact sheets and exercises will be available to all extension agents.

Afforestation is usually defined as planting trees on land that has not supported trees in the past, or has not been forested for >50 years (Fahey *et al.* 2010). Afforestation can have large impacts on carbon density, because most alternative land uses, such as agriculture or pasture, have much lower carbon densities than forests. Opportunities exist to afforest marginal farmland or pasture, where the dual benefits of economic return to landowners in the form of wood production, as well as increased C sequestration will be achieved. CAP research into the economic drivers of management decisions for landowners and the potential of policy based incentives (Aim 4) will aid in decision making.

Forestry and Agriculture Extension agents will work with Climatologists and outreach foresters to influence the afforestation behavior of approximately 50 landowners, owning an average of 100 acres per year in each of the 10 study states over a five year period. This equates to 5,000 acres per state per year afforested. Cost share programs such as EQIP will be important components of this transition, and may require effort to reprioritize state funds. Regardless of cost share assistance, the Extension and outreach foresters will work with forest and agricultural economists and climatologists to show the value and importance of afforesting marginal agriculture lands.

Avoided deforestation: Loss of forestland to development can be an important driver of land cover change, and by extension landscape decrease in carbon density, especially in rapidly urbanizing regions (Drummond and Loveland 2010). The development of cost-effective and profitable management regimes, perhaps coupled with incentive programs, can slow rates of deforestation, and result in the maintenance of carbon density in the region. The NIPF landowner research that will occur under Aim 4 will be especially helpful for uncovering barriers

to NIPF forestland maintenance and development of NIPF management regimes which may encourage continued forest management. Surveys of NIPF owners show that profit margin, while important, is often not the main reason for owning forested land (Butler, 2008).

State extension and outreach forester teams will be encouraged to join forces with several environmental and land preservation groups to more strongly promote the concepts of working forests. This project can act as a catalyst to engage many groups working to slow unnecessary conversion of forests to nonforest use. A similar target of avoiding at least 5,000 acres per state per year for five years will be set, however these efforts will likely vary across the region, based on high priority areas and urbanization trends. These efforts have been gaining momentum even without strong Land Grant and Extension involvement. Funds from this project will be a welcome addition to this effort. Conservation easements provide economic incentives to limit development on forest lands. Forest industry has been receptive to conservation easements because the rights for timber harvest and reforestation are maintained. We will monitor the importance of such contracts and identify barriers for NIPF owners.

Increased resilience to catastrophic disturbance: Catastrophic disturbances such as wildfire, hurricanes, and pest outbreaks can have significant impacts on region wide C stocks and sequestration rates (*e.g.* Powell *et al.* 2006, Xiao *et al.* 2008). Treatments or management practices which reduce the impact of these disturbances will have the effect of increasing sequestration by maintaining carbon density on the landscape that would have been reduced after disturbance. A major emphasis of the project is on region-wide assessment of the effects of climate change scenarios and management alternatives on resilience to disturbance. Disturbance scenario assessment procedures were discussed in detail in the written response submitted to the Reverse Site Visit panel. The role of small private forests is critical with regard to pest outbreaks, as these areas could become refuges for forest pests if they are not well managed. Up to this point industrial cooperatives have not directly addressed how climate change could alter disturbance patterns and risks. This project will provide a framework for helping member companies develop risk assessment and mitigation tools related to climate change. Thus, this CAP is poised to make a substantial contribution to these organizations.

Recent hurricanes, ice storms, and pest outbreaks have increased landowner interest in information concerning risks and the resilience of their forests. This project will provide the funding and coordination to develop materials and deploy programs that help landowners improve their forests' health and resilience. Materials from this project, including new research results on climate and southern pine resiliency will be incorporated with a target of influencing 20,000 acres per state per year for five years.

Increased growth from deployment of advanced generation seed: Cooperative Tree Improvement programs develop virtually all of the advanced generation selections for commercial seedling production. Plantations that are being harvested now were planted with unimproved or first generation material. Compared with unimproved seed, each cycle of tree improvement has led to increased gains of 10%, so second and third cycle selections are 20% and 30% greater, respectively than unimproved seed. As more seed from second and third generation material is deployed, we expect a 10% increase in average growth and yield relative to first and second generation material that is being replaced. Proper deployment anticipating climate change risks

is crucial to obtaining this gain. Currently, ~600 million genetically improved loblolly and slash pine seedlings are planted every year on ~ 1 million acres. We are conservative in our estimated adoption rate in Table 1.

Enhanced efficiency N fertilizers: The growth of most forest ecosystems in the southern United States is limited by deficiencies of N, often in combination with P. Consequently, approximately 100,000 tons of urea are applied annually to pine plantations in the South (Albaugh et al. 2008). Following a single application of 200 lbs ac⁻¹ N + 25 lbs ac⁻¹ P, the average growth increase of southern pine plantations compared with no fertilizer addition is around 1.5 tons ac⁻¹ yr⁻¹ over an 8 year period or an additional 12 tons ac⁻¹ of wood production (Fox et al. 2007). Unfortunately, N uptake efficiency following fertilization in forest ecosystems is low, with less than 25% of the applied N taken up by the crop trees. The remainder is tied up in competing vegetation, immobilized in the soil, or lost through volatilization. Recent work in the South, including our own, has shown that volatilization losses range from 10% to 50% of the fertilizer applied N, depending on season of application, soil and climatic conditions, and the characteristics of the forest (Kassel et al. 2004, 2009; Zerpa and Fox 2010). Most operational applications of N are made during the winter months when rainfall is greater and temperatures are lower in an effort to reduce volatilization losses. However, it has been shown the N use efficiency is greater when N fertilizers are applied during the growing season, despite a greater risk of volatilization (Blazier et al. 2006). Newly developed, enhanced-efficiency N fertilizers use a variety of mechanisms to improve N uptake efficiency and reduce potential losses. These typically involve either a coating to alter N release characteristics of urea or use of more complex forms of N such as ureaform. In addition, urease inhibitors such as NBPT (n-butyl thiophosphoric triamide) can be added to urea to reduce volatilization losses. Nitrogen uptake and nitrogen use efficiency also varies among genotypes of loblolly pine, suggesting that selection of genotypes with improved N use efficiency could significantly improve N fertilizer efficiency.

The use of enhanced efficiency N fertilizers and genotypes with improved nitrogen use efficiency will make it possible to significantly reduce fertilizer use in forestry without sacrificing the yield improvements needed to increase timber supply and carbon sequestration in plantation forests. This will also reduce the greenhouse gas emissions associated with the manufacture, transport and application of N fertilizers. We estimate that the use of enhanced efficiency fertilizers would reduce volatilization losses by 25% (Zerpa and Fox 2010) and improve N uptake efficiency by 25% compared with urea (Blazier et al. 2006). If this assumption is correct, it would be possible to reduce per acre N fertilizer rates by 50% and still obtain similar gains in production, i.e., reducing the per acre application rate of N from 200 lbs ac⁻¹ to only 100 lbs ac⁻¹. If enhanced efficiency fertilizers were used on half of the acres of forests fertilized annually, it would be possible to reduce the total amount of N fertilizer applied in the South by 25,000 tons each year.

Small and medium sized nonindustrial forests, less than 100 acres, typically are not fertilized due to the high cost (Minogue, 2010). Extension and outreach efforts will be focused on larger landowners with the goal of reaching 5,000 acres in each of the ten states per year with modified and improved fertilization recommendations.

Once enhanced efficiency N fertilizers are developed and proven, their application will have effects in addition to the reduced N loss, lower application rates, and energy savings described above. Because of their higher efficiency and lower rates of application, the cost of fertilization should decline, perhaps by up to 50% per acre. This will make the financial hurdle for fertilization much lower, which should enable both industrial and NIPF ownerships to increase the acres receiving fertilizer, which in turn will increase productivity and C sequestration.

Reduced water consumption: The RFA sets an additional goal of reducing water consumption by 10% by 2030, relative to 2010 values. Planted pine production systems are without exception rainfed, *i.e.* there are no cases where irrigation water is added to pine plantations, other than experimental situations. Irrigation is used for the nine months that pine seedlings are reared in nursery beds prior to planting and water is used in the manufacturing of wood products, but both of these endeavors are beyond the scope of this CAP project. For this reason, the only means by which we can address the water consumption goal is through genetic improvement of water use efficiency. We have proposed to investigate these genetic mechanisms to lay the groundwork for such improvement, but changes will likely account for very small percentages of total water consumption – enhanced water use efficiency is usually desirable as a means to maintain productivity under water stress, rather than as a water saving measure.

Table 1. Potential pathways to achieving the mitigation outcomes outlined in the RFA: 15% increase in C sequestration and 10% reduction in N and energy use by 2030, relative to 2010 baselines.

Management Alteration	Scenario assumptions	Potential Stand-Level Impact due to Management Change	Potential adoption by 2030		Total potential mitigation outcome across all planted pine by 2030
			Industrial	NIPF	
Increase rotation age from pulpwood to solid wood regime on existing and new plantations	Stand-level impact from Gonzalez-Benecke <i>et al.</i> 2010; largest impacts likely in sub-regions with greater focus on pulpwood, <i>e.g.</i> Florida, NC/SC/GA coastal plain	20% increase in <i>in situ</i> + <i>ex situ</i> C stocks	4 million ac	700,000 ac	38 million Mg C, 2.4% increase in C sequestration
Increased acreage fertilized due to lower fertilizer cost associated with improved N efficiency fertilizers	Decreased fertilizer cost due to improved fertilizer N efficiency plus outreach efforts will spur fertilization of additional acres; average increase in <i>in situ</i> + <i>ex situ</i> C stocks due to fertilization ~ 15% (Gonzalez-Benecke <i>et al.</i> 2010)	15% increase in <i>in situ</i> + <i>ex situ</i> C stocks	10 million ac	500,000 ac	63 million Mg C, 4% increase in C sequestration
Substitution of wood for more C emission-intensive building materials, based on more solidwood production from increased rotation age and fertilizer scenarios above	~ 4 times forest C pool, Perez-Garcia <i>et al.</i> (2005); assume that 25% of increased solid wood production ends up being used as a substitute for steel or concrete	160 Mg C / ac	--	--	188 million Mg C, reductions in emissions equivalent to 12% increase in C sequestration
Deployment of genetically improved seedlings on reforested plantations	Reforested plantations will use seedlings with improved genetics relative to what was harvested; assume 10% productivity gain per tree breeding generation (McKeand <i>et al.</i> 2006)	4 Mg C / ac	10 million ac	1 million ac	44 million Mg C, 2.8% increase in C sequestration
Silvicultural treatments and seedling genetic deployment that increase resilience to catastrophic disturbances	Assume avg. of half of C stocks lost to catastrophic disturbance; sub-regions with largest impacts will depend on disturbance	20 Mg C / ac	2 million ac	1 million ac	60 million Mg C, 3.8% increase in sequestration
Use of enhanced efficiency N fertilizer to reduce amount of N applied per acre	Reduce volatilization losses by 25% (Zerpa and Fox 2010) & improve N uptake efficiency by 25% compared with urea (Blazier <i>et al.</i> 2006); 1 million ac/yr fertilized on industrial (Albaugh <i>et al.</i> 2007); 100,000 ac/yr fertilized on NIPF; assume 100 lb/ac enhanced fert N applied	50% reduction in N fertilizer application	50% of fertilized acres / 500,000 ac/yr	50% of fertilized acres / 50,000 ac/yr	Reduction of N application by 27,500 tons N / year = 25% reduction in applied N
Use of enhanced efficiency N fertilizer to reduce C cost associated with N fertilizer manufacture	manufacturing of urea = 3.127 kg CO ₂ eq. kg ⁻¹ N and 0.0208 kg CO ₂ eq. kg ⁻¹ (Nemecek and Kägi 2007)	--	--	--	180,000 Mg C reduction in emissions from N fert manufacture, equivalent to a marginal % increase in sequestration
Afforestation of marginal agricultural land	Improved profitability of forest operations resulting from this project will encourage some portion of NIPF or farmers to convert marginal ag. land to forest; Assume negligible C stocks on ag land, average stand-level forest C stocks from Gonzalez-Benecke <i>et al.</i> 2010	40 Mg C / ac	NA	1 million ac	40 million Mg C, ~ 2.5% increase in sequestration
Avoided conversion of forestland to non-forest use	Improved profitability of forest operations resulting from this project will enable some portion of acreage to remain in forestland that would have been converted; Avg. forest C stocks from Gonzalez <i>et al.</i> 2010	40 Mg C / ac	1 million ac	1 million ac	80 million Mg C, ~ 5% increase in sequestration

#3: Please describe, in detail, the qualifications and experience that are desired in the Project Manager. What will be the responsibilities of the Project Manager? Is this just an administrative position? How will you ensure that the 39 key/senior persons on the project will be responsive, in a timely manner, to the requests of a Project Manager? What authorities and responsibilities will the Project Manager have?

The Project Manager position is a critical one, and we welcome the opportunity to articulate our thinking about this position. In addition, if our CAP is funded, we hope NIFA staff will provide feedback and guidance on these issues, based on their experience with similar large projects. Our thinking about the program manager position has been developed through discussions with leaders of a few large projects, but in particular has been influenced by the very successful model used in the SE Climate Consortium, that includes eight southeastern universities.

Qualifications and experience

The person filling the Project Manager position would assist the Executive Committee (EC) in managing all aspects of the project, including: budgeting; coordinating and drafting project reports; providing technically accurate guidance to investigators and staff related to spending, reporting, and other decisions directly related to the project funds; developing a strong working relationship with investigators and key staff at all participating institutions; and coordinating project-level communication, activities, and meetings.

Requirements:

- At least 5 years' experience managing projects (grant administration experience preferred)
- Formal training and certification in project management (e.g., Project Management Professional Certification or Certified Associate in Project Management Certification), and formal training in grant management; or willingness to complete (at no cost to manager) formal training and certificate programs offered by the University of Florida including:
 - Project management certificate program leading to PMP or CAPM certification (<http://xms.dce.ufl.edu/reg/groups/ldi/default.aspx?p=20>)
 - UF Project management workshop (<http://www.hr.ufl.edu/training/catalog/other.asp>)
 - UF Grant management training (<http://www.hr.ufl.edu/training/myUFL/toolkits/grants.asp>)
- Masters' degree in a relevant field preferred
- Excellent communication skills and ability to convey technical information to staff and investigators in diverse fields, and ability to develop high quality and timely draft reports and other documents needed to administer the project in coordination with the EC
- Excellent organizational and time management skills, and ability to successfully monitor grant compliance, including progress toward the work plan, appropriate spending, and required timely reporting by collaborators
- Excellent interpersonal skills and an ability to manage conflict

- Proficiency with MS Office, PeopleSoft, and other software necessary to complete required tasks

Is this just an administrative position?

Yes. This is a full-time administrative position with no research responsibilities. Given the size and scope of the project, we recognize the value of having a full-time administrative position to ensure that all project objectives and requirements are met in a timely manner, and allow PIs to focus more of their efforts on research. Also, based on our conversations with lead PIs on other large projects, a joint project manager/researcher position could lead to perceptions by collaborators that the manager is disproportionately focused on their own research area. A full-time administrative position would also help avoid problems with distractions that may arise from having the manager also tasked with completing research, which can be especially problematic in an academic environment where research publications are critical for advancement.

Responsibilities and authorities

Specific responsibilities and authorities of the Project Manager include:

- Support the EC in managing the project budget, work plan, and grant compliance
- Provide feedback and technical guidance to the EC on issues relating to work plan progress, the budget, reporting requirements, etc.
- Serve as ex-officio member of the EC
- Assist the EC with communication between project coordinators and collaborators
- Organize and coordinate the recurring EC, External Advisory Board, and Cooperative Industrial Advisory Council conferences/video call meetings
- Organize and coordinate annual all-project meetings
- Supervise half-time clerical staff
- Coordinate and draft components of annual reports
- Represent the project in meetings and workshops (with EC members)
- Update and maintain the informational portions of the project web site (*e.g.* project descriptions, personnel, news, publication lists, etc.)
- Other minor administrative duties to be determined

The Project Manager reports directly to the EC, working most closely with the Project Director (who is also Chair of the Executive Committee). The manager is the executor of the decisions and policies of the EC, and will have the necessary authority to act as agent for the EC.

Ensuring that the 39 collaborators respond, in a timely and appropriate manner, to the project manager

As mentioned in the reverse site visit, the first task of the EC will be to set written, formal operating guidelines and policies for important and/or potentially contentious project management matters such as funding, authorship, and contribution to the integrated project. Two items of particular significance are: (1) responding in a timely and appropriate manner to the

Project Manager in his/her capacity as executor of EC decisions; and (2) addressing any inadequate contribution by collaborators.

Operating guidelines and policies will clearly indicate that the Project Manager is acting on behalf of the EC in all matters relating to the project, and that failure to adequately respond to requests for information, communication, etc. in a timely manner will be taken seriously by the EC and addressed in an appropriate fashion.

Policies will also specify a deliberative process and repercussions for those who fail to adequately contribute to the integrated program, and when project requirements are not met. These issues are not easy to deal with, but the existence of written policies developed by the full EC, and shared with all project participants *at the beginning of the project* will help to establish a “culture of accountability”. In the end, these efforts will be appreciated by those who are contributing to the integrated project, and will help to maintain morale and engagement, both of which will suffer if investigators are allowed to drain project resources without contributing to the project goals. We assume this approach will also be appreciated by NIFA program managers, and will facilitate their job of justifying continued investment in the project.

#4: Describe areas in which the Southern Conifer Climate Change CAP might collaborate with the Conifer Genome CAP and the discoveries that it made. And how the southern conifer CAP project might be expected to collaborate with the loblolly genome CAP project.

We will directly collaborate with scientists involved in the loblolly Genome CAP as the goals of both projects are highly complementary. To formalize this collaboration and enhance communication, we will invite the Conifer Genome CAP project director or designee to participate on our external advisory board. We also propose that a Climate Change CAP member participate on the external or scientific advisory board of the loblolly Genome CAP.

Our Climate Change CAP team includes all of the US scientists directly involved in southern pine breeding and tree improvement as well as the vast majority of scientists who conduct molecular research with southern pines. Consequently, we will be the primary users of the DNA sequence information from the loblolly Genome CAP, expanding on and applying these discoveries to breeding, applied tree improvement and enhancing fundamental understanding of loblolly pine productivity, resistance and adaptation.

The major deliverable for the Genome CAP is a fully assembled and well annotated sequence of one reference genotype of loblolly pine. A good quality loblolly pine reference sequence will facilitate and enhance our proposed allele and gene discovery goals. We will identify alleles in genes that control productivity, disease and pest resistance, as well as adaptive traits by discovering and mapping DNA sequence variation in ~2000 individual genotypes in our three mapping populations and relating the presence of genetic variants with phenotypes. We propose to simultaneously discover and genotype single nucleotide polymorphisms (SNPs) with next generation sequencing (NGS) methods, because this will provide the most number of SNPs for the lowest cost. While it is feasible to use NGS without a genome sequence, the availability of a good reference sequence will dramatically facilitate our bioinformatic efforts and improve our understanding of the location and potential relevance of the SNPs. For example, to identify the SNPs in the short reads typical of NGS methods, the sequences need to be aligned. This alignment will be easier and work better with existing approaches using a complete genome sequence rather than just cDNA sequences. Aligning with the reference genome sequence will also provide additional information about gene family members and the ability to discover SNPs in regulatory regions located outside of the coding region but near genes which are not represented in the cDNA resource. Thus, in our Climate Change CAP, we will generate large amounts of genomic sequence information; this low depth sequence information from a large number of genotypes will be made available to the Genome CAP to incorporate into their sequence alignments and for iteratively refining the reference genome sequence.

#6: Describe what exactly makes this a climate change project and not just a wood production project.

The overarching goal of this proposal is to create, synthesize, and disseminate the knowledge necessary to enable southern pine landowners to harness forest productivity to mitigate atmospheric CO₂, to more efficiently utilize nitrogen and other fertilizer inputs, and to adapt their forest management approaches to increase resilience in the face of changing climate. We believe that improving planted pine productivity in the face of a changing climate is well aligned with NIFA's desired long term outcome of increasing carbon mitigation. Productivity is central because management decisions, particularly by industrial and large non-industrial private forest landowners, are principally financial decisions. Large southern pine landowners control two-thirds of the southern pine plantation estate and profit is an important motive. Timber production is also an important motive for many NIPF landowners. Thus, we argue that better rates of returns for forest landowners make a stronger case for reforestation, keeping lands in forest production and enhancing the justification for new lands to be afforested with southern pines, all of which are vital for us to achieve NIFA's broader desired outcome of a 15% increase in C sequestration, and 10% reduction in nitrogen and energy use by 2030.

Even with this overarching goal of harnessing forest productivity, the majority of research proposed is not directly aimed at improving wood production through increasing growth rate, which is the primary focus of most cooperative research. Rather, the majority of the proposed research complements our existing empirical understanding of southern pine productivity by measuring carbon, nitrogen and water pools and fluxes that we currently have limited knowledge about but are important for regional modeling simulations that quantify impacts and tradeoffs and integrating climate change into our management decision support systems to increase carbon sequestration and forest resilience. For example, the proposed measurements of soil heterotrophic respiration, N₂O and N soil efflux, understory carbon and other measurements are important for creating accurate carbon and greenhouse gas emission budgets. The regional level modeling relates to carbon, nitrogen and water footprints and not wood production. The landowner and regional insect and fire risk modeling are aimed at quantifying the impacts of these disturbances. The life cycle analysis assesses the whole forest product chain's impact on carbon and energy balance. The proposed ecophysiological research aims at quantifying regional differences in water use efficiency and understanding the mechanisms of drought tolerance with reduced rainfall (exclusion studies). The proposed genetic research aims to discover genes that control not only growth but a large set of genes involved in improving forest resilience such as disease and insect resistance, cold hardiness, and water use efficiency. The educational materials focus on climate, how climate change relates to forests, and use of renewable forest products as alternatives to nonrenewable or CO₂ emission intensive products. The extension and outreach is focused on integrating climate change and resilience into management decisions to help large industrial as well as small nonindustrial landowners and citizens better understand and appreciate the role of southern forests in climate mitigation by reducing nitrogen fertilizer use while increasing carbon sequestration. Education and extension activities will focus on climate change impacts to pine production, pine management, and pine markets. The goals of the extension and education activities are to not only improve the community understanding of these issues but to also provide landowners and citizens with the tools to inform and enhance their decision-making on policies, land-use changes, and forest management.

#7: Describe what will be accomplished funding that would not happen anyway, given the existing and strong network of research cooperatives and extension programs and the work that they are currently doing.

Summary: *This funding will enable a new set of trans-disciplinary activities within and across research, education, and extension that would not occur without this opportunity. The industry cooperatives are not conducting research on climate change and forest scientists and extension specialists are not working with climatologists. This project will dramatically strengthen research, extension, and education activities, by integrating across land grant and 1890 institutions in the region and across research, educational and extension functions, thereby increasing southern pine landowners' capacity to manage for ecosystem services, such as carbon sequestration, while improving the resiliency of their forests to changes in climate.*

Research Activity

The research agenda for industry-supported Cooperatives is driven by landowner's applied interests, because member companies need to justify their investment with the potential of economic returns. Consequently, the Industry Cooperative research has largely focused on improving productivity with empirical research on growth and yield information such as survival, tree height and diameter, and disease incidence. With growth and yield information, members can readily calculate economic returns which in turn drive management decisions. Cooperatives do not typically conduct more basic research on processes, for example, the genetic basis of responses to silvicultural treatments and ecophysiological mechanisms. No N modeling efforts to scale from the stand to the watershed to the region are conducted, because markets are not available for carbon, water or other ecosystem services, making it is difficult for industrial landowners to justify the substantial costs of quantifying these services for their lands and even more difficult to justify regionwide scaling and modeling efforts. For the most part Cooperative research has not explicitly taken into account the effects of climate and climate change on forest productivity. In fact an informal poll of a subset of industry representatives from the largest industrial landowners in the region indicates that these companies do not have a clear understanding of the potential impacts of climate change to their businesses or what can be done to improve their ability to respond to climate change. Thus, this CAP is poised to make a substantial contribution to these organizations.

The Industry Cooperatives are well positioned to leverage their existing infrastructure of empirical trials for the new process based work the CAP needs to achieve the milestones and outcomes laid out in the RFP. Industry-sponsored research into alternative management methods (e.g., variable spaced planting, timing of thinning, fertilizer application, weed control, and rotation length) has focused exclusively on maximizing return on investment. In contrast, the alternative management scenario testing that will take place in our biophysical and economic modeling efforts differ in at least two significant ways. First, at the stand level, alternatives will be evaluated in terms of their impact on carbon sequestration, nitrogen use efficiency, and resilience to disturbance impact, in parallel with economic analysis of the alternatives. Second, and perhaps most significantly, biophysical and economic models will evaluate alternative scenarios at the regional level. For example, if 20% of industrial and 5% of non-industrial landowners in the region adopt a longer rotation alternative, then what will be the impact on

regional carbon sequestration, N use, and resilience to disturbance? Analysis of forest management on this scale has never been undertaken by the industrial cooperatives alone, because it has been considered outside the direct scope of their research investments. The discovery of alleles in genes controlling productivity and adaptive traits has great potential for accelerating forest tree breeding and refining deployment decisions; however, the investment is still too high for industry to justify because it is not yet proven technology; hence the limited resources of the tree breeding cooperatives are used for classical breeding efforts that develop germplasm for commercial production and all molecular efforts to date have been funded from competitive federal grant programs. Thus, funding this CAP will dramatically accelerate the integration of climate and climate change scenarios into the whole research efforts of the cooperatives.

Education Activity

This funding will enable undergraduate students to experience a research program, to work with middle school classrooms after appropriate training, and to learn about the role of southern pine in climate mitigation actions. The teachers and young people they work with will increase their awareness about the role of pine trees in carbon and climate change. These funds will help create a secondary Project Learning Tree module that would not otherwise exist.

Extension Activity

Despite a well-coordinated regional group of extension foresters, none of them work with the Southeast Climate Consortium. This funding will enable this relationship to occur, which will enable climate specialists' to extend their agricultural work into forestry and enable foresters to build climate knowledge and impacts of climate change into their programs. The Decision Support System is a central example of an extension deliverable that would not occur without this relationship. Also, without resources for this project, NIPF lands would continue to produce at suboptimal levels. The resources will allow a coordinated Extension effort that not only has a visible impact on the ground via higher valued, more environmentally, economically and socially productive stands, but the added benefit of increased carbon stored on private lands as well.

Research-Research Integration

In general, cooperatives are led by single disciplinary experts in fields, such as forest biometrics, economics, genetics, and silviculture. The research to be accomplished in Aims 1-4 requires integrating this disciplinary expertise across the cooperatives to conduct trans-disciplinary research. Such integration requires a significant investment of time to do well and is not likely to occur without a specific project to focus the efforts. The CAP is designed to develop this capacity across the region.

Research-Extension Integration

In a few states, researchers working with industrial cooperatives share information effectively with extension specialists, but this is not the norm. This funding will enable researchers to work closely with extension specialists to deliver science-based information to industrial and non-industrial landowners. Developing the DSS will foster integration between forest researchers, forest extension specialist's and climatologists and that should build capacity for all participants. For example, researchers, including graduate students, will become more adept at communicating with industrial and non-industrial landowners. Non-industrial

landowners will access more current and helpful research results. Since the DSS will be available to consulting and county foresters as well as our traditional audiences, all forest landowners who are planning to harvest or reforest their land and who use a local expert for assistance will have the opportunity to learn more about current research. This DSS will allow extension and outreach specialists to better support individual forest owners and potential forest owners who have questions and concerns about what climate change might mean for them in their specific area. One useful activity will be the development of “risk maps” that highlight areas where landowners might be at the greatest risk for planting, drought, and disturbance. Other maps developed by the research project will also be developed to highlight areas most suited for planting under various future climate and market scenarios. These maps will help extension professionals target landowners in high risk areas with appropriate information.

Research-Education Integration

This funding will enable 36 graduate students and post-doctoral scholars to obtain experience with climate change adaptation, mitigation, education, and extension with southern pine. These students will be part of a large, integrated, regional activity and know their work will be used by stakeholders. They will hear from and work with these stakeholders as they define their research questions and share results. They will be better trained to 1) work across disciplines to help solve real problems, 2) work with stakeholders, 3) share information with others, 4) value integrated, interdisciplinary, applied research and extension.

Education-Extension Integration

There will be close cooperation between the development of educational activities for secondary students and extension program development which will lead to creative, interactive extension programs for 4-H youth, master gardeners, and other interested groups. Educational activities focusing on basic climate education will be useful to a variety of extension agent programs, as well as information on life cycle analysis, product comparison, and rural land policy. Climatologists will assist with the development of the educational exercises and extension specialists will help review and pilot test them. Graduate students will be expected to assist in all aspects of program development in both education and extension to build their skills in communication.

#8: In addition to education and extension programs, describe any factors (e.g., incentives) that will be important to bring about change on the part of landowners, or, if not known, describe how those change factors will be discovered.

***Summary:** We expect many factors are important for inducing the diverse group of southern pine landowners to adopt altered forest management approaches. Among these factors, market and non-market incentives have strong appeal and can make substantial impacts. Throughout the project we will assess federal and state policies and programs likely to affect southern forests and southern pine landowner behavior. For example, policies that provide direct incentives for afforestation to increase carbon sequestration or for renewable energy targets and standards are likely to dramatically affect southern pine landowner decisions. Because we don't currently understand the importance of specific policies to landowners we will assess their potential impacts, by surveying industrial and non-industrial landowners. We will conduct a multi-attribute utility surveys to quantify landowners' willingness to adopt important practices according to relevant mitigation and resilience factors. We expect that our results will allow us to move beyond a crude list of major factors provided from the literature review and interviews with landowners, to estimate the relative importance of specific factors on programmatic participation.*

Assessment of salient features of C sequestration and mitigation policies and programs

We will assess current and expected features of policies and programs that are anticipated to have significant impacts on land management activities, carbon sequestration and climate change mitigation efforts in southern planted pine forests. A review of major current and proposed state and federal programs and policies and a literature review will inform a white paper that will both support the efforts of other team members and serve as an important outreach/extension resource. Collaborators have training in law and policy analysis, and they expect to review and catalogue significant policy/programmatic features, including: carbon accounting criteria, land use restrictions, data/information demands, registration/monitoring/regulatory burdens and costs, enrollment and opt-out provisions, program complexity and flexibility, risk mitigation, educational support, and technical and financial resources (e.g. cost share). The white paper will be subjected to extensive review by experts in relevant fields, and will be used to inform evaluation of proposed policy scenarios using a bio-economic model that has been proposed by other team members.

Evaluate the expected adoption of management practices

To date, the factors affecting participation by landowners in programs that incentivize altered silviculture practices are not well understood. For example, while there exists a large potential for C offsets income from forestland in the southern US, participation rates in C markets remain low despite the growing interest by landowners in sustainable production systems, low-impact harvest methods, and other environmentally-friendly approaches to forestland management (Tavoni et al., 2007), and the ability to supplement income from carbon offsets trading programs (e.g., Climate Action Reserve, American Carbon Registry, and the Voluntary Carbon Standard) with payments from popular federal programs (Adams, 2009). Lack of available knowledge about contracts, regulations, institutional trust, expected income and risk has been cited in the literature as barriers to landowner participation in similar programs (e.g., Butterfield et al., 2005; Bigsby, 2009).

Without adequate participation rates, mitigation efforts in planted pine forests may be insufficient to achieve policy and/or programmatic success. For this reason, our proposed project includes a study of factors impacting adoption of C sequestration strategies with private industrial and NIPF landowners.

To evaluate the expected adoption of altered silviculture practices, we will survey our cooperative members and NIPF landowners. Data from the ongoing project can be used to estimate current and potential carbon sequestration rates on these lands based on landscape characteristics. However, we do not know at what point these landowners would modify existing production practices in response to programmatic incentives. Using a multi-attribute utility survey method, we would specify landowners' willingness to adopt important practices according to relevant mitigation and resilience factors.

The survey is expected to include behavioral, attitudinal, demographic, and preference elicitation questions. Behavioral questions observe current and past landowner behavior with respect to values, beliefs, available carbon offset alternatives (e.g., contracting with C offsets aggregators) and participation in relevant federal or state programs or ecosystem services markets that may provide insight into broader landowner motivations. To model behavior, levels of participation will be defined based on conversations with members of the target population and a literature review. Reasons behind landowner decisions may vary widely depending on unique outlooks on important programmatic features; economic incentives; institutional participants; belief systems; and values about stewardship, patriotism, frugality, and family (Kaufman, 2010). In-depth interviews, focus groups, and questionnaires will help inform the design of attitudinal questions, including: (1) interviews and focus groups with landowners to create a list of possible economic and non-economic factors that influence current or future programmatic participation and drive decisions about forest management, and particularly forest conversion; and (2) a ranking/rating exercise to narrow the list of those factors most likely to influence participation. To capture attitudes toward identified factors that may influence participation, a series of Likert-like questions will be specified following an established methodology for constructing summated scales (Spector, 1992). A battery of demographic questions will also be included. This range of data collection methods will help us understand, for example, what could motivate southern farmers who are working marginal lands to plant trees.

A suite of well-accepted preference elicitation methods (e.g., choice modeling) and econometric methods (e.g., parameterizing predictive logistic regression models) can be applied to quantify preferences for factors such as expected income, risk, contract terms, verification, etc. Several different preference elicitation constructs will be considered to determine the format that yields the best information and the highest quality response. The survey design process will include consultation experts and landowners. Extensive interviews, reviews, and pre-tests will take place before the survey is administered, and we will employ a standard survey implementation methodology for mixed mode surveys (Dillman, 2006), where internet-based, mail and telephone surveys will be conducted as needed. The investigators have experience conducting these types of surveys.

We expect that our results will allow us to move beyond a crude list of major factors provided from the literature review and interviews with landowners, to estimate the relative importance of specific factors on programmatic participation. Results of the econometric model should allow us to infer how various policy features would generate varying degrees of landowner participation. That is, we believe we will be able to model expected participation rates on program attributes and landowner characteristics using parameter estimates from the econometric model. Since parameter estimates are based on responses from landowners, if we apply these as weighted estimates of the analogous parameter estimates for representative sites throughout the Southeast US, we can arrive at some very useful predictions about programmatic participation and C sequestration potential in a policy context. For example, the model could be calibrated and applied to all NIPF landowners in Florida by applying group-specific weights to make the study sample representative of the policy population. When coupled with data that will already be collected by the researchers, parameter estimates can be used to calculate expected acreage enrolled in a given program for specified carbon offsets prices and other important programmatic attributes, and coupled with a timber supply model (e.g., SubRegional Timber Supply Model (Abt et al., 2009)) to estimate regional market impacts of alternative mitigation and adaptation strategies. Analytic results can also be interpreted to inform policy and public programs, such as programs to educate and inform landowners about program enrollment contracts or give landowners more land use flexibility within a contract.

#9: Describe the rationale for the 8.33% time commitment of the Project Director (T. Martin) to this project. NIFA is concerned that this is not adequate given the size and complexity of the project, the hiring of a project manager notwithstanding. NIFA recommends that the Project Director time allocation be increased in order to have sufficient oversight for the project and its proposed deliverables.

The Project Director is fully invested in the proposed project, and is committed to devote the full measure of time and energy necessary to assure the success of the project should it be funded. The budget allocation of 1 month/year for the Project Director salary was made with the intent to maximize resources for other administrative needs. In retrospect, however, it is apparent that this sent the wrong message with regard to the PD's commitment to the project. Accordingly, we will shift administrative funds to triple the PD salary commitment to three months / year. This change will have no net effect on the total project budget request. It should be noted that administrative funds have been budgeted to hire a full-time Project Manager as well as a fiscal assistant, which will ease administrative pressure on the PD. In the management plan in the original proposal, Dr. Martin held the position of Integration Leader for Mitigation. In order to free up additional time for Dr. Martin to provide broader project oversight, Dr. Thomas Fox (Virginia Tech) has agreed to serve as Integration co-Leader for Mitigation.

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