USDA - Forest Service

SOUTHERN RESEARCH STATION SCIENCE AREA CHARTER	1. Title **Forest Watershed Science**

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

SRS-4353: Center for Forest Watershed Research
(Otto, NC; Blacksburg, VA; Charleston and New Ellenton, SC)
SRS-4155: Center for Bottomland Hardwoods Research
(Stoneville, Oxford, and Starkville, MS; Hot Springs, AR)
SRS-4352: National Agroforestry Center - Research
(Huntsville, AL; Lincoln, NE; Blacksburg, VA; Moscow, ID)

3. Science Area Leader

Gregory A. Ruark, Assistant Station Director for Research, Huntsville, AL

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

6. Mission

To help sustain the provision of clean water and healthy aquatic systems by providing landowners, land managers, policy makers, and society with the knowledge and technologies for managing forests and agroforestry systems at local, watershed, and regional scales.

Signature	Title	Date
Prepared By: /s/ Gregory A. Ruark	GREGORY A. RUARK Assistant Director for Research	8/1/07
Recommended: /s/ Thomas R. Crow for	DEANNA J. STOUDER Staff Director, Environmental Sciences Research	8/6/07
Approved: /s/ Peter J. Roussopoulos	PETER J. ROUSSOPOULOS Station Director, Southern Research Station	8/22/07
Concurred: /s/ Ann M. Bartuska	ANN M. BARTUSKA Deputy Chief for Research & Development	8/29/07

7. Description

The Forest Watershed Science (FWS) area is comprised of three Research Work Units (RWU) within the Southern Research Station (SRS).

The Center for Forest Watershed Research (SRS-4353) - includes the Coweeta Hydrologic Laboratory in Otto, NC and the Center for Wetlands Research in Charleston, SC, as well as scientists located at Virginia Tech in Blacksburg, VA and the Department of Energy Savannah River Site in New Ellenton, SC.

The Center for Bottomland Hardwood Research (SRS-4155) - has most of its employees located in Stoneville, MS, but also has scientists located at Mississippi State University in Starkville, MS and in Forest Service facilities at Oxford, MS and Hot Springs, AR.

The National Agroforestry Center-Research RWU (SRS-4352) - is a component of the USDA National Agroforestry Center (NAC), which is a formal partnership with Forest Service State & Private Forestry (S&PF) and the Natural Resources Conservation Service (NRCS). The headquarters for NAC are in Huntsville, AL and the Center has employees from all three partners. Most of them are located at the in Lincoln, NE, with some additional scientists located at Virginia Tech in Blacksburg, VA and at the University of Idaho in Moscow, ID.

The FWS area contains about 40 research scientists plus technicians and administrative support staff. Employees are deployed at 11 locations in eight states. These scientists work in partnership with scientists in other SRS RWUs, other federal government agencies, state and local governments, universities, and non-profit organizations to conduct research and develop technology on a broad suite of topics. The importance of using interdisciplinary approaches in watershed science is reflected by the wide array of research disciplines represented in our scientists. They include aquatic ecology, chemistry, entomology, fishery biology, forestry, geographic information systems, hydrology, landscape ecology, plant pathology, plant physiology, riparian ecology, soil science, statistics, terrestrial ecology, and wildlife biology. Key elements of the base research program are:

- Long-term watershed studies are conducted to improve the understanding of linkages among terrestrial, riparian, and aquatic ecosystems at multiple scales. The relationships among forests and forested wetlands and their management and use to the supply and quality of are quantified. Studies include investigations of aquatic ecosystems and cold water fisheries. Our long term research programs on both high and low gradient hydrologic systems provides a foundation from which to understand hydrologic changes due to changes in climate, forest management, species mix, and land use. Experimental watersheds are used to provide benchmarks of forest watershed structure and function, for monitoring and analyses, for testing management options and novel experiments, and for demonstration and education. Contemporary issues that affect water supply and aquatic ecosystems, like climate change and variability, land use change, invasive species, all require a mechanistic understanding of watershed ecosystem structure and function to protect and sustainably manage healthy watersheds or restore degraded watersheds. The methods required to develop an understanding of watershed ecosystem structure and function go well beyond classic hydrological studies and require a merger of ecological and hydrological sciences, such as the use of “ecohydrology” to link an understanding of the functional interactions among vegetation, soils, and hydrologic processes.

- Bottomlands, which occur mostly in the floodplains of major rivers and their tributaries within the broad coastal plain stretching across the southeast, contain a diverse set of forest ecosystem types. Much of the original bottomland hardwood forests of the region was cut and converted to agricultural uses, especially in the 1960's in response to high crop prices. Research is conducted on how best to manage the remaining bottomland forest resource, where high rates of timber and fiber biomass production are possible without compromising environmental benefits, such as wildlife and fisheries. Bottomland hardwood forests provide critical benefits that are fundamental to ecosystem health at multiple scales such as functions that protect freshwater resources and habitats for terrestrial and aquatic fauna. Research is conducted on ways to reestablish bottomland hardwood forest ecosystems on a large portion of the Lower Mississippi Alluvial Valley that was converted to agriculture, particularly on flooded and marginally productive sites. We also conduct research on how climate, forest management, and land use change affect the hydrology of upper elevation streams. This understanding is used to develop models that connect the hydrology of upland systems to that of lowland systems.

- Agricultural activities account for the majority of non-point source water pollution nationally. However, due to their high profitability, these lands are likely to remain in production agriculture. Research is conducted on cost-effective ways to establish upland agroforestry and riparian forest buffer systems within these croplands to improve water quality and restore many other forest-derived ecological benefits. These systems are designed to be effective in reducing the input of sediment, fertilizers, pesticides, and livestock waste into surface waters. Tools are developed to help target the strategic placement of these practices within a watershed. Research on other agroforestry practices that improve landowner economics and therefore increase the likelihood that forests will be retained or that agroforestry will be used include the utilization, cultivation, and marketing of non-timber products in forests and agroforestry settings, and the design and management of silvopasture systems that combine livestock grazing with timber production in ways that minimize water pollution commonly attributed to livestock feeding operations.

Forests in the region are being converted to other uses, at an alarming rate, resulting in diminished forest area, increased fragmentation, and the loss of key ecosystem services. Most forest land in the region is privately held, and there remains a need to improve the profitability of landowners to lessen the pressure to convert forests. Within this same landscape agricultural lands are being farmed intensively, with row cropping often extending to the stream's edge. Riparian forests that once protected water quality and stabilized stream banks have been removed. Layered onto this dynamically changing landscape are population increases, climate variability, episodic disturbances, invasive species, and changing markets; all of which can dramatically affect the availability and demand for water resources.

8. Goals

The Forest Watershed Science area will provide the scientific basis, technologies, and tools to:

1. Improve the understanding of how forests, including upland forests, bottomland forests, forested wetlands, and agroforests, function to influence water quality and quantity, as well as related key ecosystems services.

2. Assist landowners and natural resource professionals in establishing, managing, and strategically linking forests across landscapes of diverse land uses to provide a balance of social, economic, and environmental benefits to landowners and society.

3. Enhance landowner and public awareness of the importance of forests in producing and protecting water and providing other ecosystem benefits.

9. Focus Areas

Although research and technology development in the FWS area will continue to advance base programs, four areas have been identified for special focus. Efforts on these focal areas are coordinated with work by scientists in other SRS science areas across the Station. Research will be highly integrated at the watershed and landscape scales. Models will be developed to help manage and conserve water as it moves from the mountains and piedmont, through the coastal plains, and to the sea. Studies will focus on how the management of existing forests affects water quality and quantity, as well as how the restoration of bottomland hardwood forests, riparian forest on agricultural lands, and wetlands can help reestablish ecological functions and connections in the landscape. Efforts will be made to better couple the influences of rural and urban activities on water resources. The Forest Watershed Science Area will focus research on science related to four areas:

1. Changing Land Use
2. Changing Climate
3. Changing Biodiversity
4. Changing Markets

Partnerships: These four focus areas of research are broad, requiring an interdisciplinary approach to provide knowledge and technology for landowners, managers, and communities and to link the ecological science to social and economic science. Although the SRS has significant talent and resources to address these issues, 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 FS scientists and with researchers from other agencies, universities, private industries, and non-governmental organizations.

Scientists in the three RWUs in the FWS 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 Ecosystem Restoration and Management
-Threats to Forest Health
-Forest Values, Uses, and Policies
-Natural Resources Inventory and Monitoring

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 and State and Private Forestry. Working with these 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, the Southeastern Association of Fish and Wildlife Agencies, and the National Association of Conservation Districts 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. 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: Changing Land Use

The region is increasingly affected by the conversion of forests to other land uses. Moreover, large tracts of forests that were owned and managed by forest industry are being sold to timber management investment organizations. The impacts of these changes on water supply and quality and on aquatic ecosystems are unknown. Detrimental effects on numerous wildlife species have been documented. Understanding how the changing landscape of the southeastern U.S. will influence the quantity, quality and value of surface and groundwater will require expanded research in all physiographic regions in the southeastern US. While studies examining the impacts of forest practices (i.e., harvesting, roads, drainage, etc.) on water will continue to have value, the specific effects will need to be considered cumulatively, and in the context of large spatial scales and a rapidly urbanizing landscape. Building on this foundation, we can then begin to provide the information and technologies needed for the strategic use of forest restoration, riparian or otherwise, to mitigate water resource degradation created from shifting land uses.

a. Top Priority Research and Development Needs

- Continue and expand hydrologic research to quantify cumulative effects of mixed land uses on hydrologic processes and water quality within physiographic regions and develop models that link the hydrology across these regions.
- Understand how, where, and at what rate population pressures and consequent land use change will impact southern US water supplies and aquatic ecosystems.

- Understand key structural and functional attributes of riparian areas and how they should be managed to protect aquatic ecosystems.
- Quantify the effectiveness of efforts to create and restore riparian areas, forests, and wetlands on former agricultural land and within the context of the urban-rural land use mosaic.
- Continue to develop knowledge of regeneration biology, seedling quality, silviculture, and forest management across upland and lowland landscapes to insure sustained yields of a host of desired goods and services.
- Continue studying the bionomics of migratory forest-dwelling birds relative to changes in land use at varying scales.
- Incorporate buffer functions, especially riparian forest buffers, into watershed-scale hydrologic, water quality, and ecosystem models.
- Synthesize research from a diverse range of disciplines on the effects of tree-based buffers on ecosystem services and translate this knowledge into best management practices and tools for resource managers.

b. Key Barriers to Conducting Research and Implementing Results

- Our nation's water quality and quantity are determined by the many individual actions of the multitude of landowners and political entities that comprise the private landscape, making it extremely difficult to successfully implement watershed efforts that can satisfy landowner concerns and meet societal goals.
- Minimal Forest Service resources are allocated to the science of managing forests in mixed land-use and urban watersheds.

c. Role of Each Research Work Unit

SRS-4353

- Provide the science to effectively manage upland forest watersheds for a wide array of ecosystem services and understand their linkages with riparian, wetland, and associated aquatic ecosystems
- Provide the science required to minimize and mitigate impacts of disturbance on hydrologic processes within and across physiographic regions.

SRS-4155

- Provide the scientific basis to manage southern bottomland hardwood and wetland forests and associated stream ecosystems for a sustained yield of forest products and other desired values.

SRS-4352

- Provide the scientific knowledge and tools to effectively manage trees and forests in mixed land-use landscapes for providing, restoring and sustaining ecosystem services.

9.2 Focus Area: Changing Climate

Climate variability can be exhibited by direct changes in precipitation amounts and temperature averages, as well as by changes in the variability of temperature extremes and in the intervals between rain events. The frequency of extreme weather events, like hurricanes, and their severity, also varies. Water resources can be affected by air pollution, atmospheric deposition, shifts in forest tree species composition, increased wildfires, and episodic weather events. Conversely, alterations in water resources will directly and indirectly affect many plant and animal species.

a. Top Priority Research and Development Needs

- Continue and expand research on forest watershed responses to climate change and variability, atmospheric deposition, and other disturbances that alter carbon, nutrient, and water cycling processes and subsequently impact water quality and quantity.

- Determine thresholds or 'critical loads' for atmospheric deposition at which watersheds can not sustain water quality capable of supporting aquatic functions and processes.
- Determine how to manage forests to enhance resilience and resistance against extreme events and climate change.
- Determine interactions among land use patterns, multiple stressors (e.g., climatic variability, insect outbreaks), and critical loads.
- Document changes in aboveground and belowground carbon pools resulting from the afforestation of agricultural lands.
- Develop predictive capacity and management methods to deal with oak decline events incited by climatic extremes and human induced stresses.

b. Key Barriers to Conducting Research and Implementing Results

- Biomass/carbon estimates for forest stands are not applicable to the more open-grown agroforestry plantings, making it difficult to construct accounting and modeling tools for carbon sequestration and other greenhouse gases in these systems.
- Agroforestry and other "*Working Tree"* plantings are not explicitly inventoried by either of the two primary national resource inventories: FS Forest Inventory and Analysis (FIA) and NRCS National Resource Inventory (NRI), making it difficult to report and model the contributions of these systems to greenhouse gas mitigation.
- Interactive effects of land management and key environmental variables are poorly quantified.
- Growth and yield models for southern hardwoods are not available for most single-species plantations and mixed-species forest types.

c. Role of Each Research Work Unit

SRS-4353

- Conduct long-term research to develop the tools and technologies needed for the measurement, modeling, and reporting of carbon sequestration in upland and wetland forests.
- Conduct long-term research to determine the capacity of upland and wetland watersheds to store and cycle nutrients and chemicals, and buffer the impacts of chronic and extreme events.

SRS-4155

- Conduct the research and develop tools and technologies needed for the measurement, modeling, and reporting of carbon sequestration in afforested and natural bottomland hardwood forests.

SRS-4352

- Conduct the research and develop the tools and technologies needed for the measurement, modeling and reporting of carbon sequestration, and other GHG fluxes, in agroforestry plantings.

9.3 Focus Area: Changing Biodiversity

Shifts in climate, land use, and management have altered the biodiversity within our forested landscapes which in turn impacts the quality and quantity of services derived from them. Many non-native and/or invasive plant and animal species have been either intentionally or inadvertently introduced to the region. Although some of these species provide benefits, many have wrought unintended and undesirable consequences on forests, water resources, and aquatic life. Likewise, the loss of native species has impacted the quality and quantity of these services. Restoring forest-derived services from these lands necessitates understanding how native and non-native species influence ecosystem service delivery and developing tools and protocols for strategically managing biodiversity.

a. Top Priority Research and Development Needs

- Improve our understanding of the bionomics of rare and endangered plant and animal species within the context of multiple watersheds across the landscape.

- Continue and expand hydrologic research to quantify and predict impacts of losing species or functional groups and of non-native invasive species on ecohydrologic processes at the watershed scale.
- Continue developing methods to detect and control the non-native European woodwasp (*Sirex noctilio*) a pest that could alter the hydrology and productivity of Eastern conifer forests.
- Model alterations to the hydrology and productivity of oak forests should Sudden Oak Death, caused by the non-native pathogen *Phytophthora ramorum*, become established in Eastern hardwood forests.
- Develop practical management information on using native plants for restoration of ecosystem services within the forest/rural/urban landscape continuum.
- Develop technology products to facilitate the transfer of watershed science to tribal groups interested in improving riparian/wetland function.

b. Key Barriers to Conducting Research and Implementing Results

- Conducting research on nonnative species often involves challenges in coordinating ongoing efforts and defining roles and responsibilities with other federal and state agencies, some of which have regulatory responsibilities regarding the introduction, detection, and control of nonnative species.
- Testing actual impacts of nonnative species to native species and forests is difficult if not impossible to do because of quarantines, or is ill-advised from a biological standpoint, requiring novel approaches and the development of theoretical models.

c. Role of Each Research Work Unit

SRS-4353

- Develop a predictive understanding of the impacts of changing biodiversity on watershed ecosystem structure, function, and ecosystem services.
- Conduct long-term research on the environmental consequences of invasive species control strategies.
- Conduct long-term research on restoration strategies to mitigate the impacts of invasive species.

SRS-4155

- Develop techniques for collecting, propagating, and reestablishing native plants in and management guidelines for sustaining new and existing populations.
- Describe the bionomics of aquatic and terrestrial faunal species of concern to develop guidelines for managing species appropriately.
- Develop techniques to identify nonnative species of interest.
- Develop methods to control the spread of nonnative species of interest.
- Develop guidelines for managing forests affected by nonnative species for sustained yields of timber and non-timber resources.

SRS-4352

- Develop techniques for the collection, propagation and deployment of native plants for restoration and other uses.
- Transfer technology about nursery systems and native plants propagation to traditional and underserved portions (indigenous peoples) of the nursery industry nationally.

9.4 Focus Area: Changing Markets

Although forested watersheds and trees provide valued services to society, those on private lands must also meet landowner objectives if forests are to be sustained. Emerging ecosystem service markets, such as carbon and water quality credits, if properly coupled to actions on the lands, could protect and enhance watershed services to society while generating additional income for landowners. A number of other emerging markets, from biofuels to non-timber forest products

(NTFPs), can also help generate additional income. Understanding the potential impacts of these markets on forest-derived services and how markets can be better developed and coupled with these broader ecosystem service goals will be key. For instance, in the production of short-rotation woody crops for bioenergy, it will be important to calibrate biomass production levels with the need to protect and sustain water resources. As NTFPs become increasingly recognized as alternative sources of income for forest landowners, impacts regarding sustainable management of native plants in forests, as well as production and harvesting protocols for deliberate cultivation will need to be understood. Research on agroforestry land management alternatives, such as pine silvopasture, can help landowners improve their profitability, while protecting the environment.

a. Top Priority Research and Development Needs

- Provide sound science and accounting and monitoring methods to inform developing carbon sequestration and water quality credit markets.
- Develop floristically sound silvicultural techniques to optimize economic and ecological values for multiple markets, including wood and fiber production, conservation easements, carbon sequestration, and bioenergy.
- Understand the socio-economic market dynamics of NTFPs that affect landowner decisions and develop methods to monitor and track their market conditions.
- Conduct economic assessments of potential agroforestry systems to improve water quality and wildlife habitat in the LMAV.
- Develop propagation methods to enhance establishment of native plants that can be utilized in the NTFP industry.
- Develop pine silvopasture systems for landowners to blend timber production and livestock production in sustainable practices on the same land.

b. Key Barriers to Conducting Research and Implementing Results

- Lack of silvicultural practices that integrate timber and non-timber objectives
- A thorough understanding of the impact that timber harvesting has on non-timber production
- A lack of methods to systematically track and monitor NTFP markets
- Production and consumption functions for non-timber forest products
- Basic economic analysis of NTFP opportunities for landowners
- Limited funding for the needed research and development
- A lack of understanding among decision makers of the economic and social value of non-timber forest products to local and regional economies

c. Role of Each Research Work Unit

SRS-4353

- Develop models, tools, and technologies to evaluate tradeoffs and optimize benefits of alternative land uses on wood, biofuels, water, wildlife, and other ecosystem services in upland and wetland forests.

SRS-4155

- Develop appropriate growth and yield models, silvicultural prescriptions, and monitoring techniques to facilitate stakeholder use of non-timber products in natural and afforested bottomland hardwood systems.
- Develop useful hydrologic models so that landowners and managers can make wise stewardship decisions in managing water quantity and quality and take advantage of any developments in nutrient credit markets.

- Develop combined hydrological and silvicultural resource analyses and models so that landowners and managers can make wise decisions about growing and harvesting biomass for biofuels in economically and ecologically sustainable ways.

SRS-4352

- Facilitate research and technology transfer in the area of non-timber forest products
- Serve as a conduit for the transfer of knowledge to private landowners and forest managers to improve forest management and realization of opportunities.
- Undertake basic and strategic research to improve the understanding of the importance of non-timber forest resources and their markets.

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.

Appendix A:

Relationship of Forest Watershed Science Focus Areas to Forest Service Strategic Objectives and to Forest Service Research & Development Strategic Program Areas
(*numbers in parentheses refer to FWS Focus Areas*)

Forest Watershed Science Focus Areas:

1. Changing Land Use
2. Changing Climate
3. Changing Biodiversity
4. Changing Markets

Relationship to Forest Service Strategic Objectives

1.1 Reduce the risk to communities and natural resources from wildfire. (2, 4)
1.2 Suppress wildfires efficiently and effectively. (-)
1.3 Build community capacity to suppress and reduce losses from wildfires. (-)
1.4 Reduce adverse impacts from invasive and native species, pests, and diseases. (2, 3, 4)
1.5 Restore and maintain healthy watersheds and diverse habitats. (1, 2, 3, 4)
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. (2, 3)
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 Help meet energy resource needs. (2, 4)
2.4 Promote market-based conservation and stewardship of ecosystem services. (1, 4)
3.1 Protect forests and grasslands from conversion to other uses. (1, 4)
3.2 Help private landowners and communities maintain and manage their land as sustainable forests and grasslands. (1, 2, 3, 4)
4.1 Improve the quality and availability of outdoor recreation experiences. (4)
4.2 Secure legal entry to national forest lands and waters. (-)
4.3 Improve the management of off-highway vehicle use. (-)
5.1 Improve accountability through effective strategic and land-management planning and efficient use of data and technology in resource management. (1, 2)
5.2 Improve the administration of national forest lands and facilities in support of the agency's mission. (2, 3)
6.1 Promote conservation education to increase environmental literacy through partnerships with groups that benefit and educate urban populations. (1, 2)
6.2 Improve management of urban and community forests to provide a wide range of public benefits. (1, 2)
7.1 Increase the use of applications and tools developed by Forest Service R&D stations and the T&D centers. (1, 2, 3,4)

Relationship to Forest Service Research & Development Strategic Program Areas

Wildland Fire (2,4)
Invasive Species (2,3,4)
Wildlife and Fish (1,2,3,4)
Air and Water (1,2,3,4)
Resource Management and Use (1,2,3,4)
Recreation (4)

Appendix B: Research Work Unit Descriptions

SRS-4353 – Center for Forest Watershed Research
Otto, NC; Blacksburg, VA; Charleston and New Ellenton, SC
Project Leader: James M. Vose

Mission: To evaluate, explain, and predict how water, soil, forest, and aquatic resources respond to ecosystem management practices, natural disturbances, and the atmospheric environment; and to identify practices that restore, protect, and enhance watershed health.

Problem 1. To develop a fundamental understanding of the structure, function, and interactions among terrestrial, riparian, and aquatic components of forested upland and wetland watersheds.

Watershed health is a critical issue facing land managers in the southeastern U.S. Changes in historical and contemporary disturbance regimes, invasive species, climatic extremes, and human population growth and resultant land use change are putting considerable stresses on upland, wetland, and aquatic ecosystems from the mountains to the coast. Fundamental knowledge on ecosystem structure and function will be required to restore, enhance, or maintain healthy watersheds across the southeastern landscape.

Problem 1a. Understanding biotic and abiotic ecosystem processes.
The unit will develop a detailed understanding of biotic and abiotic ecosystem processes in upland and wetland forest watersheds and their interaction with silvicultural practices.

Problem 1b. Landscape level analyses.
The unit will develop landscape level analyses techniques that incorporate new approaches in modeling, scaling, and uncertainty analyses to incorporate science, land use, policy options, and regulations into assessments of landscape function and productivity, and to design landscapes to accomplish specific functions and deliver specific outputs.

Problem 1c. Fish distribution, abundance, and resilience.
The unit will determine how the distribution, abundance, and resilience of fish and other aquatic organisms in the southern Appalachians are influenced by natural and human factors.

Problem 2. To develop knowledge, methods and guidelines to evaluate the effects of natural resource management on forested upland and wetland watersheds.

The magnitude and diversity of human needs and expectations from southeastern ecosystems have increased sharply in recent years and are expected to accelerate even more in the future. As forest management activities intensify and diversify to include restoration of watershed health, there is a critical need to evaluate the ecological consequences of alternative practices from an ecosystem perspective and at large spatial scales.

Problem 2a. Sustain and restore aquatic communities.
The unit will develop and test techniques to sustain and restore aquatic communities and the aquatic and streamside habitats on which they depend.

Problem 2b. Ecosystem restoration and health.
The unit will develop new or improved technologies, reference system models, and reliable indictors of restoration success and ecosystem health for forested upland, wetland, and riparian ecosystems.

Problem 2c. Linkage between ecohyhydological processes and management practices.
The unit will develop a detailed understanding of the functional linkages between ecohydrological processes in forested upland and wetland landscapes and management practices required for water quality improvement, quantity control, and productivity.

Problem 3. Long-term hydrologic and ecological research on forested upland and wetland watersheds.

Problem 3a. There is a continuous need for long-term data collection, maintenance, and analyses.
The unit will continue long-term monitoring of gauged watersheds, climate stations, permanent plots, and experiments. Studies will continue on both high and low gradient hydrologic systems. These data provide the cornerstone of the Center for Forest Watershed Research program and underpin the RWU's mission.

Environmental considerations: Proposed research activities under each of the problem areas outlined in this Research Work Unit Description are 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. 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 District or Forest staffs.

Key Partners:

University of Georgia
University of Minnesota
University of New Hampshire
University of North Carolina-Chapel Hill
University of North Carolina-Asheville
Duke University
College of Charleston
Clemson University
Virginia Tech
Furman University
Western Carolina University
North Carolina State University
US Environmental Protection Agency
USDA Forest Service, National Forests in NC, GA, TN, VA, SC
National Science Foundation
USDA Natural Resources Conservation Service
Jones Ecological Research Center
The Nature Conservancy
Oak Ridge National Laboratory
Southern Group of State Foresters
USDA Forest Service, State & Private Forestry

SRS-4155 Center for Bottomland Hardwoods Research
Stoneville, Oxford and Starkville, MS; Hot Springs, AR
Project Leader: Theodor D. Leininger

Mission: To provide the scientific basis to manage southern bottomland hardwood and wetland forests and associated stream ecosystems for a sustained yield of forest products and other desired values.

Problem 1. Regeneration and restoration biology
Bottomland hardwood forests supply critical benefits that are fundamental to ecosystem health at multiple scales and they can protect freshwater resources and habitat for terrestrial and aquatic fauna of national and international significance. Information on hardwood seeds, seedling quality and stand regeneration and restoration methods can insure sustained yields of desired goods and services sought from forested landscapes.

Problem 1a. Scientifically sound regeneration treatments are needed.
Unit will develop methods to predict the effects of regeneration treatments on species composition and stand structure, with emphasis on oaks.

Problem 1b. Seed storage physiology of key hardwood species is poorly understood.
Unit will study the physiology of recalcitrant or desiccation-sensitive hardwood seeds to improve storage methods.

Problem 1c. Reproductive biology and germination requirements are lacking.
Unit will study relationships between flower and seed production and quality in key bottomland hardwood species.

Problem 2. Stand management and forest health
The utilization and value of hardwoods in the southeast continue to increase along with national and international demand for hardwood lumber and pulpwood. Forest managers need improved silvicultural systems and better information on growth and yield, stand development, and the management of insect and disease problems to provide sustained yields of multiple-use benefits from bottomland forests.

Problem 2a. Effective silvicultural guidelines and quantitative tools are needed.
Unit will develop tools to predict stand growth and development to manage bottomland hardwood and wetlands forests for sustainable yields of forest products.

Problem 2b. Impacts of insects and diseases on bottomland forests need improvement.
Unit will develop management guidelines for healthy bottomland hardwood and wetland forests will be improved by the unit's production of knowledge about insect and disease problems.

Problem 3. Ecology of aquatic and terrestrial fauna
Streams and associated riparian ecosystems of the southeastern United States provide important habitats for the most diverse terrestrial and aquatic fauna on the continent. Forested watersheds in the region often serve as the last refugia for many sensitive species of birds, non-game fishes, mussels, crayfishes and other riparian-dependent wildlife. It is important that research approaches to management of forest ecosystems treat these non-game animals, whether aquatic or terrestrial, as integral components and critical ecological benefits of the management process.

Problem 3a. Sampling and monitoring techniques for aquatic and terrestrial fauna are needed.
Unit will develop methods for sampling and monitoring at a variety of spatial and temporal scales to enable the monitoring of trends of abundance and distribution for various organisms of interest.

Problem 3b. Factors affecting community ecology and diversity are poorly understood.
Unit will develop information on the effects of landscape-scale processes, local processes, and historical events, including biotic and abiotic factors, on the distribution, abundance, and ecology of aquatic and terrestrial organisms.

Problem 3c. Population biology issues for management and conservation need clarification.
Unit will study population dynamics, including recruitment, mortality, migration/immigration, and population growth rates, to provide better predictions and evaluations of the long-term influence of land management activities and nonnative species invasions on aquatic and terrestrial species.

Problem 3d. Life histories, distributions, and autecology of some organisms are poorly defined
Unit will study life histories and distributions of poorly studied species in the southeastern U.S. to provide the ability to evaluate possible responses of these species to land-use activities and nonnative species invasions.

Problem 3e. Aquatic-terrestrial linkages need to be better understood to improve management.
Unit will study aquatic-terrestrial linkages that occur at the interface between land management and aquatic ecosystems in forested wetlands and bottomland streams.

Problem 4. Ecological processes and restoration
At the landscape scale regional hydrologic cycles and floodplains are influenced by the ways in which upland, bottomland ,and wetland forests are managed and/or restored. .A quantitative understanding of the dominant physical, chemical, and biological processes that define specific upland, bottomland, and wetland forest types is needed to facilitate efforts to manage these ecosystems, as well as to restore them on lands that were converted to agriculture. Techniques are needed for restoring mixed species stands, including understory and midstory species; for establishing and maintaining populations of rare and endangered flora and fauna; and for restoring riparian and aquatic communities lost when river systems were modified.

Problem 4a. Ecological processes in bottomland hardwood forests are poorly understood.
Unit will study biological productivity and nutrient cycling processes within bottomland hardwood systems are and their linkages with adjacent upland or aquatic systems. The potential storage of carbon in biotic and abiotic components of wetland ecosystems is potentially large and will be studied for the benefit of conservation programs.

Problem 4b. Effective management practices for bottomland hardwood forest ecosystems are needed
Unit will study effects of management practices on bottomland hardwood forest systems to provide managers with techniques to manage forests, and associated aquatic ecosystems, in ways that will sustain these systems.

Problem 4c. Techniques for restoration of bottomland hardwood systems are needed.
Unit will continue developing techniques to restore bottomland hardwood forests on abandoned agricultural fields and examine economically viable ways of restoring lands that have been heavily degraded including alternative forest restoration methods such as the use of nurse crops.

Problem 4d. Improved understanding of bottomland hardwood and wetland forest hydrology is needed.
Unit will provide managers, private forest landowners, and investors with a better understanding of the regional water balance and how hydrologic processes affect afforestation in the Lower Mississippi River Alluvial Valley.

Problem 4e. Improve the understanding of upland hydrologic processes and linkages to lowland forests.
Unit will study hydrologic processes associated with upland forests and their management and improve the understanding at the landscape scale of the hydrologic linkages between upland and bottomland forests.

Environmental consideration: Most of the proposed research activities to be conducted under each of the problem areas outlined in this Research Work Unit Description are 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 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 Partners:

USDOI Fish and Wildlife Service
USDA Natural Resources Conservation Service
USDOD Army Corps of Engineers
Southern Hardwood Forest Research Group
The Nature Conservancy
Mississippi Forestry Commission
Mississippi State University
Mississippi Department of Wildlife, Fisheries and Parks

SRS-4352 – National Agroforestry Center – Research
Huntsville, AL; Lincoln, NE; Blacksburg, VA; Moscow, ID
Project Leader: Michele M. Schoeneberger

Mission: To provide the scientific knowledge and tools required to effectively manage trees and forests in mixed land-use landscapes for providing, restoring, and sustaining ecosystem services nationally.

Problem 1: Ecological Services in Mixed Land-Use Landscapes
Trees and forests provide an array of critical ecosystem services in mixed land-use landscapes, like clean water, soil conservation, wildlife habitat, and renewable energy. However, trees and forests must be integrated on agricultural lands, and in urban areas in ways that complement these other land uses to achieve adoption by landowners and must be strategically arranged, designed, and managed within larger landscapes in to realize environmental benefits.

Problem 1a - Develop scientific knowledge and tools to support site design of agroforestry systems.
Unit will conduct studies on the ecological functions and values of tree-based practices in mixed land-use settings and develop tools that enable creation of designs that efficiently produce ecological benefits.

Problem 1b – Develop scientific knowledge and tools for strategic placement and management at landscape scale.
Unit will conduct studies of landscape-scale ecological relationships between tree-based practices and other land uses and develop tools that enable proper juxtapositions of trees and forest in mixed landscapes that augment the ecological services that they provide.

Problem 1c - Develop knowledge of factors that influence the adoption of agroforestry practices.
Unit will conduct research on the use of visual simulations, economic models, and other communication tools that can foster adoption of tree-based practices in order to modify communication tools for promoting implementation.

Problem 2: Sustainable Management of Non-Timber Forest Products
The knowledge needed to understand the ecologic, economic, or social impacts of sustainably collecting and trading non-timber forest products (NTFP) is lacking. This hinders the United States's efforts to adhere to the requirements of international agreements on NTF resources. Likewise, landowners interested in alternative income opportunities, lack the knowledge needed to sustainable harvest or profitably cultivate forest botanicals and other NTFPs.

Problem 2a. – The amount of NTFPs and their potential contribution to local and regional economies is lacking.
Unit will develop methods to collect and validate non-timber production output

Problem 2b. – Sustainable harvest levels for most NTFPs have not been established.
Unit will develop and test methods and protocols to establish sustainable harvest practices.

Problem 2c. – The information needed to successfully cultivate forest botanicals and other NTFPs is lacking.
Unit will investigate interactions methods to better integrate non-timber forest products into forest farming to provide cultivation protocol and improve landowner opportunities.

Problem 3: Alternative Forest Management Options for Landowners
The pulpwood market in the southeastern U.S. has weakened making it difficult for pine plantation owners to generate a profit or even pay for the cost of a mid-rotation thinning. If left unthinned, the plantation stagnates; producing a stand that poses a high risk for wildfire and insect damage, and it fails to realize its potential to produce quality sawtimber. Agroforestry practices, such as silvopasture and alley cropping, are alternative forest management options for landowners who desire both annual and long-term income generation from their lands.

Problem 3a. The economics and management of pine silvopasture systems need further research.
Unit will determine system guidelines for the production of southern pine sawtimber in combination with the production of understory forage and browse needed to profitably graze livestock.

Problem 4. Nursery and Reforestation Technologies for Native Plants Propagation
There is an increasing demand for tree and plant materials for reforestation and conservation programs. Very little is known about their propagation of most native plant species. Production protocols must also take into account

environmental concerns regarding nursery operations, necessitating the formulation of new water and nutrient management guidelines. Further, most disease problems in nurseries are associated with poor water management practices. As a component of the intra-deputy area Reforestation, Nurseries and Genetics Resources (RNGR) team, this Problem Area addresses the need to provide nurseries, on regional and national scales, information about producing commercial and non-commercial species of importance for ecosystem restoration, function, and health.

Problem 4a. – Information is lacking on how to produce native plants required for ecosystem restoration.
Unit will develop techniques for the collection, propagation, and deployment of native plants for restoration.

Problem 4b. – Fusarium root disease is a major pest in western conservation nurseries.
Unit will investigate potential biological controls for Fusarium root disease.

Problem 4c. – Science synthesis is needed to improve nursery efficiency.
Unit will transfer technology about nursery systems and plant propagation to traditional and underserved portions (indigenous peoples) of the nursery industry.

Problem 4d. –Plant and water relationships during nursery production are poorly understood.
Unit will investigate nursery—plant water interactions and effects on seedling quality and outplanting performance.

Problem M1: USDA National Agroforestry Center (NAC)

The NAC is a formal partnership between US Forest Service Research & Development and State & Private Forestry and the USDA Natural Resources Conservation Service. In addition to the research program of RWU SRS-4352, this national Center has a strong technology transfer mandate. It develops and delivers technology on a broad suite of agroforestry practices, like alley cropping, forest farming, riparian forest buffers, silvopasture, and windbreaks. The Center gathers and packages research into technology transfer products that include field demonstrations, training workshops, a quarterly newsletter, technology notes, computer software, videos, brochures, and displays. Another component of NAC is the Forest Service National Reforestation, Nurseries, and Genetics Resources (RNGR) Team's unit for Nursery and Reforestation Technologies located in Moscow, ID. In addition to its research as described under Problem 4, RNGR delivers technology, and tools to enhance nursery production and increase the survival of trees and other native plants used in ecosystem restoration projects nationally.

Environmental considerations: Proposed research activities under each of the problem areas outlined in this Research Work Unit Description are 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. 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 District or Forest staffs.

Key Partners:

USDA Natural Resources Conservation Service
USDA Agricultural Research Service – National Soil Tilth Lab
USDA Global Change Program
Virginia Landcare
Intertribal Nursery Council
University of Nebraska / University of Missouri / Purdue University / University of Idaho
University of Georgia / University of Minnesota/Virginia Polytechnic Institute and State University, Alabama A&T University, North Carolina A&T University, Alabama A&T University
1890 Agroforestry Consortium
The Nature Conservancy
National Association of Regional Councils
National Association of Conservation Districts
National Association of State Foresters
IUFRO-5.11-Non-wood Forest Product