USDA - Forest Service

SOUTHERN RESEARCH STATION SCIENCE AREA CHARTER	1. Title **Forest Ecosystem Restoration and Management**

2. Primary Research Work Units (RWU Number, Title, Locations)

SRS-4157: Upland Hardwood Ecology and Management (Asheville, NC; Clemson, SC; Normal, AL; Knoxville, TN; Hot Springs, AR)
SRS-4158: Restoring and Managing Longleaf Pine Ecosystems (Auburn, AL; Clemson, SC; Pineville, LA)
SRS-4159: Southern Pine Ecology and Management (Monticello, AR; Hot Springs, AR; Pineville, LA; Nacogdoches, TX)
SRS-4160: Forest Genetics and Ecosystems Biology (Saucier, MS; Research Triangle Park, NC; College Station, TX; Gainesville, FL)

3. Science Area Leader

Nancy G. Herbert, Assistant Station Director for Research, Asheville, NC

4. Area of Research Applicability	5. Estimated Duration
Regional, national, and international	5 years

6. Mission

To provide forest landowners and managers with the improved knowledge and technology needed to restore, enhance, and manage southern forest ecosystems for a variety of benefits.

Signature	Title	Date
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7. Description

Public and private forest lands are critical to the environmental, social, and economic well-being of the South and the nation. However, southern forests are rapidly changing as human populations increase and land ownership trends shift, and are increasingly affected by human influences such as fragmentation, urbanization, and global climate change.

While public lands account for only one-sixth of the forest land base in the southern region, they represent a higher proportion of the unfragmented forest landscapes, providing unique habitats and recreational opportunities and protecting landscape-scale vistas from development. Private lands dominate the Southern forest ownership, providing a large share of forest products, values and benefits. Changes in ownership, parcelization, potential conversion to non-forest use, degradation through unmanaged exploitation, and emergent value streams such as bioenergy are factors in determining whether this forest land remains working forest.

Forest landowners and user expectations are changing as well, raising new needs and questions about how to manage southern forests for a wide array of benefits and uncertain futures. A wide range of goals—from the restoration of natural habitats to intensive forest management—are desired by private forest landowners and public forest users. Some are interested only in the amenity values of their land or in restoring their forests to a certain vegetation type and condition; many others continue to want revenue from their forests. In addition to the traditional revenue sources of timber and pulp, forest landowners are seeking alternative income sources such as carbon sequestration, wildlife habitat, agroforestry, and biofuels products and credits. Still other forest landowners do not manage their land at all, and if interested, do not know where to turn for advice. These changes in our constituencies are raising new questions about how to manage southern forests for a wide array of benefits in an ever changing world. In a broad sense, the desired resource outcome is that Southern forest ecosystems are healthy, productive, and can provide a sustainable supply of services, products, and values that enhance the quality of life for present and future generations.

The **Forest Ecosystem Restoration and Management** (FERM) science area develops science and technology to enhance the management of southern forests for multiple values and benefits for landowners and society. FERM includes 33 scientists and five emeritus scientists whose primary research disciplines include forest management, silviculture, ecology, wildlife biology, genetics, ecophysiology, and soil science. In the coming years, these scientists will work with partners and cooperators to provide new and improved tools and technologies, using the latest science delivery mechanisms, to restore, enhance, and manage southern forest ecosystems in a changing environment.

8. Goals

The goal of the FERM science area is to provide the tools and technologies to:

- Sustain and enhance healthy, productive forests that provide forest products, wildlife, biodiversity, and recreation benefits to the American people.
- Restore and manage southern forest ecosystems in a changing physical and social environment, with special emphasis on urbanization, global climate change, and biofuels production.

- Manage forests to mitigate and adapt to environmental changes from global climate change through practices that sequester carbon and reduce net greenhouse gas emissions.
- Use enhanced understanding of genetics, physiology, ecology, silviculture, and their interactions to more effectively manage and restore southern forest ecosystems.
- Provide forest landowners and managers the scientific information they need in a form that is useful for making sound land management decisions.

9. Focus Areas

The FERM science area will initially focus on five areas:

1. Predicting forest ecosystem response to natural disturbances
2. Managing southern forest ecosystems
3. Maintaining the biodiversity of southern forest ecosystems
4. Restoring ecosystem structure, function, and productivity
5. Developing sustainable forest bioenergy systems

How we will address these focus areas through partnerships:

These areas of research are broad, requiring an interdisciplinary approach to provide knowledge and technology for landowners and managers. The Southern Research Station (SRS) has significant talent and resources to address these issues, but we cannot do it alone. Over the years, we have developed a network of partners who add value to our research and demonstration capabilities, enabling us to address the most pressing natural resource questions of the day. SRS scientists routinely work across boundaries with other Forest Service scientists and with researchers from other agencies, universities, private companies, non-governmental organizations, and other countries.

Scientists in the four RWUs in the FERM science area will work closely with one another, including scientist-to-scientist collaboration, joint support of cooperative agreements, and participation in informal and formal discussions about research planning and execution. We will also rely upon the expertise of scientists in the four other SRS science areas:

-Forest Watershed Science
-Threats to Forest Health
-Forest Values, Uses, and Policies
-Natural Resources Inventory and Monitoring

In addition to our own SRS colleagues, we will reach out to scientists in other Forest Service Research Stations and to key National Program Leaders in the Forest Service Washington Office to enrich and expand the applicability of our research efforts.

The benefits from working closely with the users of our research cannot be overstated. We maintain a special partnership in the Southern Region with both the National Forest System (NFS) and State and Private Forestry. Working with our partners keeps our research focused on practical questions and alerts us to emerging issues in public and private forest land management in the South. Our research scientists have particularly close relationships with their local national

forests, where they share expertise and ideas in the land and resource management planning process, the implementation of forest plans, and the management of experimental forests.

Our research would also be difficult to accomplish without our partners in the State forestry, wildlife, and natural heritage agencies. We work closely with the Southern Group of State Foresters and the Southeastern Association of Fish and Wildlife Agencies to address issues common across public and private lands in the South, and with our local State agencies on issues of local importance.

Our research is conducted in partnership with other federal scientists, and with key academic researchers, especially those at the land-grant universities and the historically black colleges and universities in the South. Many of our university colleagues serve as principal investigators in our research and demonstration studies, and our work is the richer and more rigorous for their involvement. Finally, we have many partners in the private sector who support, use, and participate in our research and demonstration programs, including forest industry, landowner groups, and conservation organizations.

9.1 Focus Area: Predicting forest ecosystem response to natural disturbances

Southern forests are subject to a variety of natural disturbances at different spatial scales (e.g., hurricanes, major insect/disease outbreaks, localized wind and ice storms, and wildfires). Some of our research will focus on predicting the response of forested ecosystems to natural disturbance and developing methods to influence the outcome of such events. Understanding the ecological responses of forests to these disturbances will allow us to better restore and manage southern forests.

a. Top Priority Research and Development Needs:
   - Characterize the parameters of disturbance in terms of probabilities of occurrence, intensities of disruption, and extent of damage
   - Quantify the response of forest ecosystems to disturbance at different spatial scales
   - Quantify the interactions among a variety of disturbances
   - Define the properties of forest stand and landscape conditions that make forest ecosystems resilient in the face of disturbance
   - Document and quantify the response of southern pine ecosystems to hurricanes under a variety of environmental conditions
   - Predict response of upland hardwood ecosystems to natural disturbances across environmental gradients
   - Predict the effects of exogenous and endogenous disturbance on southern pine-dominated ecosystems, with special emphasis on wildlife populations and habitats
   - Develop models for predicting the spread and impact of southern pine beetle infestations under different silvicultural regimes and practices
   - Provide decision support systems and simulation models to landowners and managers dealing with natural disturbances

b. Key Barriers to Conducting Research and Implementing Results:
   - Ecological responses to disturbance are complex, yet we need to provide clear decision support options for forest landowners and managers.

- Future environmental conditions are uncertain, so forests must be resilient and management options must be flexible.
- Resistance mechanisms within southern forest ecosystem to insect and disease outbreaks are incompletely understood and evolving. Genetic variation of both the pest and the host vary across their geographic range.

c. Role of each RWU:

SRS-4157:

- Conduct integrated experiments to understand and quantify how disturbances affect vegetation and wildlife across environmental gradients in upland hardwood-dominated landscapes, so that silvicultural applications can be developed to manage vegetation and wildlife

SRS-4158:

- Predict the response of longleaf pine ecosystems to a suite of natural disturbances so that management strategies and tactics based on fundamental ecological relationships can be developed and applied

SRS-4159:

- Provide knowledge on the response of loblolly and shortleaf pine forests and their wildlife to natural disturbances such as fire, hurricanes, ice storms, and insect outbreaks, so that silvicultural practices and forest management decisions can be grounded in fundamental ecological relationships

SRS-4160:

- Provide information on the genetic variation of traits involved in resistance to southern pine beetle (SPB) for use by forest landowners and managers in modeling responses of pine stands to SPB infestation
- Provide knowledge on the relative impacts of severe hurricanes on longleaf, loblolly and slash pine and their ability to recover, so that forest landowners and managers in coastal areas can better manage their working forests.

9.2 Focus Area: Managing southern forest ecosystems

Southern forests are increasingly affected by human influences such as fragmentation and urbanization. Research is needed to sustain and enhance the production of commodities and ecological services from a natural resources land base that is decreasing in area, increasingly dominated by human activities, and whose structure and function are being stressed by invasive species and global climate change. New and refined silvicultural strategies, systems, and practices for managing stands and landscapes are needed by landowners and resource managers to continue to deliver the needed goods, services, and values from southern forest ecosystems across all ownership classes.

a. Top Priority Research and Development Needs:

- Provide management strategies, systems, and practices so that owners and managers can continue to deliver needed/desired goods, services, and values
- Provide managers with tools to predict changes in forest structure, composition, and habitat quality under different management practices
- Quantify the biological processes that affect the production of seed and the establishment, growth, and development of plants and plant communities in longleaf pine ecosystems

- Predict the effects of a variety of traditional and innovative silvicultural treatments on stand development and ecosystem response of southern pine-dominated forests
- Conduct key genetic and structural genomics research that will enable advances in forest management and forest tree improvement
- Assess genetic variation in traits of pines that have a significant influence on resistance/tolerance to southern pine beetle
- Develop genetic markers for fusiform rust resistance genes in the host and avirulence genes in the pathogen

b. Key Barriers to Conducting Research and Implementing Results:
- Rapidly changing patterns of forest land ownership in the South make it difficult to understand the landscape-scale effects of management on forest ecosystem sustainability.
- Fragmentation of ownership limits our ability to reach non-industrial private forest landowners with latest research results.
- Globalization of trade brings more invasive species to our country and its forest ecosystems, making it necessary to continually refine forest management recommendations to accommodate changing conditions.
- The spatial scale of research on habitat for some animals greatly inflates the cost of conducting research.
- Forest trees and their pathogens/pests are typically difficult to work with in genetics and genomics research.

c. Role of each RWU:

SRS-4157:
- Conduct integrated experiments to understand the effects of silvicultural treatments across environmental gradients in upland hardwood-dominated landscapes, so that landowners and managers can apply silvicultural systems with greater attention to variation in site and stand conditions on public and private upland hardwood stands across the South
- Develop models to predict outcomes of silvicultural practices that managers can apply when they make management prescriptions in upland hardwood forest ecosystems of the South

SRS-4158:
- Use expertise in seed and seedling physiology to assist in development of nursery protocols to meet the growing demand for high quality seedlings for longleaf pine ecosystem restoration, and thereby address existing issues of container quality and size, nutrition, and the toppling of container seedlings after outplanting in the field
- Develop predictive models that incorporate knowledge on effects of silvicultural treatments in longleaf pine ecosystems and fundamental knowledge of longleaf pine physiology; with better predictive models, forest managers will be able to make decisions that are more informed in their efforts to successfully restore longleaf pine ecosystems
- Explore the option of using prescribed burning and other silvicultural treatments to minimize wildfire risk in the wildland-urban interface

SRS-4159:

- Provide expertise and long-term data from experimental forests on how silvicultural management affects southern pine-dominated forests and their wildlife habitats, so that better management decisions can be developed and implement to meet a wider array of management objectives on public and private forests across the South
- Develop metrics, standards, and guides for silvicultural systems in southern pine-dominated forest types that maintain and quantify forest health, diversity, productivity, and sustainability, so that landowners and the foresters who advise them have a broader set of scientifically-based silvicultural practices and systems available for application in southern pine stands to meet objectives of ownership across the region

SRS-4160:

- Work with partners to conduct research on the genetic variation in traits that are associated with resistance to southern pine beetle (SPB), so that SPB resistance can be incorporated into tree improvement programs in the South
- Work with partners to conduct fusiform rust research across the entire natural range of both loblolly and slash pine, both to develop trees with greater resistance to fusiform rust, and to develop silvicultural practices to control this disease in southern pines
- Work with partners to develop comprehensive functional genome knowledge on the southern pines especially as it relates to improving the practice of tree improvement and gene conservation, so that forest management and restoration in southern pines can be informed and enhanced by a fundamental understanding of genetics and genetic diversity
- Develop knowledge and tools to manage forests in light of global climate change by modifying management to suit new environmental conditions and by explicitly managing forest ecosystems to sequester carbon

9.3 Focus Area: Maintaining the biodiversity of southern forest ecosystems

Our southern forests contain a diversity of native plants and animals, many unique to the region. Our research will inform efforts to maintain and restore this biodiversity and to protect the uniqueness of these forests, especially if predictions of changes in weather and climate come to pass. Technology is needed to quantify and predict the impacts of management on the biodiversity of southern forest ecosystems, to maintain and restore native species, and to control unwanted elements of diversity such as invasive plants and animals.

a. <u>Top Priority Research and Development Needs</u>:

- Understand wildlife response to disturbance-induced changes in vegetation composition, habitat structure, and food resources
- Provide managers improved techniques for inventory and monitoring of wildlife and rare plant species.
- Prioritize TES species for study and fill in knowledge gaps that are needed for developing management/protection measures
- Better understand the relationship between southern pine beetle management and red-cockaded woodpecker management at the stand and landscape scale
- Develop rapid genetic assessment tools and conduct population genetic studies, with a focus on key endangered or threatened species in the South

b. Key Barriers to Conducting Research and Implementing Results:

- There are insufficient resources to study the many endangered, threatened or sensitive species that warrant attention. Research funding tends to be focused on a few very charismatic species while others are disappearing from forest ecosystems in the region nor sub-region.
- Some populations are too small to study.
- Forest fragmentation limits the effectiveness of management efforts on smaller land ownerships.
- Optimal conservation and restoration prescriptions need timely genetic diversity information and interpretation
- Genetic diversity assessment tools are expensive to develop limiting the number of species that can be effectively monitored.

c. Role of each RWU:

SRS-4157:

- Conduct integrated experiments to understand how vegetation and wildlife of upland hardwood-dominated forests respond to a changing forest environment, including effects of forest fragmentation and hemlock woolly adelgid, so that land managers can make scientifically-based management decisions in upland hardwoods that account for these changes
- Provide tools for wildlife managers to predict hard and soft mast availability given annual and climatic variation
- Conduct studies on herbaceous plant response to forest management practices and silvicultural practices, so that landowners and managers can better understand the effects of forest management decisions on the herbaceous community at various spatial scales
- Develop silvicultural practices to maintain or restore forest communities that are at risk, so that foresters can prescibe these treatments in the context of risk reduction and improvements in forest health

SRS-4158:

- Provide expertise in botany and especially the rare plants found in the understory of intact longleaf pine ecosystems, so that forest managers can make better decisions about desired vegetation composition as they functionally restore disturbed ecosystems
- Develop a long-term database on amphibian and reptile populations in a longleaf pine ecosystem, and how they respond to changing conditions due to disturbance processes such as hydrological fluctuations, fire, or fire suppression; such databases are important components in integrated ecosystem level models that will allow forestland managers to better predict the outcomes of their actions

SRS-4159:

- Conduct integrated experiments to understand how vegetation and wildlife of southern pine forests respond to a changing forest environment, including effects of global climate change, such that landowners can prescribe silvicultural systems and make forest management decisions that ackowledge and account for these changes
- Provide expertise in monitoring a wide range of wildlife species, so our partners can make better management decisions that reflect appropriate levels of accuracy and variation for the species of interest

- Quantify forest stand structural attributes in the context of forest health, diversity, productivity, and sustainability at the stand and landscape scale, so that landowners can make better silvicultural prescriptions within the stands they manage, and can make forest management decisions for their own ownership that reflect the reality of conditions within and beyond their ownership boundaries.

SRS-4160:

- Develop genetic monitoring tools and conduct research on genetic population structures and gene flow of key species, so that resource managers can use scientifically sound information about genetics of species and populations to make management decisions
- Develop strategies for using genetic diversity data in species recovery and restoration efforts, so that genetically-robust silvicutlural practices can be developed for application in forest restoration and recovery

9.4 Focus Area: Restoring ecosystem structure, function, and productivity

Southern forests contain important species and forest types that are underrepresented or degraded in a landscape context. Research is needed to better understand the concepts of restoration and the practical tools for accomplishing it. Decision support systems and models can help managers prioritize areas for restoration. Our research will provide specific management techniques designed to promote recovery from disturbances, to restore natural disturbance regimes and the biodiversity they maintain, and to guide the reintroduction of species to their former range.

a. Top Priority Research and Development Needs:

- Evaluate how the structure, function, and productivity of southern forest ecosystems are changing, especially those ecosystems underrepresented across the landscape
- Develop tools for restoration of structure, function, and productivity of ecologically or economically critical ecosystems
- Underrepresented ecosystems that are in high priority need of understanding and restoration techniques include:
  - Longleaf pine ecosystems
  - American chestnut in upland hardwood forests
  - Various minor pine components in hardwood-dominated stands and landscapes
  - Pine and hardwood woodlands and grasslands

b. Key Barriers to Conducting Research and Implementing Results:

- With many Americans building their homes in the wildland-urban interface, there are increasing liability issues related to use of prescribed fire to meet restoration goals in these areas.
- The combination of developing restoration strategies in a fragmented landscape increases the complexities of both the research and the implementation of research results.
- With an increasing number of restoration issues and flat or declining budgets, there are limited resources to address a multitude of needs, including lack of funding for cooperative work with partners.
- Fragmentation of ownership and variation in landowner goals limit our ability to see implementation of our research results on a landscape scale.

c. Role of each RWU:

SRS-4157:

- Provide silvicultural expertise to design and test protocols for outplanting resistant American chestnut seedlings, so land managers can optimize establishment and development of outplanted seedlings
- Contribute silvicultural expertise to collaborative efforts to restore hemlock function in riparian systems, so that land managers can minimize the adverse effects on riparian systems as hemlocks diminish on the landscape
- Conduct an integrated research program in restoration and maintenance of systems where oaks are dominant or prominent, so that land managers can support their vigorous restoration efforts with sound scientific information

SRS-4158:

- Conduct integrated research program on how to restore longleaf pine ecosystems on a variety of sites with a range of past land use histories, so that our partners interested in longleaf pine restoration have better information upon which to base management decisions
- Conduct research in conjunction with partners on the role of fire in restoring the longleaf pine ecosystem, so that prescibed burning can be applied by our partners more effectively in ongoing restoration efforts
- Use long-term data sets to develop a growth and yield model for naturally regenerated longleaf pine, which will be an important management tool for our partners wanting to restore and manage for natural forest structure and associated native plant communities
- Provide important linkages to partners, especially the Longleaf Alliance, the land management staffs at military bases and The Nature Conservancy, and researchers at the Joseph Jones Ecological Center and Tall Timbers Research Station, so that research results can be more quickly applied in the field

SRS-4159:

- Conduct an integrated research program on how to restore shortleaf pine-bluestem ecosystems, so that land managers can support their vigorous restoration efforts with sound scientific information
- Conduct an integrated research program in Coastal Plain pine-grassland restoration emphasizing loblolly-shortleaf pine, so that land managers can implement restoration prescriptions within this important southern forest type
- Explore opportunities for expanding shortleaf pine restoration efforts in the southeastern States, to give land managers better silvicultural tools to promote shortleaf pine especially in landscapes where it is currently underrepresented
- Develop the ecological rationale and silvicultural practices to restore a minor and varying pine component in hardwood-dominated stands, so that managers can bring pines back to landscapes where they once occurred but are now lost

SRS-4160:

- Identify genetic markers in American chestnut for resistance to chestnut blight, to give scientists a better tool for resistance screening in breeding trials of chestnut and related species. Conduct cytogenetic research to aid in the chestnut backcross breeding program, which can provide scientists with better ways to develop resistant families

- Identify genetic sources of longleaf pine with attributes that contribute to successful ecosystem restoration efforts, so that scientists and resource managers can build the southwide restoration of longleaf pine upon a broader genetic base
- Quantify the potential of longleaf pine to withstand disturbance and to sequester carbon--attributes that could increase the rate of restoration across the landscape
- Develop genetic markers for eastern, Carolina and Chinese hemlocks that scientists can use to aid the restoration and preservation of these species in the face of hemlock woolly adelgid (HWA). Work with partners to assess genetic variation with the hemlocks and develop strategies for developing resistance/tolerance to HWA

9.5 Focus Area: Developing sustainable forest bioenergy systems

As the woodbasket of the nation, the South's forests provide wood and fiber resources for the United States and the world. These forests are sources of renewable feedstocks for energy, biofuels, and biobased products such as industrial chemicals in the form of under-utilized material and tree crops grown specifically for energy. Landowners who view bioenergy feedstock production as an opportunity need management guidance. Our research will provide integrated management systems and options for sustainably producing forest bioenergy feedstocks and will quantify the impacts of bioenergy production on ecosystem processes and biodiversity.

a. Top Priority Research and Development Needs:
   - Quantify resource availability and sustainability for forest biomass production
   - Develop the technology to increase biomass production as feasible and to use biomass management in forest restoration
   - Expand genetic and physiologic understanding of the key traits of the primary biomass crops and their effects on production of bioenergy
   - Explore tree improvement approaches for sustainably producing genetically improved materials for biomass crops
   - Investigate long-term ecological impacts of bioenergy production on southern forests
   - Quantify biomass availability and the potential use of woody materials that are byproducts of traditional silvicultural practices

b. Key Barriers to Conducting Research and Implementing Results:
   - Much of the information on key traits and ideotypes that hold the greatest promise for bioenergy and biomass production are the proprietary interests of private companies.
   - The current lack of understanding of how bioenergy production will be developed and applied to the landscape leaves research on the ecological impacts of bioenergy without a clear target for study.

c. Role of each RWU:

   SRS-4157:
   - Develop models that predict amounts of biomass available for use as biofuel in naturally managed upland hardwood systems, so that landowners and resource managers can evaluate the potential contributions of biomass utilization in their management plans

SRS-4158:

- Evaluate longleaf pine and other plant species common in these ecosystems as a potential feedstocks for bioenergy production, and thereby assist in the development of alternative sources of energy for the nation
- Quantify energy feedstock production potential from longleaf pine restoration and management using predictive models based on long-term databases for plant communities in longleaf pine ecosystems, and providing those models to our partners

SRS-4159:

- Develop integrated, sustainable silvicultural systems for production of forest biomass in Coastal Plain loblolly and slash pine forest ecosystems, so that landowners and managers can evaluate the potential contributions of biomass production in their forest management planning
- Quantify the ecological importance of leaving residual materials in the woods versus the values gained by removing them for biomass production, so that silvicultural prescriptions for biomass production can be grounded in ecological sustainability
- Conduct carbon cycling studies on impacts of biofuel harvesting operations on long-term site productivity in the West Gulf region, so that land managers can make better decisions about the tradeoffs of biomass versus forest soil sustainability
- Provide guidance on the feasibility of biomass harvesting in forest stands and an assessment of the potential benefits such a harvest might have in stand improvement for management or restoration, which will allow land managers to better integrate biomass production with other elements of wood and fiber utilization in devising silvicultural systems that meet ownership objectives

SRS-4160:

- Conduct combined genetic/physiologic/genomic/silviculture studies for pine, sycamore, sweetgum. and poplar as potential biomass crops, so that better decisions can be made by landowners about the best species and varieties to use in biomass production
- Conduct carbon cycling studies on impacts of biofuel harvesting operations on long-term site productivity in the southeastern Coastal Plain and Piedmont, so that land managers can make better decisions about sustaining forest productivity

10. Environmental Analysis Considerations

Proposed research activities in this science area will likely be limited in context and intensity and are not expected to have a significant effect on the quality of the human environment. However, the environmental effects of specific actions will be considered during the development of study plans, at which time the existence of extraordinary circumstances related to the proposed action, and categorical exclusion will be documented as a part of the study plan as described in FSH 1909.15, Chapter 30. Where environmental concerns exist regarding particular studies, these may be evaluated within individual study plans, or by Environmental Assessments or Environmental Impact Statements prepared with and reviewed by the cooperating national forest staffs (or other federal partner, where appropriate). For research having the potential to affect a plant or animal species that is federally listed as endangered or threatened or proposed for such listing, the unit will consult with the U.S. Fish and Wildlife Service as per Section 7 of the Endangered Species Act of 1973, as amended.

11. Science Capacity

Staffing--
FERM includes 33 scientists and five emeritus scientists whose primary research disciplines include silviculture, genetics, ecology, ecophysiology, soil science, botany, and wildlife biology. The FERM science area research receives additional support from professional natural resource specialists, statisticians and data analysts, technicians, and administrative and clerical staff.

Infrastructure--
- Six federally-owned research facilities (Auburn, AL; Bent Creek, NC; Nacogdoches, TX; Pineville, LA; Research Triangle Park, NC; Saucier, MS)
- Six other research locations on university campuses (Clemson, SC; College Station, TX; Gainesville, FL; Huntsville, AL; Knoxville, TN; Monticello, AR)
- One research facility in space leased from another federal agency (Hot Springs, AR)
- Research facilities equipped with experimental laboratories and greenhouses for experiments on plants and animals in controlled environments
- Ten experimental forests in seven States

Unique Capability/Instrumentation--
- Experimental forests that provide unique opportunities for both short- and long-term research, with between 60 and 80 years of long-term research at each sites.
- Demonstrations of forest and wildlife management practices at experimental forests that provide unique opportunities for science delivery to forest landowners, public and private natural resource managers, university faculty and students, NGOs, Congressional staff, and Forest Service leaders.
- State-of-the-art technology transfer and science delivery capabilities at the Bent Creek Experimental Forest in Asheville NC, and the Crossett Experimental Forest in Ashley County, AR
- Unique facilities for research on DNA-based genetic marker development and high-throughput genotyping, structural and functional genomics, and molecualr cytogenetics.
- Growth and yield datasets that extend for 70 years
- Longleaf pine cone crop estimates for 50 years
- Genetic trials and data that extend for 50 years

Appendix A: Relationship of Science Area Focus Areas to Forest Service Strategic Plan and National Strategic Program Areas

1. Predicting forest ecosystem response to natural disturbances
2. Managing southern forest ecosystems
3. Maintaining the biodiversity of southern forest ecosystems
4. Restoring ecosystem structure, function, and productivity
5. Developing sustainable forest bioenergy systems

Relationship to Forest Service Strategic Objective (numbers in parentheses refer to which of the above FERM Focus Area contributes to each FS Strategic Objective):

1.1 Reduce the risk to communities and natural resources from wildfire. (1, 2, 3, 4, 5)
1.2 Suppress wildfires efficiently and effectively. (1, 2)
1.3 Build community capacity to suppress and reduce losses from wildfires. (2, 4)
1.4 Reduce the adverse impacts from invasive and native species, pests, and diseases. (1, 2, 3, 4, 5)
1.5 Restore and maintain healthy watersheds and diverse habitats. (1, 2, 3, 4, 5)
2.1 Provide a reliable supply of forest products over time that (1) is consistent with achieving desired conditions on NFS lands and (2) helps maintain or create processing capacity and infrastructure in local communities. (1, 2, 3, 4, 5)
2.2 Provide a reliable supply of rangeland products over time that (1) is consistent with achieving desired conditions on NFS lands and (2) helps maintain ranching in local communities. (2, 3)
2.3 Help meet energy resource needs. (2, 5)
2.4 Promote market-based conservation and stewardship of ecosystem services. (1, 2, 3, 4)
3.1 Protect forests and grasslands from conversion to other uses. (2, 3, 4, 5)
3.2 Help private landowners and communities maintain and manage their land as sustainable forests and grasslands. (2, 4, 5)
4.1 Improve the quality and availability of outdoor recreation experiences. (2, 3, 4)
5.1 Improve accountability through effective strategic and land- management planning and efficient use of data and technology in resource management. (1, 2, 3, 4)
5.2 Improve the administrative National Forest lands and facilities in support of the agency's mission. (1, 2, 3, 4, 5)
6.1 Promote conservation education to increase environmental literacy through partnerships with groups that benefit and educate urban populations. (1, 2, 3, 4)
6.2 Improve management of urban and community forests to provide a wide range of public benefits. (2, 4)
7.1 Increase the use of applications and tools developed by Forest Service Research and Development and the Technology Development Centers. (1, 2, 3, 4, 5)

Relationship to Forest Service Research and Development Strategic Program Areas (numbers in parentheses refer to the FERM Focus Areas that contribute to each Strategic Program Area):

Wildland Fire and Fuels (1, 2, 3, 4)
Invasive Species (1, 2, 3, 4)
Recreation (3, 4)
Wildlife and Fish (1, 2, 3, 4)
Watershed, Air, and Soil (1, 2, 3, 4)
Resource Management and Use (1, 2, 3, 4, 5)

SRS-4157- Upland Hardwood Ecology and Management

Asheville, NC; Clemson, SC; Knoxville, TN; Huntsville, AL; Hot Springs, AR
Project Leader: Cathryn (Katie) H. Greenberg

Mission: We will develop and disseminate knowledge and strategies for restoring, managing, sustaining, and enhancing the vegetation and wildlife of upland hardwood-dominated forest ecosystems of the central region of the eastern United States. We will concentrate on the oak and yellow-poplar dominated forests of the southern Appalachian Mountains and the oak and hickory forests of the Interior Highlands, Boston Mountains, and Missouri Plateau.

Area of Research Applicability: Regional- Forested ecosystems dominated by oak, hickory, and yellow-poplar and ecotones of mixed hardwood-pine types of the east-central United States; National- Related ecosystems dominated by upland hardwood forests, particularly in the north-central and northeastern United States; International- Related environments dominated by upland hardwood forests, particularly in eastern Asia, central Europe, southeastern Australia, and New Zealand.

Problem 1.
We need a better understanding of how upland hardwood-dominated forests are affected by disturbances across environmental gradients. Understanding the range of responses will enable land managers to better predict changes in forest structure, composition, and habitat quality and to develop methods to meet management and restoration goals.

Problem 1a. We need methods for classifying forest sites using ecological approaches. Ecological approaches to forest site classification will enable land managers to better predict species composition and productivity in relation to environmental gradients across landscapes in upland hardwood-dominated forest ecosystems.

Problem 1b. We need methods for predicting and controlling changes in the structure and composition of upland hardwood-dominated forest vegetation. Understanding how forest structure and composition changes in response to natural disturbance, silvicultural activities, climate change, and non-native invasive species will enable land managers to better meet the goals of management and restoration of native upland hardwood-dominated forest communities.

1b.1. We do not fully understand the complexities of natural regeneration in upland hardwood-dominated forests. A fuller understanding will enable land managers to better maintain the productivity and sustainability of upland hardwood-dominated forest stands.

1b.2. We need to improve the competitive ability of planted seedlings through better prediction of seedling performance given variations in nursery seedling quality, stand conditions and cultural practices. An increased knowledge base on the cultural practices and biological mechanisms affecting seedling success will enable land managers to maintain or restore hardwood species using artificial regeneration.

1b.3. We need a better understanding of the ecological patterns and processes that govern stand dynamics and development. A fuller understanding will enable land managers to better apply and modify silvicultural practices in young and mature stands of naturally regenerated hardwoods, and to predict and control changes in species composition and stand structure.

1b.4. We need to better understand the range of natural disturbance types, frequencies, intensities, and conditions in upland hardwood-dominated forests. A fuller understanding will enable land managers to better predict changes in upland hardwood forest structure and composition resulting from natural or silvicultural disturbances.

Anticipated outcomes in Problem 1:

We will develop a tool for land managers to better predict species composition and productivity in relation to environmental gradients across landscapes in upland hardwood-dominated forest ecosystems.

We will provide models and information to enable land managers to better predict and control changes in the stand structure and species composition in upland hardwood-dominated forest vegetation.

We will provide information to land managers on how prescribed fire in upland hardwood-dominated forests affects species composition, stand structure, fuel loading, and residual tree health.

We will provide land managers prescriptions needed to artificially regenerate oaks, American chestnut, and other hardwood species across a range of site conditions and nursery seedling qualities.

We will work with partners to help develop a model to simulate stand development and forest growth in response to both planned and unplanned disturbance, that applies to upland hardwood-dominated forests in the South.

We will build upon a growing knowledge base of forest ecology and silviculture that may be used by land managers and research scientists.

Problem 2.

We need more information on wildlife responses to silvicultural or other disturbance-induced changes in vegetation composition, habitat structure, and food resources, and improved techniques for wildlife inventory and monitoring. Obtaining this knowledge will enable land managers to improve conservation and management strategies and practices for wildlife communities and endangered species in upland hardwood-dominated forests and associated ecosystems in the southern Appalachians.

Problem 2a. We have an incomplete knowledge of how habitat modification and climate change affect populations, habitat quality, and habitat use by neotropical migratory birds at the stand and landscape level. A fuller understanding will enable land managers to better develop and implement effective conservation and management strategies for neotropical migratory birds in upland hardwood-dominated forests and associated forest types in the southern Appalachians.

Problem 2b. We need to develop effective methods to inventory and monitor bats, and obtain fundamental knowledge on bat population trends, habitat requirements, and factors affecting

habitat use and quality at the stand and landscape level. This understanding will enable land managers to better develop and implement effective strategies for bat conservation and management.

Problem 2c. We need more information on reptile, amphibian, and small mammal population trends, habitat requirements, and how natural or silvicultural disturbances affect habitat use and quality. This information will enable land managers to better develop and implement strategies for effective conservation and management of reptiles, amphibians, and small mammals in upland hardwood-dominated forests.

Problem 2d. We do not fully understand how different silvicultural and natural disturbances affect food resources for wildlife, such as fleshy fruit, hard mast, and invertebrate prey, or how availability of these food resources vary over time and landscapes. Improved knowledge will enable managers to more effectively manage food resources for wildlife communities at a landscape level in upland hardwood-dominated ecosystems.

Anticipated outcomes in Problem 2:

We will develop information on how habitat modification and climate change affect populations, habitat quality, and habitat use by neotropical migratory birds at the stand and landscape level.

We will develop more effective methods to inventory and monitor bats.

We will provide information to land managers, land planners, and wildlife biologists on bat population trends, habitat requirements, and factors affecting habitat use and quality at the stand and landscape level that can assist in land management planning for effective bat conservation and management.

We will provide information to wildlife biologists and land managers and planners on reptile, amphibian, and small mammal habitat requirements, and factors affecting habitat use and quality, that can assist in land management planning for wildlife conservation and management.

We will provide land managers and land planners with models for evaluating and quantifying forest food resources such as acorns and fleshy fruit.

We will provide guidelines to land managers and land planners on how different silvicultural and natural disturbances affect food resources for wildlife, such as fleshy fruit, hard mast, and invertebrate prey, and how availability of these food resources varies over time and across landscapes.

We will build upon a growing knowledge base of wildlife ecology that may be used by land managers and research scientists.

Environmental considerations: The program of research proposed in this Research Work Unit charter includes research activities that are generally limited in context and intensity and are not expected to have a significant effect on the quality of the human environment. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and categorical exclusion

will be documented as a part of the study plan according to FSH 1909.15, Chapter 30. For research involving the use of toxicants, environmental considerations will be evaluated within individual study plans, or by Environmental Assessments or Environmental Impact Statements prepared with or reviewed by the cooperating District or Forest staffs. For research having the potential to affect a plant or animal species that is federally listed as endangered or threatened or proposed for such listing, the RWU will consult with the U.S. Fish and Wildlife Service as per Section 7 of the Endangered Species Act of 1973, as amended.

Key Cooperators and Partners:

Government

Ozark-St. Francis NF	William B. Bankhead NF	Cherokee NF
Daniel Boone NF	Nantahala-Pisgah NF	GW-Jefferson NF
Chattahoochee NF	Black Hills NF	Francis Marion/Sumter NF
NFS-Region 8	NFS-Savannah River	Talledaga NF

Dr. Kurt Gottschalk, NRS; Dr. Gary Miller, NRS; Dr. Steve Shifley, NRS; Dr. Mark Twery, NRS; Dr. Dan Dey, NRS; Dr. Linda Joyce, RMRS; Dr. Wayne Sheppard, RMRS (Retired); Dr Jim Vose, SRS; Dr. Bob Rummer, SRS; Dr. Emile Gardiner, SRS; Dr. Tom Waldrop, SRS; Dr. Dana Nelson, SRS; Dr. Jim Guldin, SRS; Dr. Kris Connor, SRS; Dr. David Cleland, R9&NRS; Dr. Dan Yaussy, NRS.

Alabama State Lands Division, Tennessee Division of Forestry, Kentucky Division of Forestry, North Carolina Division of Forest Resources, South Carolina Forest Service, Georgia Forestry Commission, Virginia Division of Forestry, North Carolina Wildlife Resources Commission, Tennessee Wildlife Resources Agency, North Carolina Department of Environment and Natural Resources, United States Geological Survey, North Carolina Division of Water Quality, The North Carolina Arboretum, U.S. Department of Energy, Joint Fire Sciences Program (BLM), Congaree National Park, U.S. Fish and Wildlife Service, Alabama Forestry Commission, Natural Resources Conservation Agency, City of Huntsville, U.S. Army Garrison Redstone Arsenal, Arkansas Division of Foresty, National Park Service, Blue Ridge Parkway, Great Smoky Mountain National Park, U.S. Environmental Protection Agency.

Colleges and Universities

Clemson University, North Carolina State University, Duke University, University of Tennessee, Alabama A&M University, University of the South, University of Kentucky, Purdue University, University of Missouri, Mississippi State University, Eastern Kentucky University, University of Florida, Western Carolina University, Mars Hill College, Warren Wilson College, University of North Carolina at Asheville, Virginia Tech, University of North Alabama, Jacksonville State University, Auburn University, University of Alabama

Other

Stevenson Land Company, The Nature Conservancy, American Chestnut Foundation, North Alabama Treasure Forest Landowners, Society of American Foresters, Hayes Nature Preserve, Platte River Whooping Crane Trust, Archbold Biological

SRS-4158 -- Restoring and Managing Longleaf Pine Ecosystems
Auburn, AL; Pineville, LA; and Clemson, SC
Project Leader: Kristina Connor

Mission: Our mission is to provide knowledge and strategies for restoring, managing, and sustaining longleaf pine ecosystems in the southeastern United States.

Area of Research Applicability: Longleaf pine ecosystems once dominated up to 90 million acres in the southeastern United States. The 3 million acres of remaining longleaf pine ecosystems are refuges for hundreds of threatened and endangered plants and animals. Restoring longleaf pine ecosystems across its range is critical for the long-term survival of these threatened and endangered species. Although longleaf pine is not normally managed outside its native range, we can also make comparative relationships in ecology and management with other pine-dominated forest types in the United States and worldwide.

Problem 1. We need fundamental biological knowledge to understand the processes that affect the fecundity, establishment, and development of plants and plant communities in longleaf pine ecosystems. We will then better understand how native vegetation responds to natural disturbances in terms of growth, vigor, disease resistance, and longevity. This improved understanding will enable us to better restore and manage longleaf pine ecosystems.

We will use our expertise in the biology of seeds, seedlings, trees, and rare plants to study the basic biology, physiology, and ecology of longleaf pine and its associated plant species. Specific problem areas are as follows:

Problem 1a. We will discover and develop knowledge of the reproductive and population biology of ground-layer and at-risk plant species, and will use that knowledge to maintain and restore plant communities and to understand the synergies among plants within frequently burned longleaf pine ecosystems.

Problem 1b. We will quantify the physiological and developmental strategies that sustain longleaf pine in frequently burned systems, so that we can better understand the consequences of resource limitations in frequently burned systems on longleaf pine health and sustainability.

Problem 1c. We will discover and develop knowledge of root system support (i.e. soil resource uptake and morphology) of aboveground processes during the establishment and development of longleaf pine, and will use that knowledge to better establish tree plantings and insure their long-term success and to link physiological performance to soil physical and chemical properties.

Problem 1d. We will discover and develop knowledge of the physiological and morphological control of longleaf pine in the grass stage, and will use that knowledge to lessen the time longleaf pine is in the grass stage helping to better establish longleaf pine plantings and leading to greater acceptance of longleaf pine as the species of choice.

Anticipated outcomes in Problem 1:

-Restore and sustain diverse understory plant communities in open longleaf pine forests
-Discover why diversity is important to plant community well being
-Determine population and community processes that affect threatened and endangered plant species in the ground layer of longleaf pine ecosystems
-Discover the physiological processes that determine how and why longleaf pine responds successfully to loss of needle mass from heat injury by rapidily refoliating after intense fires so that managers can plan prescribed fires based on the physiological state of the trees
-Learn how site limitations in terms of water and nutrient availability influence the ability of longleaf pine to successfully recover after intense heat injury
-Discover the physiological processes that affect establishment, growth, and development of longleaf pine seedlings specifically through a better understanding of how longleaf pine begins height growth, how seedlings utilize soil resources, and through a better understanding of root system morphology

Problem 2. We need practices, strategies, and models to quantify and predict the impacts of management and disturbance on maintaining and restoring longleaf pine ecosystems. This knowledge will help land managers to better establish and manage longleaf pine forests and thereby expand the acreage of longleaf pine and increase the habitat for threathened and endangered plants and animals in the southeastern United States.

We will use our expertise in the structure and function of longleaf pine ecosystems, and our skills at predictive model development and database management, to conduct an integrated research program for restoring longleaf pine ecosystems across a range of conditions. Specific problem areas are as follows:

Problem 2a. We will quantify and evaluate fire as a management tool in longleaf pine ecosystems--specifically the introduction or reintroduction of fire to long-unburned longleaf pine forests, the use of fire in conjunction with other silvicultural treatments to establish longleaf pine forests, and the use of such practices to minimize wildfire risk. This will provide landowners with the tools to manage healthy, diverse, and productive longleaf pine ecosystems.

Problem 2b. We will develop knowledge of even-aged and uneven-aged silvicultural methods used to regenerate longleaf pine forests; apply new biological knowledge to silvicultural methods used for stand conversion from offsite overstory species to longleaf pine, and develop silvicultural methods to manage understory species as a way of restoring ground-layer and at-risk plant species on degraded sites. This will allow us to comprehensively address the silviculture of longleaf pine ecosystems and provide land managers with the tools to manage these forests.

Problem 2c. We will combine information on longleaf pine silviculture with existing and new biological knowledge to develop models that predict the restoration success, production, and sustainability of longleaf pine ecosystems, and concurrently, we will develop long-term databases on plant communities as well as amphibian and reptile populations in longleaf pine

ecosystems and their responses to disturbances such as hydrological fluctuations, silvicultural practices, fire, and climate change. As a result, land managers will have valuable tools to manage longleaf pine ecosystems across the southeastern United States.

Problem 2d. We will use our expertise in seed and seedling biology and physiology to develop nursery and field protocols that meet the demand for high quality planting stock because landowners need better quality seedlings and innovative establishment techniques for restoration efforts than currently exist and this problem will directly address that need.

Problem 2e. We will evaluate longleaf pine and its associated plant species as potential feedstocks for bioenergy production and the influence of such activities on longleaf pine ecosystems. Bioenergy feedstocks is seen as a way to help offset dependence on foreign oil, but land managers need information on how this process will affect longleaf pine ecosystems.

Anticipated outcomes in Problem 2:

-Develop reliable models for longleaf pine stands that account for both evenaged and unevenaged regeneration systems, how understory plant communities respond to different management options, and provide information on bioenergy potential
-Refine models to include season of burning and the use of fire with other silvicultural practices
-Develop brochures and other written and web-based materials that provide the public and policy makers with information on longleaf pine ecosystem restoration and management
-Conduct tours and workshops primarily for non-industrial private landowners but also for land management professionals to help them solve their longleaf pine restoration and management problems
-Work closely with other longleaf pine technology transfer efforts to effectively restore and sustain longleaf pine ecosystems so that products and amenities will be available to future generations while maintaining habitats for dependent plants and animals

Environmental Considerations

RWU-4158's program of research includes activities that are generally limited in context and intensity and are not expected to have a significant adverse effect on the quality of the human environment. The environmental effects of specific actions will be considered during the development of study plans, at which time the existence of extraordinary circumstances related to the proposed action and any categorical exclusions will be documented as a part of the study plan as described in FSH 1909.15, Chapter 30. For research involving the use of toxicants, environmental considerations will be further evaluated through Environmental Assessments or Environmental Impact Statements prepared with and reviewed by the cooperating District or Forest staffs. For research having the potential to affect a plant or animal species that is federally listed as endangered or threatened or proposed for such listing, RWU-4158 will consult with District or Forest biologists and the U.S. Fish and Wildlife Service as per Section 7 of the Endangered Species Act of 1973, as amended.

Key Cooperators: We will collaborate with professional resource managers and academic colleagues from public and private organizations across the Region to address invasive plants, destructive insects and pathogens, the effects of fire on forest structure, function, and processes, and to study the effects of prescribed fire on root health and decline syndrome in longleaf pine. We will collaborate with research scientists to study threatened and endangered plants and animals, alternative management approaches like agroforestry and the production of various alternative commodities and services, such as pine straw, biofuels, carbon sequestration, ecotourism, and wildlife habitat. We will collaborate with government and private organizations to develop tours, field trips, publish brochures and other written and web-based materials, and to develop reliable prediction models. Key cooperators would include the following organizations:

Southern Research Station:	SRS-4156--Center for Disturbance Science
	SRS-4159--Southern Pine Ecology and Management
	SRS-4352--National Agroforestry Center
	SRS-4552--Insects, Diseases, and Invasive Plants of Southern Forests
	SRS-4703--Forest Operations
	SRS-4704--Utilization of Southern Forest Resources
	SRS-4801--Forest Inventory and Analysis
	SRS-4804--Forest Health Monitoring
	SRS-4854--Eastern Forest Environmental Threat Assessment Center
	SRS-4952--Integrating Human and Natural Systems
Federal Agencies:	Kisatchie National Forest, Louisiana
	Region 8, Regional Office, USDA Forest Service
	Region 8, State and Private Forestry, Forest Health Protection
	Department of Defense
	U.S. Fish and Wildlife Service
Universities:	Auburn
	Clemson
	Louisiana State
	Louisiana Tech
State Agencies:	Alabama Cooperative Extension Service
	Alabama Forestry Commission
	Louisiana Cooperative Extension Service
	Louisiana Department of Agriculture and Forestry
Private organizations:	Joseph Jones Ecological Research Center
	Tall Timbers Research Station
	The Nature Conservancy
	Alabama Foresty Association
	Louisiana Forestry Association
	Longleaf Alliance
	Cedar Creek Land and Timber Co, Alabama
	Martin Timber Co, Louisiana

SRS-4159 -- Ecology and Management of Southern Pines
Monticello, AR; Hot Springs, AR; Pineville, LA; Nacogdoches, TX
Project Leader: James M. Guldin

Mission: Our mission is to develop and disseminate the scientific information necessary to realize the full range of benefits from vegetation, wildlife, and soils in pine-dominated forest ecosystems of the southeastern United States. Our emphasis is on mixed loblolly-shortleaf pine and pine-hardwood forests of the West Gulf Coastal Plain and the shortleaf pine and pine-hardwood forests of the Ouachita and Ozark Mountains.

Area of Research Applicability: Regional—Ecosystems dominated by southern pine and mixed pine-hardwood forest cover types in the southeastern United States; National—Comparative relationships in ecology and management of southern pine forest types with other pine-dominated forest types in the United States; International—Comparative relationships in ecology and management of southern pine forest types with other pine-dominated forest types around the world.

Problem 1. We will discover and develop new knowledge about the ecology of southern pine-dominated forest ecosystems, to refine the silvicultural principles and practices for these ecosystems, so that land managers can make better management decisions and take more effective action to achieve desired results on public and private forest lands in the South.

Problem 1a. We will quantify the establishment and early development of natural and artificial regeneration of pines and hardwoods, and will use that knowledge to manage and restore pine-dominated forest stands in the South.

Problem 1b. We will discover and develop knowledge about the ecological patterns and processes that govern forest stand dynamics and development, so that we can improve the silvicultural practices used to manage immature, mature, mixed-age, and old-growth pine-dominated forest stands in the South.

Problem 1c. We will quantify the cumulative and long-term responses of ecosystem dynamics to changes in soil quality brought about by management practices such as harvesting, fire, fertilizers, herbicides, and various forms of mechanized traffic, so that managers can more effectively maintain and improve the health, sustainability, and productivity of southern pine-dominated forest stands.

Problem 1d. We will discover and develop knowledge about the interactions of soils and silvicultural practices, so that managers can more effectively manage southern pine-dominated forests for diverse resource outcomes and outputs such as timber, cellulosic biomass for bioenergy, high quality wildlife habitat, and abundant and clean water.

Anticipated outcomes in Problem 1:
-develop predictive models for resprouting of planted and naturally-regenerated shortleaf pine seedlings when topkilled by prescribed burning, which will provide guidance for land managers when young stands are part of a landscape-scale prescribed fire burning program (1a)

-provide guidelines for land managers on the use of planted pine seedlings to ameliorate failures or shortfalls in natural regeneration under even-aged and uneven-aged reproduction cutting methods (1a)
-develop guidelines for thinning to accelerate development of mixed pine-hardwood stands, which meet needs of landowners interested in optimizing diversity (1b)
-make recommendations on modifying traditional uneven-aged silvicultural prescriptions to integrate retention of biological legacy elements above recommended diameter limits while maintaining acceptable development of new age cohorts, so that timber production can be integrated with greater structural and habitat diversity for wildlife (1b)
-develop one-pass marking rules for uneven-aged silvicultural prescriptions that allow a forester to inventory and mark those stands at the same time rather than in separate entries, saving both time and money (1b)
-refine computer models to better predict the effects of prescribed burning on growth and yield of southern pine stands (1c)
-give recommendations to landowners about the timing and intensity of forest operations to limit soil compaction, and to improve soil structure adversely affected by compaction (1c)
-make recommendations on silvicultural treatments needed to maintain forest health and productivity under different intensities of site preparation and utilization, so that foresters can sustainably manage for biomass and biofuels (1d)
-provide guidance on maintaining productive soils that managers can use when managing for different mixtures of forest resources on public and private forest lands. (1d)

Problem 2. We will synthesize and evaluate the influence of regional, continental, and global forcing factors on pine-dominated forest ecosystems in the South, and will provide land owners and managers with the tools to manage healthy, diverse, and productive southern pine ecosystems that are resilient in response to these changes

Problem 2a. We will discover and develop knowledge about the effects of climate change, large-scale natural disturbances, and other anthropogenic influences on forest ecosystems so that managers can anticipate and detect when forest ecosystems may be affected by these events, and make appropriate changes in management plans and prescriptions

Problem 2b. We will synthesize and evaluate the cumulative ecological effects resulting from management activities imposed in varying patterns and intensities across a forested landscape, so that stand and forest management decisions may be made and actions taken in the context of larger landscapes fragmented by different ownership patterns.

Problem 2c. We will develop and discover knowledge on natural patterns, processes, historical conditions, and disturbances in southern pine-dominated stands and landscapes so that managers can identify trajectories and alter management actions to restore and enhance southern pine ecosystems

Anticipated outcomes for Problem 2:
-refine computer models to include the influence of regional ice storms on growth and yield of southern pines (2a)

-develop internet-based models of hazard, exposure, and risk for outbreaks of native insect species such as southern pine beetle and red oak borer that landowners can use to make better decisions about management alternatives in pine, pine-hardwood, and hardwood-pine stands (2a)
-publish subjective decision models on the flexibility of different silvicultural systems in southern pine-domated ecosystems under projected changes in regional climate (2a)
-develop GIS-based decision support models for southern pine stands that give landowners the tools they need to make resource management decisions on their property, in the context of management action or inaction on adjacent properties within and across forested landscapes (2b)
-quantify presettlement forest stucture and function so that those wishing to recreate those conditions have tools available to guide and inform their management decisions (2c)
-evaluate and synthesize information from ongoing forest restoration prescriptions in southern pine stands across the South, to provide management guidelines and expected outcomes as restoration prescriptions are implemented across a wider variety of forest types (2c)

Problem 3. We will discover, develop, and synthesize knowledge about the effects of forest management, insect pests, and climate change on wildlife and wildlife habitat in southern pine-dominated ecosystems, so that managers have better tools to restore and manage wildlife populations that are healthy, diverse, and sustainable.

Problem 3a. We will develop and discover knowledge about how forest management, forest fragmentation, and climate change affect the quality and quantity of riparian/aquatic habitats and associated wildlife species, so land managers can make better decisions about managing riparian zones and wetlands for resource benefits that feature wildlife species of interest.

Problem 3b. We will synthesize and evaluate the interactions of silviculture on red-cockaded woodpeckers, other cavity nesters and southern pine bark beetles, so that land managers interested in managing for this endangered woodpecker can make more effective management decisions.

Problem 3c. We will quantify, evaluate, and synthesize the effects of even-aged and uneven-aged silvicultural systems on widlife habitat and wildlife communities, so silvicultural prescriptions can be made and applied in stands and landscapes to more effectively create and maintain desired wildlife communities and habitats across the landscape.

Problem 3d. We will quantify and model how ecosystem restoration, forest management and altered fire regimes affect fire-maintained animal and plant communities and species of conservation concern, so that managers can make better decisions about conservation and management of animal and plant communities across the landscape.

Anticipated outcomes in Problem 3:
-make recommendations about streamside management zone widths that optimize conditions for various species of small mammals and birds for managers on public and private forest lands (3a)

-model the effects of weather on frog and toad breeding activity to give managers a better understanding of the implications of climate change on this suite of species (3a)
-determine the status of the alligator snapping turtle within its historic range in Texas, to provide basic information required to manage this species (3a)
-use internet-based imagery to reconstruct stand and landscape conditions to predict hazard and risk from southern pine beetle, emphasizing landscape analysis of stands supporting the endangered red-cockaded woodpecker, to improve and integrate habitat management for this bird (3b)
-quantify the effects of windstorms on red-cockaded woodpecker cavity trees, to better advise managers about the species, size, and distribution of cavity trees and nesting clusters to minimize breakage and blowdown from hurricane-force winds (3b)
- model the use of even-aged and uneven-aged southern pine stands by small mammals and birds, so that landowners interested in these species can make better decisions about desired stand structures to create through management (3c)
-model habitat relationships for amphibians and reptiles in the Ouachita Mountains of Arkansas and Oklahoma, to help land managers understand the effeetcs of stand and landscape features on the occurrence of these species (3c)
-determine roosting behavior of six species of tree-roosting bats in the Ouachita Mountains and provide forest managers with guidelines on the effects of different forest management practices on bat roosting habitat (3c)
-quantify the effects of shortleaf pine-bluestem restoration and prescribed fire on the structure of lepidopteran communities and their nectar resources, so that managers have better tools to manage for these important pollenators (3d)
-quantify wildlife community response to forest restoration activities that include prescribed fire, so that managers can make better decisions about the frequency, area, and timing of burning as a component of forest restoration for both plant and animal species (3d)
-Develop guidelines for suitable habitat conditions for Louisiana Pine Snakes to enable managers to improve management of this species, and to work with cooperators to establish a captive pine snake breeding population so that the species can be reintroduced to restored habitats (3d)

Environmental considerations: The program of research proposed in this Research Work Unit charter includes research activities that are generally limited in context and intensity and are not expected to have a significant effect on the quality of the human environment. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and categorical exclusion will be documented as a part of the study plan according to FSH 1909.15, Chapter 30. For research involving the use of toxicants, environmental considerations will be evaluated within individual study plans, or by Environmental Assessments or Environmental Impact Statements prepared with or reviewed by the cooperating District or Forest staffs. For research having the potential to affect a plant or animal species that is federally listed as endangered or threatened or proposed for such listing, the RWU will consult with the U.S. Fish and Wildlife Service as per Section 7 of the Endangered Species Act of 1973, as amended.

Key Cooperators: Our research is conducted in partnership with professional resource managers and academic colleagues from public and private organizations across the Region. Key contacts with whom we currently have cooperative agreements, active studies, or consultations include the following organizations:

Universities:
Oklahoma State University
University of Arkansas
University of Arkansas at Monticello
Texas A&M University
Stephen F. Austin State University
University of Kansas
University of Missouri-Columbia
Louisiana State University
Louisiana Tech University
Virginia Tech
Arkansas Tech University

State Agencies:
Arkansas Forestry Commission
Arkansas Natural Heritage Commission
Oklahoma Forestry Services
Texas Forest Service
Texas Parks and Wildlife

Federal Agencies:
Region 8, USDA Forest Service
Ouachita National Forest
Ozark-St.Francis National Forest
Kisatchie National Forest
National Forests and Grasslands of Texas
National Forests in Mississippi
Region 8, State and Private Forestry, Cooperative Forestry
Region 8, State and Private Forestry, Forest Health Protection
Hot Springs National Park, US Department of the Interior
U.S. Fish and Wildlife Service

Private organizations:
The Nature Conservancy, Arkansas Field Office
The Nature Conservancy of Texas
Potlatch Corporation
Plum Creek Timber Company
Weyerhaeuser Company
International Paper Company
Roy O. Martin Timber Company
Larson and McGowin, Inc.
The Pioneer Forest, L-A-D Foundation
Temple-Inland, Inc.
The Memphis Zoo

SRS-4160 – Forest Genetics and Ecosystems Productivity

Saucier, MS, Research Triangle Park, NC, College Station, TX, Gainesville, FL
Project Leader: C. Dana Nelson

Mission: To advance the scientific understanding of the roles of genetics, environment, and their interactions to provide guidelines and tools for improving the sustainable productivity of southern forest ecosystems.

Research Teams:

Southern Institute of Forest Genetics
Team Leader: C. Dana Nelson, Saucier, MS

Southern Institute of Forest Ecosystems Productivity
Team Leader: Kurt H. Johnsen, Research Triangle Park, NC

Problem 1. Genetics and Genomics

The unit will conduct genetic and structural genomics research on forest trees and their pests with applications in evolutionary biology, forest management, and tree improvement. Knowing the genes and their effects on traits that interact with other organisms and the environment will lead to breakthroughs in our understanding of ecosystem structure and function and development of new technologies for forest management.

Problem 1a. Genome mapping and molecular cytogenetics of important forest tree species and their most damaging disease and insect pests— We currently know very little about the genes influencing insect and disease resistance. Identification of these genes will help tree breeders to efficiently produce more resilient trees and provide silviculturists with information on how best to deploy improved trees for long-term resistance.

Problem 1b. Quantitative genetics of economic and ecologic traits, including mapping genes that regulate and control these traits— We do not know which genes influence important economic and ecologic traits. Knowing the genes and how they interact with each other and the environment will help tree breeders produce better trees more efficiently and provide silviculturists with information on how to deploy the improved trees for optimal performance and production.

Problem 1c. Population and conservation genetics of important forest species, including those that are sensitive, threatened or endangered— We do not know the genetic makeup of most forest species and of those in decline we don't know whether they have enough genetic diversity for their successful recovery and future health. Knowing the level, distribution and flow of gene diversity in species of concern will let forest managers form plans which have the best chance of meeting recovery and long-term management goals.

Anticipated outcomes in Problem 1:

-develop genetic interaction models for resistance to important tree insects and diseases, to help scientists and land managers better understand and manage against losses to forest pests (1a)

-develop genetic markers for forest tree species which pinpoint the genomic location of important insect and disease resistance genes, to help tree breeders more efficiently develop trees for long-term resistance (1a)

-identify the DNA sequence of specific genes conferring insect and disease resistance in forest trees, to help scientists better understand the underlying metabolic pathways involved in pest defense responses (1a)

-develop genetic markers that can be used to estimate virulence allele frequencies in natural populations of the fusiform rust fungus to allow forest managers to predict the likely resistance of various families when planted under field conditions (1a)

-evaluate genetic variation of resin yield in loblolly and longleaf pine populations to provide tree breeders and forest health professionals a more complete picture of a likely southern pine beetle defense mechanism (1b)

-model southern pine beetle outbreaks in clonal populations of loblolly pine to provide information to forest managers about genetic diversity needed to manage risk of stand failure in clonal forestry (1b)

-evaluate genetic variation for adaptive traits of longleaf pine to provide scientists and land managers with increased knowledge of the species' biology and options for management (1b)

-model escape of transgenes and their allele frequency behavior over generations to obtain a better understanding of the impact that genetically modified organisms (GMOs) may have on native tree populations and forest ecosystems (1c)

-provide federal and state land managers an assessment of current and predicted genetic population structures, levels of inbreeding, and patterns of gene flow for pondberry and other endangered forest species (1c)

-provide southern tree breeding cooperatives data on how levels of diversity in first generation selections, as well as advanced generation selections, compare to those existing in natural populations, such information will help tree breeders assess and track the affects of small population breeding and help them select new trees that might be incorporated into their existing breeding programs (1c)

-provide forest genetic and tree improvement colleagues with a DNA fingerprint kit that can be used to determine parentage, provenance, or population parameters of North American pines (1c)

Problem 2. Physiological Processes

The unit will conduct physiological and functional genomics research on forest trees with applications in tree improvement and forest ecosystem restoration and management. This work will provide a basis for conducting benefit/risk analyses so that managers can use state-of-the-art science to best manage forests for productivity and long-term sustainability.

Problem 2a. Ideotype identification and characterization for use in sustainable production forestry systems— Ideotypes are conceptual models that explicitly describe phenotypic characteristics of trees that result in predictable growth and yield results under specific environmental conditions. We will develop and test ideotypes useful for producing different forest products such as timber and biofuel. Our work will guide the gene discovery research so that novel ideotypes can be more efficiently created using genome-guided selection and breeding.

Problem 2b. Physiologic processes of forest trees growing under limiting conditions caused by abiotic and biotic agents— Stress due to environment and forest pests greatly reduce forest productivity. In addition, the responses of forests to increasing atmospheric CO_2 is likely dependent on limitations due to abiotic and biotic stressors. Understanding the physiological bases for stress responses and resistance will allow management efforts to maximize sustainable productivity under current and future conditions.

Problem 2c. Gene discovery and gene expression studies of important forest tree traits such as growth rate, tree form, carbon-, nutrient- and water-use efficiency, bioenergy conversion— We do not comprehend the impact(s) of genes critical for both ecological stability as well as the rapid domestication of commercial tree species. This work will supplant our ability to select and breed trees particularly well suited for producing specific products under specific environments and management regimes. It will also guide the efficient selection of genotypes in natural forests and breeding programs to be included in gene conservation efforts and to be used in forest restoration.

Anticipated outcomes in Problem 2:

- identify traits and their combinations that represent ideotypes for different forest products under specific forest management regimes, to determine the benefits of developing ideotypes for deployment in plantation forestry (2a,c)

- identify genes controlling the above traits that are important attributes of productive ideotypes, to provide candidate genes for potential use in genome-guided breeding (2b,c)

- demonstrate that different genes for candidate traits can be recombined and selected for in southern pine breeding populations, to demonstrate the efficacy of developing ideotypes via genome-guided breeding (2a,b,c)

- identify genes associated with phenotypic plasticity, to guide the efficient selection of genotypes to include in gene conservation programs (2a,c)

- identify genes or combination of genes that confer phenotypic plasticity, to provide information so that forests can be managed for increased resilience under varied environmental conditions including changes that might occur due to global climate change (2b,c)

- identify genotypes that are highly productive under low native soil nutrition, to allow land managers to grow highly productive plantations while minimizing fertilizer inputs (2b)

- quantify genetic variation among and within important forest tree species regarding forest damage due to hurricanes, to improve the ecological and economonic stability of forest ecosystems in hurricane prone regions of the southeast (2b)

- characterize genetic and environmentally induced variation on cellulose, hemicellulose and lignin quantity and quality, to provide candidate genes for breeding and selection to produce bioenergy feedstock with improved conversion efficiency (2c)

Problem 3. Carbon and Nutrient Cycling

The unit will conduct research that integrates molecular, cellular, physiologic, geologic, and ecologic principles and system approaches to explain processes governing carbon and nutrient cycling for applications in sustainable forest management. We are only beginning to understand the complex array of processes associated with ecosystem health. Changing one aspect of a forest ecosystem (for example, fertilization) may increase productivity of the currently desired product (for example, timber). However it will also perturb and modify other important aspects of forest function such as below-ground process. Only by improving our understanding of how processes are impacted, and then interact with other processes, can we predict the ramifications of management actions and/or climate change on long-term forest sustainability.

Problem 3a. Productivity and sustainability of forest stands over rotations including nutrient cycling and conservation and above- and below-ground carbon sequestration— Our knowledge of below ground processes represents the weakest link in our ability to manage productive and sustainable forests over multiple rotations. We will conduct research on nutrient cycling and conservation and above- and below-ground carbon sequestration. This work will permit growth to be optimized while providing the lowest energy and nutrient inputs into the systems. It will also allow us to estimate the extent that managed forests can also sequester carbon.

Problem 3b. Process modeling to integrate research information into tools for forest managers and policy makers— The products of reductionist research need to be incrementally incorporated into the simplest models and into tools for forest managers and policy makers. We will work toward integrating research results to produce process models so the best state-of-the-art science can be applied to address an array of problems including but not limited to: quantifying forest carbon at scales ranging from the stand to the region; safely utilizing the rapidly domesticated forest trees in intensively managed ecosystems; designing management systems to optimize bioenergy yield in plantations thus creating a new forest product and reducing reliance on fossil fuels; and restoring degraded forests so that they can sustainably provide multiple benefits to society.

Anticipated outcomes in Problem 3:

- quantify the impacts of management and environmental variables on the recalcitrance of below-ground carbon, to improve the capacity of forests to sequester carbon below-ground.guide the management of forests where carbon sequestration is a primary goal or a co-benefit (3a)

- quantify the impacts of varying forest management options including the choice of both species and genotype on belowground carbon allocation, to guide the management of forests where carbon sequestration is a primary goal or can provide a co-benefit (3a)

- assess the varying recalcitrance of below-ground biomass of loblolly versus longleaf pines, assess a potential co-benefit that may provide landowners further incentives for restoring longleaf pine ecosystems (3a)

- quantify the impact of proactive carbon inputs during site preparation on mineral cycling and carbon sequestration, to explore the potential of developing new management tools for increasing carbon sequestration (3a)

- develop methodology to quantify belowground carbon allocation in forest trees, to use in developing methodology for quantifying forest carbon sequestration for use in carbon credit programs (3a,b)

- develop a system based on simple metrics so that landowners can estimate carbon stocks and carbon sequestration, to provide simple and tangible methods for landowners to use to utilize to obtain carbon credits (3b)

- provide estimates for impacts of elevated CO_2 on forest productivity to be incorporated into regional models, to provide information to be used for land use planning and developing carbon management policy (3b)

- develop management regimes to optimize bioenergy production, including both specification for both genotype and stand culture, to provide land mangers with tools to manage land to produce bioenergy feedstock and to provide policy makers information for assessing the potential of using woody crops for bioenergy production (3b)

Environmental considerations: The program of research proposed includes experimental activities that are generally limited in scope and intensity and are not expected to degrade the quality of the forest or human environment. The environmental effects of specific actions will be considered during the development of study plans, as well as the existence of extraordinary circumstances related to any proposed action, and categorical exclusion will be documented as a part of the study plan according to FSH 1909.15, Chapter 30. For research involving the use of toxicants, environmental considerations will be evaluated within individual study plans, or by Environmental Assessments (EA) or Environmental Impact Statements (EIS) prepared with or reviewed by the cooperating District or Forest staffs. For research having the potential to affect a plant or animal species that is federally listed as endangered or threatened or proposed for such listing, the principal investigator will consult with the U.S. Fish and Wildlife Service as per Section 7 of the Endangered Species Act of 1973, as amended.

Key Cooperators and Partners: Our research is conducted in partnership with academic and industrial scientists from around the world and professional resource managers from across the Southern Region. Key contacts with whom we currently have cooperative agreements, active studies and collaborations, or consultations include the following organizations:

Universities: Auburn University; Boston University; College of Charleston; Duke University; Louisiana State University; Mississippi State University; North Carolina State University; Oklahoma State University; Old Dominion University; Oregon State University; Shaw University; Texas A&M University; University of Missouri; University of Florida; University of Georgia; University of Idaho; Virginia Tech.

Federal Agencies: Brookhaven National Laboratory and Oak Ridge National Laboratory, U.S. Department of Energy; The National Arboretum, USDA Agricultural Research Service; Southern Region (Region 8), National Forests in Mississippi, DeSoto National Forest and DeSoto Ranger District, Southern Area Forest Health Protection, USDA Forest Service; Jackson Field Office, U.S. Fish and Wildlife Service

State Agencies: Arkansas Forestry Commission; Georgia Forestry Commission; Mississippi Forestry Commission; Missouri Department of Conservation; Texas Forest Service

Private organizations: Plum Creek Timber Company, Weyerhaeuser Company, International Paper Company, Temple-Inland, Inc., MeadWestvaco, Rayonier, Inc., ArborGen, LLC, CellFor, Inc., Smithsonian Environmental Research Center, The American Chestnut Foundation

International institutions: Canadian Forest Service; Czech University of Life Sciences, Prague; North American Forestry Commission; Swedish University of Agricultural Sciences; Universidad de Concepción