

Aim 1: Monitoring Network

Objectives

- Establish a regionwide three-tiered monitoring network to determine response to genetic improvement and silvicultural treatments such as planting density, thinning, weed control and fertilization.
 - Tier I Sites (Existing Trials): Empirical Data for G&Y Models – 500 sites.
 - Tier II Sites (Existing Trials): Empirical Data for G&Y Models and Ecophysiology Data for Process Models – 150 sites
 - Tier III Sites (New Trial): Detailed Ecophysiology Data on Impacts of Fertilization and Rainfall Exclusion for Process Models – 4 sites
- Develop standardized methodology to quantify C, water and nutrient storage and flux and responses to climate and management

Aim Leaders:

Tom Fox – Virginia Tech

Mike Kane - UGA

Jean Christophe Domec – NCSU

Kurt Johnsen – USFS

Eric Jokela – UF

Tom Hennessey – OSU

John King - NCSU

Tim Martin - UF

Dan Markewitz – UGA

Martha Monroe - UFGary Peter – UF

Asko Noormets – NCSU

Lisa Samuelson – Auburn

John Seiler – Virginia Tech

Jose Stape – NCSU

Brian Strahm – Virginia Tech

Eric Taylor - TAMU

Bob Tesky – UGA

Rod Will - OSU

Duncan Wilson – OSU

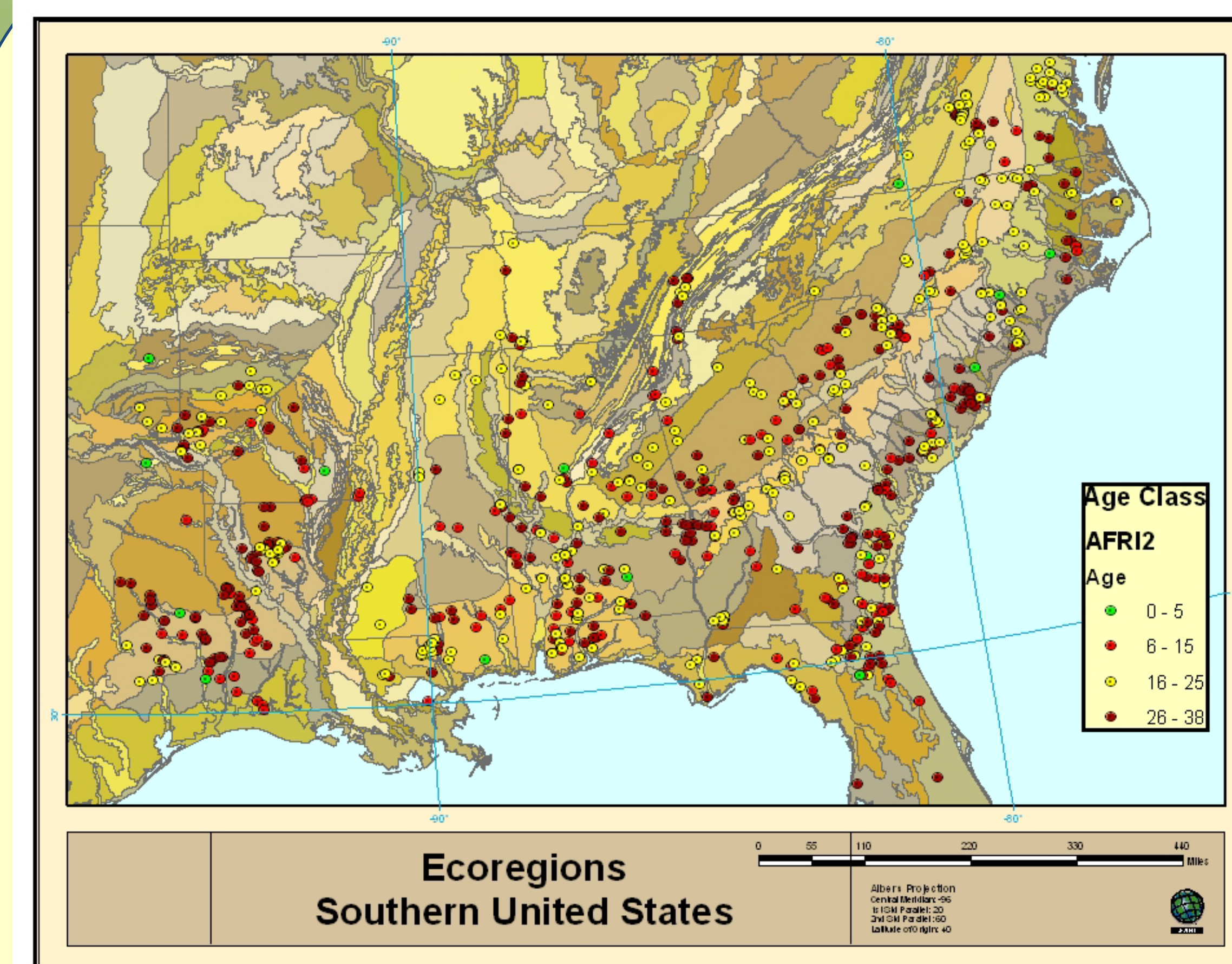
Jason Vogel – TAMU

End-of-Project Deliverables and Outcomes

- Develop empirical dataset on loblolly pine growth and yield for modeling efforts
- Produce regional baseline of carbon, water and nutrient budgets and their response to management (genetics and silviculture)
- Regional assessment of climate, soil and management impacts (genetics and silviculture) on soil GHG flux including CO₂, CH₄ and N₂O
- Regional assessment climate, soil and management impacts (genetics and silviculture) on water and nutrient use efficiency

Overview of Approach

- Based on feedback from other aims, determine standardized methods to collect required data
- Select Tier I and Tier II sites the most appropriate coop studies that are available
- Design and install Tier III fertilizer and rainfall exclusion studies
- Conduct measurements of Tier I, II and III installations and ensure appropriate Q/A and Q/C protocols are followed.
- Work to integrate graduate students and undergraduate interns into transdisciplinary nature of the research
- Provide feedback and maintain interactions with other aims as results are produced and fill in data gaps that are identified
- Provide input on suitability and utility of products produced by other aims, such as process models, LCA's, DSS's etc.



Locations and ages of existing cooperative field trials from which Tier II monitoring network sites will be chosen. The map is divided into U.S. EPA Level IV Ecoregions which delineate areas with similar geology, physiography, vegetation, climate, soils, land use, and hydrology (Gallant *et al.* 1989, Griffith *et al.* 1994, Omernik 1995, Omernik *et al.* 2000).

Year 1 Deliverables and Outcomes

- Finalize standard measurement protocols
- Select Tier I and II sites, compile existing data and begin to collect required measurements
- Install Tier III sites and begin to collect measurements
- Complete phase 1 of study using 15N to evaluate impact of enhanced efficiency N fertilizers on N uptake and volatilization losses in loblolly pine

Key Connections to Other Aim Groups

- Collaboration with Aim 2 Team to ensure that data required to parameterize and test the range of empirical and process models are available.
- Collaboration with Aim 3 Team to ensure that appropriate genotypes are evaluated and that required adaptation and mitigation traits are measured.
- Collaboration with Aim 4 Team to ensure data needed for LCA is available.
- Collaboration with Aim 5 Team to ensure that graduate students and undergraduate interns are integrated fully into the research program in a transdisciplinary fashion.
- Collaboration with Aim 6 Team to ensure that extension and outreach efforts have the information needed to create decision support tools for landowners, managers and policy makers.

Aim 2 : Multi-Scale Modeling

Objectives

- 1) Develop & assess management alternatives w/ Tier I data & existing models of C seq.
- 2) Preliminary assessment/case study of climate change factors on loblolly pine carbon and water exchange
- 3) Predict C pool dynamics at varying scales for alternative land use, management, & climate scenarios
- 4) Assessment of the resolution of alternative methods for quantifying forest water use
- 5) Assess tradeoffs btwn regional C sequestration, forest products, & maintenance of ecosystem services Refinement of forest management modules for integration into DSS
- 6) Develop a DSS carbon management decision support tools to solicit structured feedback - Climate, landuse, genetics, pest/fire risk, fertilizers

Overview of Approach

- Modeling team coordinates w Aim Leaders on field measurements
- Compile regional satellite, meteorological (including climate scenarios), soils and data needed for model runs
- Develop & assess management alternatives w/ Tier I data & existing models of C seq.
- Adapt 3PG to run as real time geoprocessing server
- Improved process & hybrid models parameterized from network measurements
- Predict C pool dynamics at varying scales for alternative land use, management, & climate scenarios Improved growth & yield models with climate inputs & C balance
- Regional map of potential climate or anthropogenic limitations to productivity
- Assess tradeoffs btwn regional C sequestration, forest products, & maintenance of ecosystem services Refinement of forest management modules for integration into DSS
- Prototype carbon management decision support tools to solicit structured feedback - Forest Management
- Refinement of climate scenario modules for integration into DSS Prototype carbon management decision support tools to solicit structured feedback - Climate Scenarios
- Refinement of climate, landuse, genetics, pests/fire risk, fertilizer modules for integration into DSS Prototype carbon management decision support tools to solicit structured feedback - Climate, landuse, genetics, pest/fire risk, fertilizers

Aim Leaders:

Randy Wynne – Virginia Tech

Steve McNulty - USFS

Ryan Boyles – NCSU

Steve McKeand – NCSU

Tom Byram – TAMU

Sabine Grunwald – UF

Tim Martin –

Wendell Cropper - UF

Mike Kane - UGA

Robert Teskey – UGA

Ge Sun – USFS

Harold Burkhart – VPI

Valerie Thomas – VPI

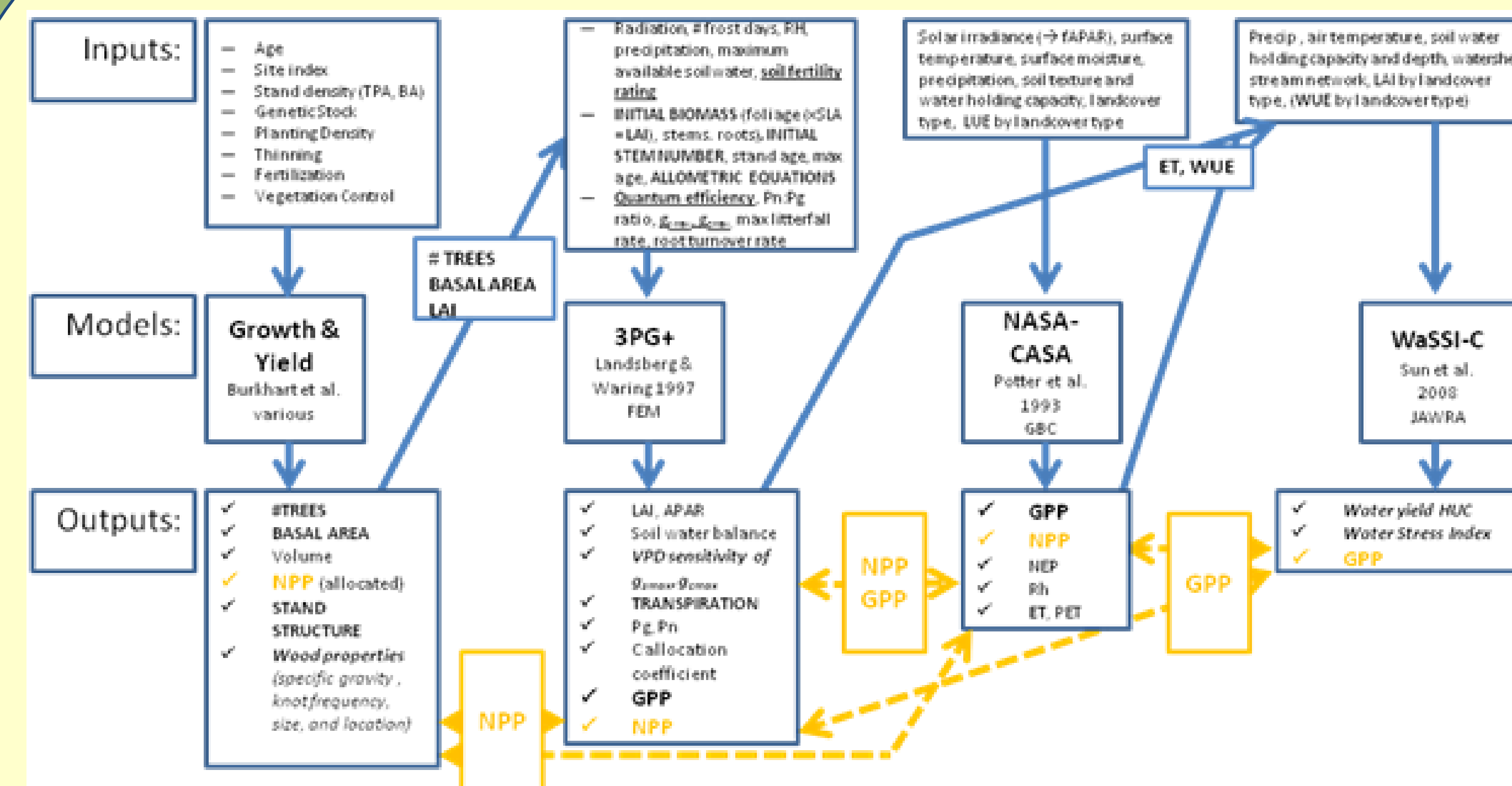
John Nowak – USFS

Asko Noormets – NCSU

J.-C. Domec - NCSU

Year 1 Deliverables and Outcomes

- Assemble geospatial databases
- Establish linkages of data/outputs between models
- Case study of management & climate effects on loblolly pine C and water budgets over a rotation cycle
- Develop & assess management alternatives w/ Tier I data & existing models of C sequestration/



Schematic depiction of the inputs, outputs, and interactions among the four primary models. Solid blue arrows indicate data flow between models, yellow dashed arrows and variable names indicate cross comparison of common model outputs, **BOLD CAPS** input & output parameters indicate variables transferred among models, underlining indicates key sources of stand-level variability, and *italics* indicates terminal outputs unique in scale.

Key Connections to Other Aim Groups

- climate scenarios will be used by the project based on input from Boyles and his colleagues.
- information from both Aims 1 and 3 as well as scrutiny of the extant models with respect to function,
- Grunwald and the Integration Team to ensure project-wide agreement

Aim 3 : Genetics and Breeding

Objectives

- Analyze genetics of breeding and natural populations to discover alleles in genes controlling important adaptation and mitigation traits that enable future tree breeding strategies
- Deliver deployment guidelines for genotypes suited for varied climatic conditions to maximize resiliency and reduce adverse impacts of climate change on productivity.

Overview of Approach

- We will investigate the genetic basis of productivity and adaptive traits in loblolly pine by conducting linkage and association mapping.
- We will measure productivity and adaptive traits in previously-studied experimental populations and expand the amount of genetic variation surveyed in these populations to discover genes and alleles controlling productivity and adaptive traits.
- Next generation sequencing will be used as a means of genotyping to deliver this expanded survey of genetic variation. Cost effective genotyping by sequencing still requires reducing the complexity of the genome component to be genotyped. Three methods for complexity reduction will be compared to determine relative merits and costs
- Our goal is to inform future deployment decisions with projected climate change scenarios taking into account uncertainty and risk introduced by performance instability.
- To accomplish this goal, available growth, survival, genetic and environmental data from our participants' and cooperators' provenance, family, and clone trials will be used to develop and parameterize uniform response functions.

Aim Leaders:

Ross Whetten – NCSU

Tom Byram - TAMU

Fikret Isik – NCSU

Steve McKeand – NCSU

Carol Loopstra – TAMU

Kostya Krutovsky - TAMU

John Davis – UF

Gary Peter – UF

Dana Nelson – USFS

Kurt Johnsen – USFS

Jason Holliday

Final Deliverables and Outcomes

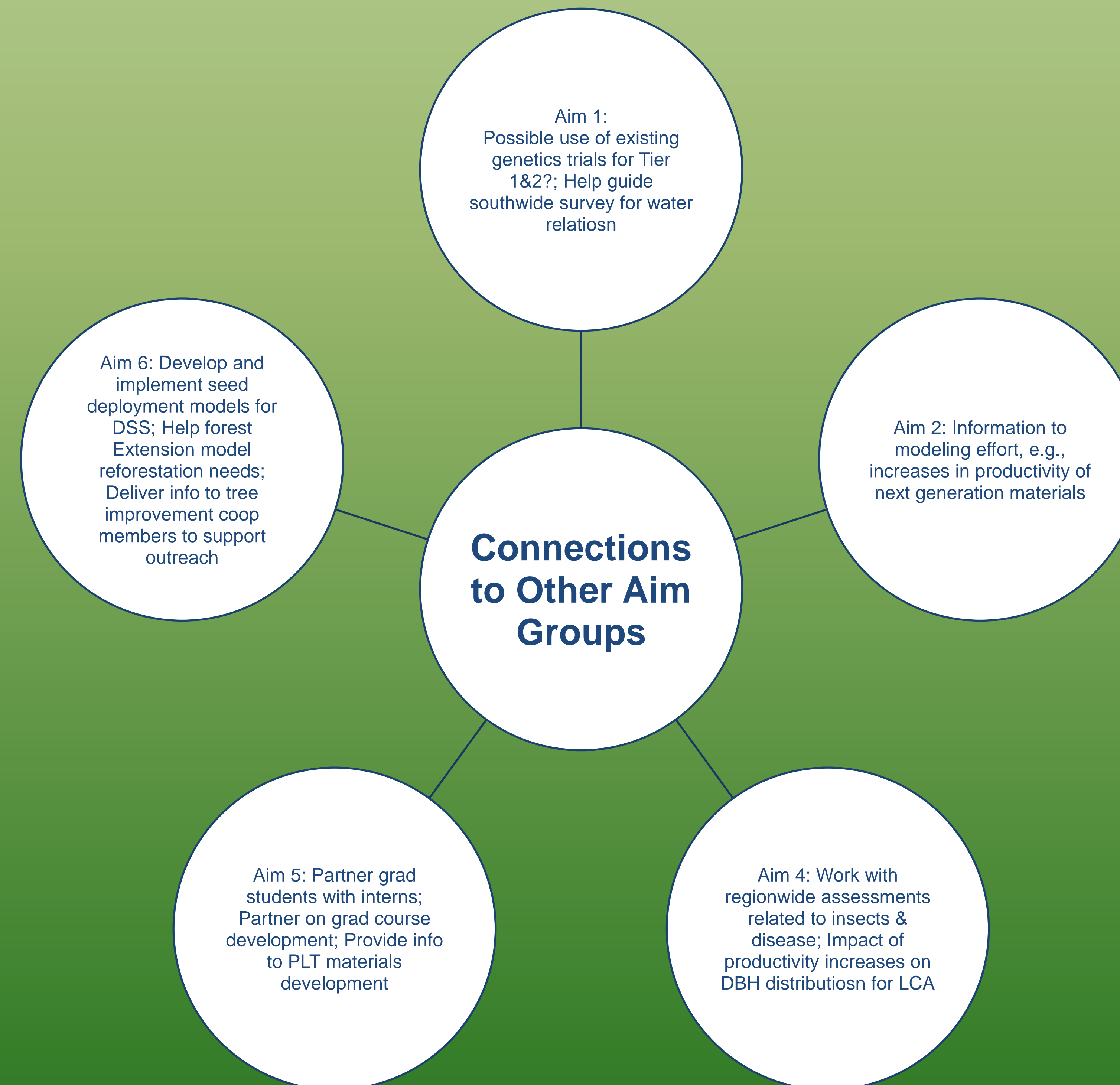
- We expect to identify alleles in genes controlling growth, nitrogen responsiveness, cold hardiness, water usage, resistance to SPB and fungal diseases. Of particular interest are alleles that influence adaptive traits because these will enable screens of fast growing material in breeding programs for adaptability to changing pest, disease and climate conditions.
- We will integrate response functions with geospatially specific climatic predictions in a dynamic model to estimate the relative productivity and adaptation of genetic material to specific climatic conditions analogous to that developed for Douglas fir. This analysis will be conducted by all three breeding cooperatives and climatologists to provide guidance for seed deployment.

Year 1 Deliverables and Outcomes

- Develop uniform response functions and version 1 of genetic deployment tool based on provenance trial and climate data
- Determine appropriate genome reduction methods for genotyping by sequencing

What is Needed from Other Aim Groups

- Aim 6
 - Information on climate science and future climate scenarios for decision support system module development
 - Presentation of state of climate science to cooperative members
- Aim 5
 - Course for graduate students to take on conducting transdisciplinary research
- Aim 4
 - Information on regional changes in insect risks
 - Impact of policy changes on reforestation needs



Aim 4 : Economics and Policy

Objectives

Conduct comprehensive life cycle analyses of regional forest management systems and multi-scale policy and economic analysis of market and non-market forest benefits and services to evaluate regional tradeoffs and interactions among policy, climate scenarios, carbon/water/nutrient/energy footprints, forest management, and genetic deployment, and assess adoption of alternative approaches by private landowners.

Aim Leaders:
 Jianbang Gan - TAMU
 Damian Adams - UF

Robert Abt – NCSU
 Douglas Carter – UF
 Don Grebner - MSU

Gary Peter – UF
 Mike Kane – UGA
 Tom Fox - VPI

Year 1 Deliverables and Outcomes

- Assessment of policies & programs anticipated to impact climate change mitigation efforts in planted pine forests;
- Regional market impacts modeled on business-as-usual assumptions;
- LCA for current management regimes

Overview of Approach

Financial analysis
 Life cycle analysis (LCA)
 Policy review and analysis
 Landowner survey
 Options analysis coupled with dynamic optimization under risk
 Panel data modeling
 SubRegional Timber Supply (SRTS) modeling

Connections to other Aims

Aim 1:
 Field-level data to support LCA and regional modeling

Aims 5 and 6:
 We will provide economic and policy analyses for education and extension purposes

Aim 2:
 Data and modeling results on forest growth and yield and C dynamics ot support LCA and regional modeling

Aim 3:
 Use findings on impact of selected genotypes on productivity and resistance to disturbance to support LCA and regional modeling

End of Project Deliverables and Outcomes

| Year | Deliverables |
|------|--|
| 1 | Assessment of policies & programs anticipated to impact climate change mitigation efforts in planted pine forests; Regional market impacts modeled on business-as-usual assumptions; LCA for current management regimes |
| 2-4 | LCA of alternative management scenarios under varying sub regional, ownership & climate conditions; NPV analysis & forecast of adaptive management impacts; Document landowner adoption of mitigation & adaptation strategies; |
| 3-5 | Estimates of landowner and regional economic losses from disturbance risks; Regional market impact of alternative mitigation & adaptation strategies |

Aim 5: Education

Martha Monroe, University of Florida
 John Seiler, Virginia Tech
 Shobha Sriharan, Virginia State University
 Your Name Could Be Here!

Objectives

Broadly, this aim reinforces integration across the project by sharing findings and increasing literacy on climate change effects on southern conifer forests with secondary school students, secondary teachers, undergraduate students, and non-forestry extension agents. It also includes sharing information among ourselves. We have four specific projects.

Year 1 Deliverables

- Launch of UG Research Internship program, Fall course on Teaching, Web site with information for teachers.
- Needs assessment with secondary educators, review of climate education materials, LCA data on rayon and nylon clothing.
- Development of graduate student course.
- Baseline data collected on our networks.

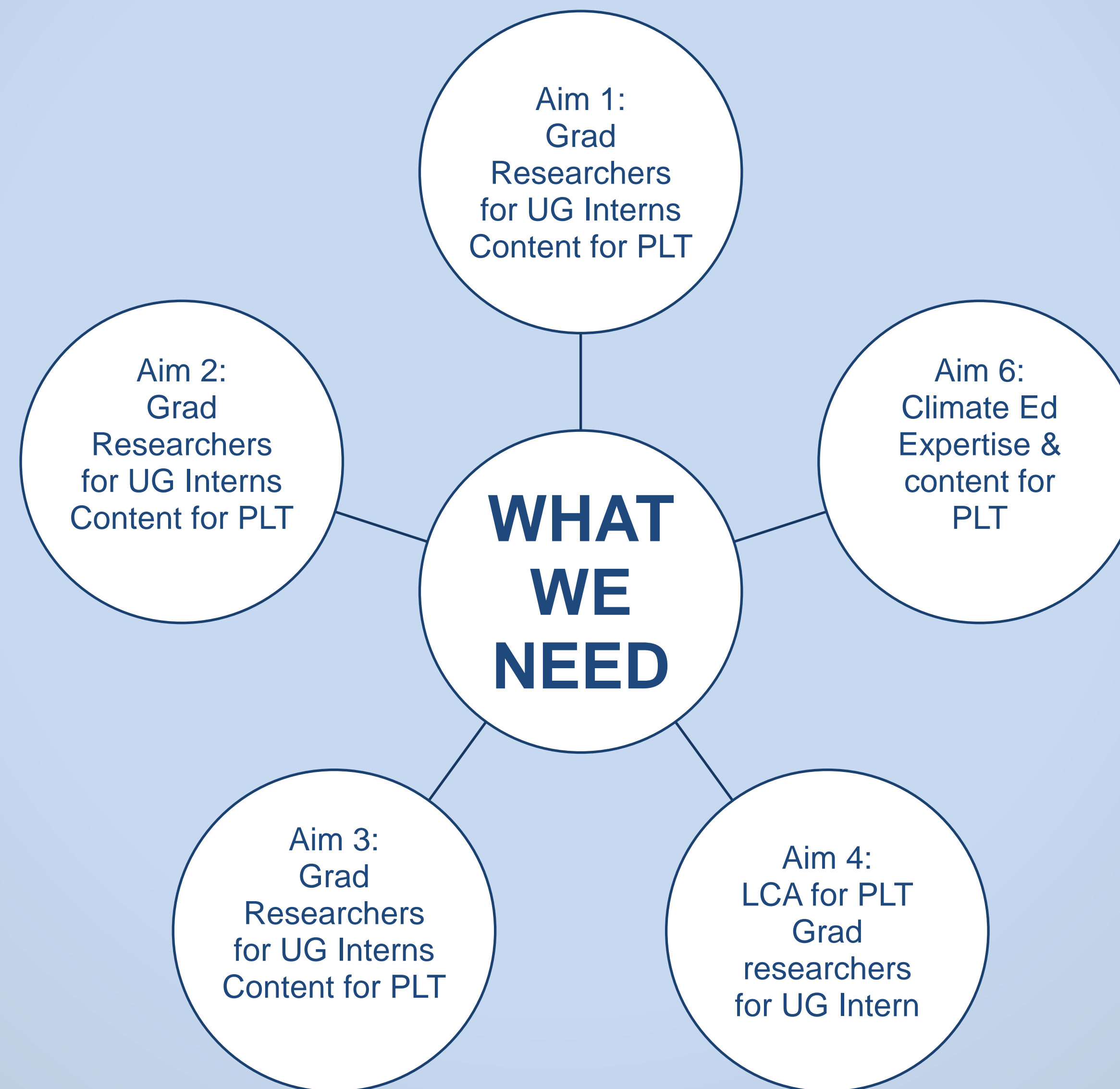
Four Approaches

1. Undergraduate Research Internship Program will pair selected UG students with a CAP graduate student mentor for a summer. UG students will take a fall course in teaching skills and develop interactive presentations and activities for secondary schools. And give them.

2. Secondary Module for Project Learning Tree will be written, tested, and implemented across the South to help teachers explore the role of trees and consumer choices in climate mitigation.

3. Graduate Student Education will be supported with a project-wide course for all graduate students that engages them in exploring interdisciplinary and integrated research.

4. Social science research to document the impact the project is having on changing our approaches to research, our networks, and our work.



End of Project Deliverables

- Distance course for grad students on integrated climate research in forestry.
- Tested and evaluated secondary supplement for teachers.
- Distance course for UG interns on experiential education.

Overview of Approach

Strengthen interaction and involvement with Forest Research, Climatologists, Cooperatives, Climate Groups & Extension colleagues

What are research capabilities and needs

Express practitioner needs and lessons learned from field application

Outreach Message - Need to all be on the same page

Assess Audience: (Cooperatives, Practitioners, Landowners)

Needs, Media, Attitudes, Barriers, Trust, Misconceptions,

Willingness to Pay: Establish a baseline

Develop audience-specific, educational materials to train trainers, practitioners, and landowners

Regional Training and Face-to-Face meetings

Pay special attention to nontraditional groups:

Underserved & socially-disadvantaged audiences

Builders / Developers / Engineers / Planners

Use Technology to assist in Outreach

DSS, Portal, Webinars, eXtension

Evaluate KASA and Behavior Change

End-of-Project Outcomes

Industry Landowners (TIMOs, REITs, Industrial)

Implementation of desirable practices on 10% of land holdings (2 million acres)

NIPLs

recruit 20% more NIPLs into Extension programs than we are currently reaching

80% of the NIPLs actively involved with state and county forest landowners association will be reached

20% will adopt at least one new practice

35% will adopt at least one new practice

Extension Agents, State Forestry, and Others

100% of the public agency natural resource community will be offered the opportunity to participate in education and training events associated with the project

65% of the public agency natural resource county Extension agents, state forestry foresters, and other forestry professionals residing in southern pine timberlands will participate in at least one event

30% will conduct at least one county-level (or multi-county) training event

Practitioners

We will reach 55% of the practicing/private forestry community that are either state registered members of SAF and/or ACF
20% will implement new/altered management of client land impacting 20% of the professionally managed NIPF pine land.

AIM 6: Extension

| | |
|------------------|--------------------------------------|
| Bill Hubbard | Southern Regional Extension Forestry |
| Eric Taylor | Texas Agrilife Extension System |
| Gwendolyn Boyd | Alcorn State University |
| Josh Idassi | North Carolina A&T University |
| Ryan Boyles | North Carolina State University |
| Mark Megalos | North Carolina State University |
| Jose Stape | North Carolina State University |
| Tom Byram | Texas Forest Service |
| John Davis | University of Florida |
| Eric Jokela | University of Florida |
| Jim Jones | University of Florida |
| Martha Monroe | University of Florida |
| Gary Peter | University of Florida |
| Tim Martin | University of Florida |
| Mike Kane | University of Georgia |
| Harold Burkhardt | Virginia Tech |
| Tom Fox | Virginia Tech |



Key Project Outcome:

A significant portion of the total southern pine plantation ownership will adopt new practices and implement changes that propels to the mitigation goals of a 15% increase in C sequestration and a 10% reduction in N and energy use by 2030.

Year 1 Deliverables:

- Consolidated realistic work plan inclusive of climatologist/forestry Extension AIM community
- Synthesized results of needs and attitude assessments
- Literature review on climate variation and forestry attitudes, etc.
- Communication model based on plan and assessment results
- Regional Multi-Aim workgroup meetings
- Online portal for documents, discussion boards, links to tools, etc.

End of Project Deliverables:

- Publications (both in print and electronic) – Fact sheets, circulars, brochures, refereed journal publications, popular press articles (magazine, newspaper), etc.
- Website Portal
- eXtension materials
- Online learning tools (video, Moodle®, archived webinars, YouTube channel with videos, etc.)
- Demonstration sites and associated learning materials
- Changes in KASA and adoption of practice
- Accomplishment of project mission (increase in C sequestration, decrease in N and energy inputs, increase in pine productivity and adaptability)

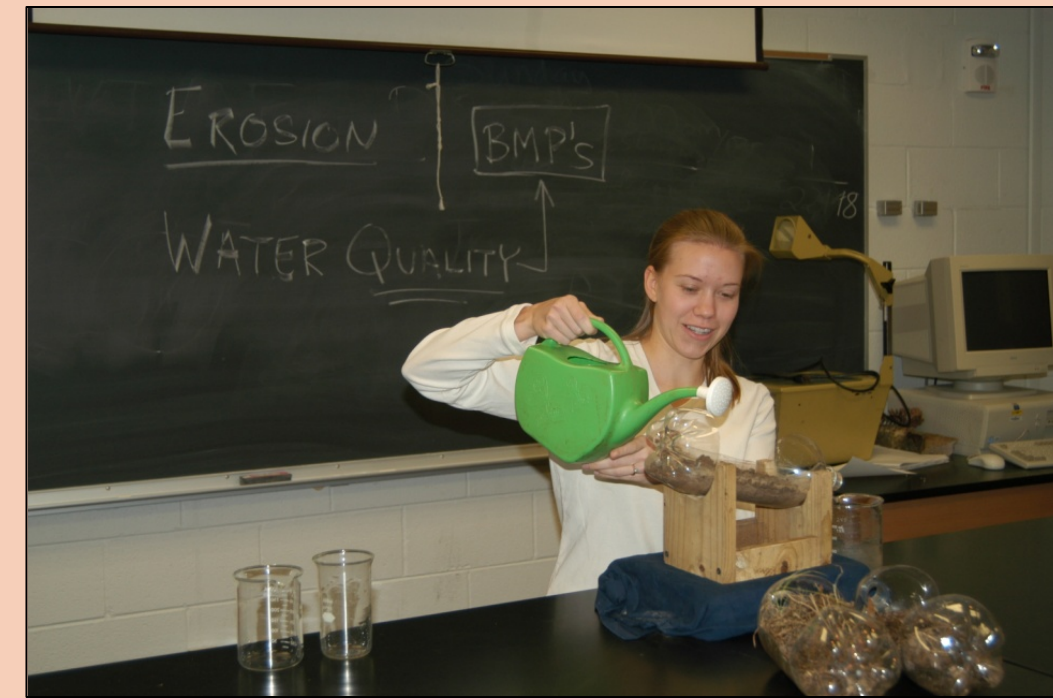
Connections to Other Aims

We Need:

- **Management:** Recommendations for industry/NIPL owners
- **Modeling:** Decision-making tools (futuring, what-if scenarios, etc.)
- **Genetics:** Recommendations for reforestation/afforestation
- **Economics & Policy:** Recommendations for industry/NIPL owners, policymakers, community development, etc. Decision-making tools; Interface with government agencies, etc.
- **Education:** Undergraduate and graduate involvement with Extension & Outreach

What Can Help:

- Build relationships, consideration, and a sense of team
- Always keep in mind the project outcomes and deliverables
- Keep Extension at the table and not an afterthought
- Consolidate realistic work plans for the Extension component of each Aim
- Clarify Extension expectations for major components of work plan
- Inclusion for any outreach, and especially survey mechanisms sent out



Undergraduate Research Intern Program

1. Work with a graduate student on research project
2. Enroll in distance course to build inquiry teaching skills
3. Present in secondary classrooms

Integrating Extension and Education throughout the Project

- **Sharing research findings with users, educators, and learners**
- **Enabling stakeholders to inform research**
- **Training future researchers and current educators**
- **Monitoring change among researchers**

Graduate Course



- Enroll current graduate students across the project to gain an appreciation for interdisciplinary and integrated research skills through webinar.
1. Discuss foundation papers in each am
 2. Work across aims to identify researchable questions
 3. Interact with other CAP students
 4. Build web modules
 5. Present plans
 6. Meet each other next year
 7. LOOKING FOR MORE FOLKS

Decision Support System

- Extend scientific models into decision tools
- Focus for interaction between users and scientists
- Vehicle to link research, extension, education efforts
- Every research group and aim team will have input & models to contribute
 - All research should influence a DSS tool
 - Some research will directly lead to new tools in the DSS
- **Final Product:** Web-based tool box that provides guidance based on CAP research
 - Interactive models, maps, education materials



Social Networks and Capacity

Still in the thinking stages
Hope to obtain outside funding



1. How does this project enable us to work differently?
2. How does this project affect our stakeholders?
3. What occurs here that would not have happened in a typical project?



Secondary Module for Project Learning Tree

1. Designing and testing engaging activities to teach learners about climate, carbon, consumer life cycle choices, the role of southern pines in climate change
2. Pilot test with teachers in South
3. Develop online and in-person training workshops
4. Make materials available across region through workshops with state PLT coordinators



AFRI 2010 - Climate Change RFA

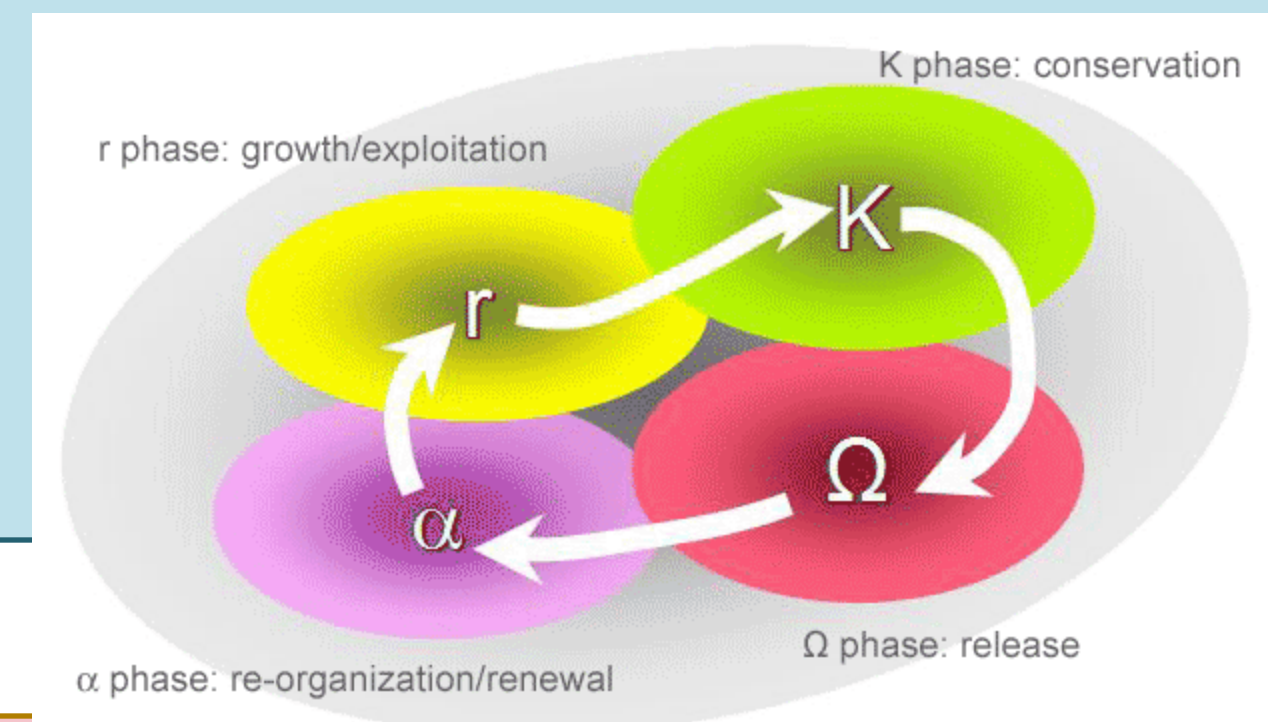
“Adaptation – Maximize resiliency and reduce the impact of climate change on the productivity of agriculture and forest systems and reduce carbon, nitrogen, and water footprints under changing climates by providing producers and decision makers with new management methods and technologies and new plant cultivars and animal breeds adapted to changing climates through classical/conventional breeding and other appropriate approaches to adapt to changing climates.”

ADAPTATION GOALS

- Increase understanding of resilience thinking among team and stakeholders
- Improve understanding of the potential impact of increased climate variability on southern pine productivity and its potential impact on the SE-US
- Transfer management approaches that maximize resiliency while improving pine ecosystem productivity
- Transfer knowledge of the adaptability of southern pine species

Resilience Thinking:

- Takes a complex systems perspective towards understanding responses to natural and human-induced change
- Identifies thresholds beyond which feedback mechanisms fail
- Studies systems dynamics & adaptive cycles
 - Slow growth & accumulation
 - Rapid reorganization & renewal
- Applies knowledge to improve the resilience of the social-ecological system



| CONCEPT | CHARACTERISTICS | PROPERTY |
|---|--|----------------------------------|
| Ecological Resilience – “The capacity of ecosystems to absorb disturbance without collapsing into a qualitatively different state controlled by a different set of ecological processes”. (www.resalliance.org) | 1. Amount of change that can occur while retaining the same controls on function & structure 2. Capacity for self-organization 3. Ability to build capacity for adaptation | Ecosystem |
| Biological Adaptation – The capacity of individuals, populations and species to adapt to changing environments | Ability of an organism to respond to environmental change | Individual, Population & Species |
| Social Resilience - “The capacity of humans to anticipate and plan for the future”. (www.resalliance.org) | Ability to build the capacity for learning & adaptation | Humans |

Managing for Social-ecological Resilience

- Importance of interaction of ecological processes across scales – micro, stand, watershed, landscape
- Complexity at various scales is desirable to maintain ecosystem resiliency
- Active adaptive forest management need to allow for diversity, learning & experimentation
- Is as much a social as a scientific process – need to develop new institutions & flexible strategies as much as new scientific frameworks

AFRI 2010 - Climate Change RFA

“Mitigation – Reduce atmospheric greenhouse gas emissions in forestry production systems and maximize carbon sequestration potential in forest working lands by providing producers and decision makers with new management methods and technologies and new plant cultivars and animal breeds through classical breeding, relevant biotechnologies, and other appropriate approaches, with the potential to mitigate climate impacts and advance emerging economic opportunities through a market system.”


MITIGATION GOALS

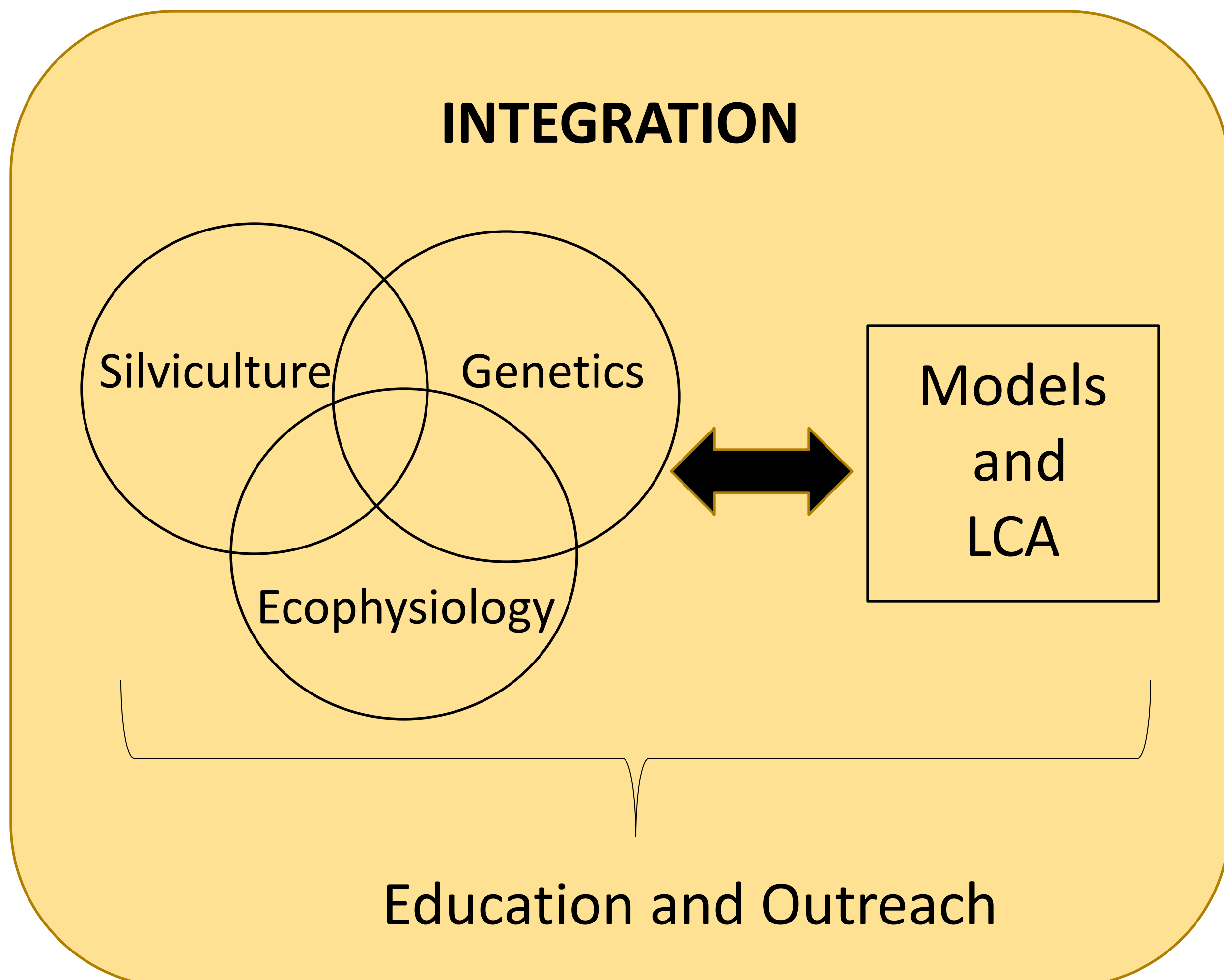
Develop state-of-the-art forest best management practices utilizing elite genotypes and site-specific silvicultural practices to:

1. Improve water and nitrogen use efficiency and increase carbon sequestration in southern pine plantations;
2. Increase the resilience of southern pine plantations to changing climate

Project Goal:

The long-term outcome for this program is to reduce the use of energy, nitrogen fertilizer, and water by ten percent (based on 2010 usage) and increase carbon sequestration by fifteen percent through resilient forest production systems under changing climates by 2030.

ENERGY - CARBON – WATER - NITROGEN



DECISION SUPPORT TOOLS

Develop decision support tools needed by land managers and policy makers at all levels to implement improved management practices

**Empirical to Process Models
 Life Cycle Analysis
 Economic Analysis**

Focus on Adaptive Forest Management to Allow for Diversity, Learning & Experimentation