USDA - Forest Service

| **SOUTHERN RESEARCH STATION SCIENCE AREA CHARTER** | 1. Title<br>**Threats to Forest Health** |
|---|---|

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

SRS-4156 Center for Forest Disturbance Science – Athens, GA; Clemson, SC

SRS-4552 Insects, Diseases, and Invasive Plants – Pineville, LA; Athens, GA; Starkville, MS; Auburn, AL.

SRS-4854 – Eastern Forest Environmental Threat Assessment Center, Asheville, NC; Research Triangle Park, NC; Raleigh, NC

3. Science Area Leader

Bruce L. Jewell, Assistant Station Director for Research, Asheville, NC

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

6. Mission

The mission of the Threats to Forest Health Science Area is to generate, integrate, and apply knowledge to predict, detect, assess, and prevent environmental threats to public and private forests of the eastern United States, to develop silvicultural treatments to reduce the vulnerability of forests to threats and to mitigate impacts, and to deliver this knowledge to managers in ways that are timely, useful, and user friendly.

| Signature | Title | Date |
|---|---|---|
| Prepared By: | BRUCE L. JEWELL<br>Assistant Station Director, Research | |
| Recommended: | CARLOS RODRIGUEZ-FRANCO<br>Staff Director, Forest Management Sciences | |
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| Concurred: | ANN M. BARTUSKA<br>Deputy Chief for Research & Development | |

## 7. Description

Forests of the eastern United States are subject to a wide variety of environmental stressors and disturbances such as insects, diseases, invasive species, drought, wildfire, hurricanes, tornadoes, ice storms, as well as development and fragmentation. A stressor is any of a variety of actors (e.g., herbivory, flooding, low/high temperature, moisture, etc.) which, at certain levels cause stress to organisms. Stress is the resulting effect of a biotic or abiotic agent to which an agent is adapted (more or less). A disturbance is any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment. Thus a disturbance event exceeds the stressor threshold because of its intensity, frequency, or spatial or temporal scale. Even then, organisms may be adapted to a level of disturbance but when another threshold is exceeded, a severe disturbance may result in degradation.

Sometimes these threats (stress, disturbance, degradation) occur individually, but more often they come in combination. The resulting effects can be severe and cause significant, lasting impact on ecological and socioeconomic values. Our current ability to predict, detect, assess, and respond to these environmental threats is piecemeal. There is a need to integrate how we deal with interacting, multiple threats, so land managers may anticipate disturbances and act to prevent or lessen the effects, or restore either the structure or the function (as appropriate) of affected ecosystems.

The Threats Science Area is comprised of three research work units with active programs in fire science, disturbance ecology, air quality, and restoration (RWU 4156), insects, diseases, and invasive plants (RWU 4552), and integrated assessment of environmental threats including global change and fragmentation (RWU-4851).

## 8. Goal

The goal of the Threats Science Area is to support effective policy for and management of potential and existing environmental threats to eastern forests with the desired outcomes of:

- reduced likelihood of uncharacteristic disturbances through better informed management strategies;
- amelioration of the effects of disturbances on the multiple values associated with forests;
- improved tracking of changes in hazard, risk, and consequences of disturbances over time and space; and
- improved decision-support tools for prioritizing management options.

## 9. Focus Areas

The Threats Science Area will initially focus on five areas:

9.1 – Impacts of severe weather events on forest ecosystems.

9.2 – Urbanization, fragmentation, and parcelization of forest lands and the associated impacts.

9.3 – Invasive species (all taxa) and outbreaks of native species beyond their normal geographical ranges or historical ranges of behavior.

9.4 – Effects of global climate change and climate variability on eastern forests, including severe drought.

9.5 – Wildland fire and its impacts.

The relationships of these Focus Areas to the Forest Service's strategic plan, and to Research and Development's Strategic Program Areas are discussed in Appendix A.

### 9.1 – Impacts of Severe Weather Events on Forest Ecosystems

The impacts of stochastic severe weather events may play a greater role in the widespread shaping of forests of the southern United States than has been previously accepted. The impacts of tornadoes, high winds, and ice have been recognized as local or sub-regional influences. Hurricanes have been recognized as widespread influences along the coasts and inland to a certain extent. What may be missing from a more complete picture of these impacts may be the geographic extent of these influences, especially when viewed over time. Hurricane Katrina in 2005 strongly influenced forests over Louisiana and Mississippi. When combined with the effects of Hurricane Rita, these effects were extended to eastern Texas. Hurricanes Jeanne and Ivan influenced forests in Alabama, Georgia, and even into the southern Appalachians in 2004. Other hurricanes that year, affected forest lands in the Florida peninsula. Between 1989 and the present, numerous hurricanes have affected the forests of the Carolinas and Virginia. When hurricane paths over the last 100 years are plotted, few areas of the deep and middle south have been untouched.

A similar picture exists for the hundreds of tornadoes that have struck the southern United States over the last 50 years. Ice storms are fewer in number, but greater in their geographic extent. Straightline winds – with or without thunderstorm activity – can affect large areas. A wind event in east Texas in 1998, for example, heavily damaged more than 100,000 acres.

What is the full geographic extent of these impacts and what is their nature? How long do these effects persist? Will global climate change alter the frequency and intensity of

these events and will it change managers' options for restoring ecosystem structure or function afterward?

a. Top Priority Research and Development Needs

Development of vulnerability risk maps
Understanding mechanisms that result in vulnerability and damage resistance.
Development of tree and stand prediction models based on wind fields.
Development of options for restoring ecosystem function or structure.

b. Key Barriers

Lack of knowledge of stand conditions that make forests resistant to severe weather damage.
Lack of precise rapid assessment tools.
Lack of knowledge about interactions among weather events and subsequent effects on/ interactions with invasive species.
Inadequate baseline information of pre-disturbance conditions

c. Role of each Research Work Unit

SRS-4156: Application of disturbance ecology, meteorology, physical modeling, and expertise in post-event fuel loading and ecosystem restoration analysis.

SRS-4552: Expertise in analyzing and predicting native insect, and invasive species response to severe weather events, also application of knowledge of wood-colonizing insects to questions of woody debris decomposition.

SRS-4854: Expertise in overall threat assessment, remote sensing technology, modeling, global climate change prediction, and other forest health monitoring techniques.

d. Key Forest Service Linkages

Forest Inventory and Analysis
Region 8 (FHP, Fire & Aviation, Resource Management, *et a.l*)
SRS FERM, Watershed, and Forest Values and Use Units
Eastern Area Modeling Center, Northern Research Station
Wood Quality Research Team

**9.2 Urbanization, Fragmentation, and Parcelization of Forest Lands and the Associated Impacts.**

In 2002 the *Southern Forest Resource Assessment* found the greatest threat to southern forests was the region's rapidly expanding human population. Frequently this is referred to as urbanization, but this general term masks a phenomenon that is more complicated. It includes not only the growth (both population and physical footprint) of the South's

major cities, but also the expansion of many small cities and towns, and rural populations. The phenomenon manifests itself as conversion of one land use to another (with varying degrees of change to forest cover), the interspersion of dwellings and businesses with forest lands (the Wildland-Urban Interface), the fragmentation of forests and habitats, and the division of forest ownerships into ever-smaller parcels.

Understanding of this phenomenon has grown in recent years, but it is still emerging. It includes many natural resource aspects – wildlife habitat, hydrology (including water quality and quantity, fuels management, invasive plant species, insects and diseases, and timber production. It also includes numerous social/legal implications, such as loss of recreation opportunity, esthetic impacts, local zoning regulations, taxation, and building codes. The interplay among these factors has not been completely understood, and how these factors might be affected by climate change has not been analyzed.

a. Top priority research and development needs

Knowledge of the economic, policy, and landscape factors that drive and shape urbanization, fragmentation, and parcelization.
Knowledge of the interactions of land use changes and natural processes.
Impacts of land use changes on fire, insects, diseases, and invasive species
Dynamic decision support tools that display values at risk in the wildland-urban interface

b. Key Barriers

Lack of agreement among stakeholders
Lack of control of land ownership
Lack of public understanding
Conflicting management objectives among government entities
Financial constraints on government agencies
Litigation and public backlash to management
Limited understanding of conservation biology of fragmented landscape
Lack of understanding relationships between patterns and processes
Limited understanding of edge effects

c. Role of each Research Work Unit

SRS-4156 – Application of fuels management and smoke management technology, as well as research on restoration of ecosystem function in urban or fragmented landscape.

SRS-4552 – Application of knowledge about insect and disease issues and the effects of landscape fragmentation on them. Also, application of knowledge of termites and other wood destroying insects on homes and structures in wildland-urban settings.

SRS-4854 – Development of knowledge and its application to the phenomena of urbanization, fragmentation, and parcelization. Understanding the forces that drive these phenomena and the factors that shape their patterns. Analysis of the interaction of urbanization and other threats to forest health.

d. Key Forest Service Linkages

Forest Inventory and Analysis
Forest Economics and Policy
Forest Watershed Science
Urban and Social Influences (especially the WUI Center)
All SRS FERM Units
Forest Health Protection

**9.3 Invasive and Native Species: Effects on Forest/Urban Ecosystems**

Invasive species and native insects and diseases continue to play a key role in shaping the southern forest resource.

The first invasive species undoubtedly arrived with European settlement 400 years ago. Many species have become so familiar that the public no longer recognizes their exotic and invasive behavior (Japanese honeysuckle and starlings, for example). However, the tempo of new introductions has increased over the last several decades with the rise of global trade. The South, with its variety of climates and growing conditions, provides fertile ground for these newcomers. Across all taxa, a growing number of non-native species now call the South home. Many of these are invasive in nature.

Many of these new species are harmful to existing ecosystems. However, some of the most destructive pests in southern forests are natives. Southern Pine Beetle (SPB) for example is the most damaging insect in southern forests. Subterranean termites are still a significant factor in wood preservation and inflict large economic losses on home owners each year.

For native pests and non-native invasives alike, human activity plays a large role in shaping how people and ecosystems are affected. Global trade is the primary route of species introduction. Domestic trade and travel often help move species throughout the nation. Silvicultural and agricultural practices have strongly influenced how native pests behave. Severe weather events and global climate change will probably affect how natives and non-natives act in the future.

Preventing introductions, choosing which species to battle, mitigating impacts, restoring native systems, and managing new ecosystems are all issues that need to be addressed by research.

a. Top priority research and development needs

Systematic approach for prioritizing threats
Enhanced detection and monitoring
Better understanding of introduction and spread pathways
Survey of potential invasive (and biological control) species in other countries
Interaction of known threats with global climate change
Prevention, detection, eradication, management, and restoration methods for high priority threats and pests moving along high priority spread pathways.

b. Key Barriers

Too many species for the resources available
Need for strategic approach across all governmental levels
Lack of data to support risk assessment
Lack of engagement of managers, policymakers, and the public
Human influences on issue are poorly understood.
Techniques for control and introduction prevention tend to be species specific.
Inadequacy of detection and monitoring technology
Lack of economic impact data critical to decision making.

c. Role of each Research Work Unit

SRS-4156 – Role of fire in spread of invasive species. Restoration of disturbed areas. Role of exotic earthworms in disturbing ecological processes such as nutrient cycling

SRS-4552 – Overall coordination and continued research on a wide variety of insects, diseases, and invasive plants, with emphasis on SPB and termites. This RWU serves as the primary coordinator on biology and ecology of specific species and provides expertise to other units engaged in other aspects of ID & P research.

SRS-4854 – Primary expertise in threat assessment, pathway analysis, detection technology, modeling, and impacts of global climate change.

d. Key Forest Service Linkages

All FERM Units
Forest Economics and Policy
Urban and Social Influences
Bottomland Hardwoods (especially on *Sirex noctilio*)

**9.4 Global Climate Change**

The evidence for global climate change and climate variability continues to accumulate, but the impacts and the practical implications for managers and policy makers in the South are not well defined. The extent and rate of change within the region need to be better refined, especially in light of intervening climate variability from other sources.

A large amount of the scientific knowledge gathered over the last eight decades will be affected by climate change. Nearly all of the Station's research portfolio will be engaged in climate-related work over the next several years. The impacts on growth and yield need to be evaluated. The effects on fuel loading and fire behavior will need to be quantified. Climate change may have significant impacts on water availability, invasive species, native pest behavior, wildlife habitat, and recreation availability. Changes in pest behavior will affect the ability of other forest species to withstand the stress of changing climate. It has the potential to alter the economics of forest land ownership ultimately affecting the pattern of land use across the entire region.

What ecosystems will change? What ecosystems might disappear? What new ecosystems might emerge, and how will non-native species figure into these?

a. Top Priority Research and Development

Development of more specific models and their supporting data
Application of model predictions to various other science questions
such as fire, insect responses, invasive plants, etc.

b. Key Barriers

Complexity and costs of research
Accuracy of models
Political and social support
Knowledge of systems and rates of change
Potential for duplication and competition with other agencies
Ability to prioritize resources

c. Role of the Research Work Units

SRS-4156 – Provision of supercomputing resources to modeling, and research on the impacts of global climate change or prolonged drought on fuel loading, fire behavior, and smoke management. Linking Global Climate Models with regional-scale climate models to improve spatial resolution of climate change predictions. Also, research on restoration of ecosystem functions in areas disturbed due to the effects of climate change.

SRS-4552 – Responses of native and non-native insects, invasive plants, diseases to the effects of global climate change and management options to reduce negative impacts.

SRS-4854 – Overall management of the global climate change program, including model development, research prioritization, threat assessment, and other related research.

d. Key Forest Service Linkages

Forest Watershed Science
Bottomland Hardwoods
Forest Economics and Policy
All FERM Units
Forest Inventory and Analysis

**9.5 Wildland Fire (including wildfire, prescribed fire, and non-fire surrogates for fuel reduction)**

Fire and its later exclusion have been key elements in the development of the South's forests. Many of the South's ecosystems are fire dependent or fire influenced. The exclusion of fire played a role in the re-establishment of forests in the region in the 1920s, but it has in later years led to conditions that discriminate against some kinds of ecosystems that were traditionally present across the region – such as longleaf pine.

Fire exclusion can also lead to the build up of hazardous fuels in fairly short time periods that threaten public safety and economic investments on public and private lands. Wildfires burn hundreds of thousands of acres annually in the region. Because of the population growth since World War II and homeowner preferences for wooded settings, the threat to communities has significantly increased.

Aggressive suppression action by local, state, and federal fire fighting agencies is supported by an active program of fuels management based largely on prescribed fire. On the national forests alone (approximately 13 million acres) managers use prescribed fires on approximately one million acres per year. Throughout the South, on average 6 million acres are burned annually by prescription. Forest managers would prefer to burn more acres, but the window of acceptable burning conditions is limiting.

Research on wildfire and prescribed fire is well-established in the South and is well balanced across all the portfolios contained in the Forest Service's strategic plan for fire. The program includes active smoke modeling research, research on the ecological aspects of fire, the economics of fire and fuels management, and fire as it relates to the wildland-urban interface. The program also looks at fire as it relates to invasive species and to the potential for altered fire regimes as a result of global climate change.

a. Top Priority Research and Development

Fire behavior and fuel models for the South linked to emissions
Effects of invasives on fire behavior

Improved smoke modeling to predict emissions transport and plume interactions from multiple burns
Improved models for regional air quality models that realistically incorporate smoke
Non-fire surrogates for fuel reduction and management, particularly in the wildland-urban interface
Effects of fire and fire management on spread of invasives
Coupled fire atmospheric model linked to global climate models to predict effects of global climate change on fire regimes in the South
Improved understanding of the economic aspects of fire and fuels management
Improved understanding of the impact of local government policies on fire risk in the wildland-urban interface

b. Key Barriers

Complexity and costs of research
Accuracy of models and need for validation data
Political and social support for prescribed burning and smoke management
Need for strategic approach to hazardous fuels management across all governmental levels

c. Roles of the Research Work Units

SRS-4156 – Overall coordination of fire related research as it relates to fire and fuels management. Smoke modeling expertise. Expertise on the ecological effects of wild and prescribed fire. Expertise in the restoration of ecosystem functions following wildfire. Application of supercomputing resources to fire and related research, particularly linkage to global climate models.

SRS-4552 – Expertise on the relationship of fire and invasive plant species; fire effects on trees and susceptibility to insects and disease, and the potential for insect and disease outbreak following major fire events.

SRS-4854 – Coordination of fire-related research with global climate change research, including the linkage of fire and smoke models to global climate models.

d. Key Forest Service Linkages

Upland Hardwood Ecology
Longleaf Pine Ecosystems
Southern Pine Ecology
Forest Operations
Forest Policy and Economics
Forest Watershed Science
Wildland-Urban Interface Center
National Agroforestry Center

Forest Inventory and Analysis
FCAMMS
International Programs

## 10. Environmental Considerations

Proposed research activities in this science area 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, 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 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 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*

Staffing for this science area includes 35 scientists whose disciplines include forestry, plant pathology, meteorology, hydrology, ecology, soil science, and entomology.

*Infrastructure*

- Five federally-owned research facilities, two of which are on university campuses.
- One federally-leased facility on a university campus
- Remote employees at three locations
- Access to six experimental forests on federal land
- Access to leased land from the University of Arizona (termiticide test site)
- Access to major field installations on cooperator lands (Auburn University Solon Dixon Center, Clemson University Experimental Forest, North Carolina Wildlife Management Area, Eglin Air Force Base, J.W. Jones Ecological Research Center, Oak Ridge National Lab, and Whitehall Forest).

*Unique Capability/Instrumentation*

SRS-4552

Gas chromatography-electroantennal detection (GC-EAD) a technology using the response of insect antennae to rapidly identify biologically active chemical compounds for use in insect monitoring and management.

Invasive plant, pathogen and insect taxonomy expertise – the greatest concentration of such expertise within the Forest Service.

Field sites for required testing of newly registered termiticides for the control of wood destroying insects.

SRS-4156

High Performance Computing Center (Southern High Resolution Modeling Center) supported by three supercomputer cluster computers, image analysis workstation, and other workstations devoted to preprocessing and running specific models such as air quality models.

Soil and Plant Tissue Analytical Lab with instrumentation including inductively coupled plasma optical emission spectrometer (Perkin Elmer Optima 2000 DV), acid digestion block, flow-injection autoanalyzer (Lachat Quick Chem FIA+ 8000), carbon/nitrogen analyzer (Perkin Elmer 2400 Series II), Tekron mercury analyzer, and an ultraviolet-visible spectrophotometer (Varian Cary 100).

Ecophysiology Lab including field and bench IRGA for photosynthesis and respiration measurements, stemflow gauges, pressure bomb, FLIR Infrared camera, digital canopy analysis system, Dynamax high pressure flowmeter.

## Appendix A

## RELATIONSHIP OF FOCUS AREAS TO FOREST SERVICE STRATEGIC PLAN AND R & D STRATEGIC PR0GRAM AREAS

*Relationship to Forest Service Strategic goals:*

The focus areas outlined above relate to the following objectives from the draft Forest Service Strategic Plan:

**Objective 1.1 Reduce the risk to communities and natural resources from wildfire**.

Focus Areas 9.2, 9.4, and 9.5

**Objective 1.2 Suppress wildfires efficiently and effectively**.

Focus Area 9.5

**Objective 1.4 Reduce the adverse impacts from invasive and native species, pests, and diseases**.

All Focus Areas

**Objective 1.5 Restore and maintain healthy watersheds and diverse habitats**.

All Focus Areas

**Objective 2.3 Help meet energy resource needs**.

Focus areas 9.1, 9.3, and 9.5

**Objective 3.1 Protect forests and grasslands from conversion to other uses**.

Focus Area 9.2

**Objective 3.2 Assist private landowners and communities in maintaining and managing their land as sustainable forests and grasslands**.

All Focus Areas

**Objective 6.2 Improve management of urban and community forests to provide a wide range of public benefits.**

All Focus Areas, especially 9.3

**Objective 7.1 Increase the use of applications and tools developed by Forest Service Research and Development and the Technology Development Centers.**

All Focus Areas

*Relationships to Forest Service Research and Development Strategic Program Areas*

Wildland Fire (9.2, 9.4, and 9.5)
Invasive Species (All Focus Areas)
Wildlife and Fish (All Focus Areas)
Air and Water (All Focus Areas)
Resource Management and Use (All Focus Areas)
Recreation (9.3)

## Appendix B

## RESEARCH WORK UNIT CHARTER

### SRS-4156, Center for Forest Disturbance Science

**Unit Locations: Athens, GA and Clemson, SC**

**Project Leader: John A. Stanturf**

**Area of Research Applicability: Regional, National, and International**

**Mission: To increase understanding of disturbance processes and their risk of occurrence in order to develop innovative management strategies for reducing vulnerability of ecosystems to degradation.**

**Problem 1. Understanding disturbances and their effects**

Disturbances are normal processes and southern forests are adapted to disturbance from fire, wind, ice, drought, and endemic pests. Human activity, including fire exclusion, fragmentation and urban development, introduction of exotic species, and forest management for goods and services, has introduced novel disturbances or altered the spatial and temporal nature of "natural" disturbances. Understanding disturbance processes and effects and the response of forest ecosystems to single disturbance events as well as multiple interacting disturbances, provides the scientific basis for sustainable forest management.

Problem 1a. Understanding disturbance mechanisms/processes and their impact on forest ecosystems (abiotic: severe weather, wildland fire and fire exclusion, and climate change/variability, biotic: invasive species, and anthropogenic: fragmentation)

Problem 1b. Understanding ecosystem response to disturbance processes.

Problem 1c. Understanding interaction and impacts of multiple disturbances and feedback mechanisms.

**Problem 2. Managing disturbances and restoring ecosystems**

Sustainable management of southern forest ecosystems is challenged by multiple interacting disturbances, both biotic and abiotic. The greatest threats to forest health are posed by meteorological events that are by nature dynamic and affected by climate variability and subject to climate change. Managers need strategies and tools for reducing vulnerability of forest ecosystems to severe disturbance events, for sustainable management, and for restoring degraded ecosystems.

Problem 2a. Developing strategies for reducing vulnerability of southern forests to severe disturbance events and climate change/variability.

Problem 2b. Developing methods for restoring ecosystems degraded by natural disasters and anthropogenic activity.

Problem 2c. Developing tools for managing wildland fire and reduce impacts on air resources.

**Problem 3. Modeling and synthesis of disturbance processes**

Integrating and synthesizing knowledge of multiple disturbances and providing managers with tools for sustainably managing forests in the face of disturbance, altered climate, and changing human demographics and preferences requires high-performance computing systems. Developing predictive capability requires skilful application of advanced numerical modeling and visualization techniques. Effectively focusing these resources on dynamic southern forest ecosystems, especially fire-affected forests, requires multidisciplinary teams and collaborations with many partners.

Problem 3a. Developing and maintaining a High Performance Computing Center for the Eastern United States to provide visualization of large three-dimensional, time-dependent data sets and access to complex physical, meteorological, ecological, and spatial models.

Problem 3b. Developing and applying numerical modeling and advanced statistical methods to predict disturbance processes and their effects.

Problem 3c. Integrating and synthesizing knowledge of multiple disturbances and/or effects on multiple ecosystem components.

***Relationships to Threats Science Area Priority Topics:***

This problem relates to all of the 5 Priority Topics, which are themselves disturbance agents. (5.1 – Impacts of severe weather events on forest ecosystems; 5.2 – Urbanization, fragmentation, and parcelization of forest lands and the associated impacts; 5.3 – Invasive species (all taxa) and outbreaks of native species beyond their normal geographical ranges or historical ranges of behavior; 5.4 – Effects of global climate change and climate variability on eastern forests, including severe drought; 5.5 – Wildland fire and its impacts.)

***Key External Contacts***:

Clemson University
Auburn University
Florida State University
George Mason University
Georgia Institute of Technology
University of Georgia
Ohio State University
Oklahoma State University
Duke University

## Appendix C

## RESEARCH WORK UNIT CHARTER

### SRS-4552, Insects, Diseases, and Invasive Plants

**Unit Locations: Pineville, LA; Starkville, MS; Athens, GA; Auburn, AL**

**Project Leader: Kier D. Klepzig**

Mission: To provide the basic biological and ecological knowledge and innovative management strategies required for management and control of native and non-native insect pests (including bark beetles and termites), pathogens and invasive plants in changing forest ecosystems.
As part of the SRS "Threats to Forest Health" Science Area, contribute to generating, integrating, and applying knowledge to: 1. Predict, detect, assess, and prevent environmental threats to public and private forests of the east; 2. To develop silvicultural treatments to reduce the vulnerability of forests to threats; 3. To mitigate impacts, and, 4. To deliver this knowledge to managers in ways that are timely, useful, and user friendly.

**Problem 1. Wood destroying insects**

The U.S. is the world's leading consumer of wood and wood products. It is imperative that we to protect wood in use from insect pests. Of the wood-destroying insects, termites pose the greatest threat to wood in use. Independent efficacy data are required for the registration of all termite control products containing insecticides.

Problem 1a. Independent efficacy data for termiticide registration.
Unit will conduct standard six year field evaluation of potential termiticides or baits.

Problem 1b. Treatment effects on pest biology, ecology, and behavior.
Unit will examine biological and toxicological effects of termiticides and alternatives.

Problem 1c. Biology and ecology of wood-decomposing insects in natural habitats.
Unit will investigate roles of termites in wood decomposition (including that associated with wood generated from severe weather events).

Problem 1d. Unit will define associated forest habitat characteristics and identify forest infestations of Formosan termites (including those in wildland-urban settings) and study their impacts.

**Problem 2. Native and non-native tree diseases**

Diseases have profound economic and ecological effects. The organisms that cause them are influenced by management practices and ecological conditions. Our mission is to

conduct the research necessary to provide the scientific basis for management of diseases in our forests to insure that we retain both their productivity and diversity.

Problem 2a. Ecological processes and interactions in disease susceptibility and severity under various management regimes
Unit will examine the Leptographum/Ophiostoma fungal complex associated with decline and mortality in pine stands after fire reintroduction and possibly other diseases.

Problem 2b. Association of exotic beetles and pathogenic fungi.
Unit will study an extremely destructive association between an Asian ambrosia beetle and an Ophiostoma sp fungus.

**Problem 3. Bark beetles and invasive insects**

The southern pine beetle is the most destructive insect pest in southern forests. While at endemic levels, bark beetles serve as natural agents of tree mortality. At epidemic levels these, and other, bark beetles pose serious threats to forest ecosystem health. In addition, southern forests have undergone an onslaught of invasive species. Hemlock woolly adelgid is already established within the southern United States. Other non-native insects (the emerald ash borer, the Asian longhorned beetle, the pine shoot beetle, and especially the European wood wasp, *Sirex noctilio*) are already established in the northeastern and north central portions of our country. Insects and diseases are also major factors impacting production in seed orchards, nurseries and managed stands.

Problem 3a. -- Ecology and biology of bark beetles and invasive insects.
Unit will focus especially on native invasive insects such as southern pine beetle. The effects of inter-relationships among bark beetles, mites, and fungi will be examined.

Problem 3b. -- Management of bark beetles and invasive insects of southern conifers.
Unit will examine alternatives to licensed synthetic pesticides such as novel insecticides and semiochemicals.

Problem 3c. Detection and management of exotic invasive insects.
Unit will cooperate in foreign exploration for new predators, and assist in their release, for control of Hemlock Woolly Adelgid. Unit will also continue studies on detecting and monitoring exotic bark and wood boring beetles (including such interactions in urbanized or fragmented forest landscapes).

Problem 3d. Impacts of insects and diseases on seed orchards and nurseries.
Unit will continue to conduct the research necessary to reduce the impact of these pests on our forests through integrated management. Unit will develop spray timing models for key pest species and examine alternatives to methyl bromide.

Problem 3e. Effects of forest management on insect and fungal diversity.

Unit will examine effects of large dead wood on insect and fungal diversity. Unit will examine interactions of pollinators with plant diversity. Unit will study effects of stand conditions on arthropod prey of red cockaded woodpecker and other birds.

Problem 3f. Quantify and predict response of native and exotic invasive insects to severe weather events, fragmentation and global climate change.

**Problem 4. Invasive plants**

Forests in the southern US are is characterized by high productivity and diversity. Exotic plant invasions can dramatically alter these forests. By 2040 the acreage in pine plantations is projected to double, as will the expansion of non-native plants. Many forest management objectives are best accomplished with the use of herbicide. A lack of understanding of forest herbicides jeopardizes their continued availability to forest managers.

Problem 4a. Risks and benefits associated with the forest herbicides.
Unit will compare environmental risks and benefits for vegetation management alternatives.

Problem 4b. Non-native invasive plant species control and management.
Non-native and even some native invasive cause billions of dollars in lost forest productivity. Prevention, early control and containment, and monitoring techniques are needed. Unit will develop vegetation management treatments, prescriptions, and strategies for control of invasive plants (including contributions to studies on effects of severe weather events, forest landscape fragmentation, and global climate change). A key part of this problem is developing the tools to help scientists and managers prioritize the allocation of resources among multiple invasive plant threats.

## Appendix D

## RESEARCH WORK UNIT CHARTER

### SRS-4854, Eastern Forest Environmental Threats Assessment Center

**Unit Locations: Asheville, NC; Raleigh, NC; and Research Triangle Park, NC**

**Project Leader: Danny C. Lee**

### Mission

The mission of the Eastern Forest Environmental Threat Assessment Center (EFETAC) is to generate knowledge and tools needed to anticipate and respond to environmental threats. The most serious threats to forests, and the benefits they provide, inevitably involve complex factors interacting at multiple scales. EFETAC's challenge is to maintain a holistic and integrated research program to tackle these complex issues. EFETAC is further charged to deliver knowledge to forest landowners, managers, and scientists in a timely, useful, and user-friendly manner. **The Eastern Forest Environmental Threat Assessment Center's mission and governance are more completely described in its chartering document dated January 10, 2005. That document is also included as *Appendix E* to this Science Area Charter**.

### Organization

**EFETAC** comprises three teams, each with regional, national, and international responsibilities. The **Threat Assessment** team emphasizes integrated approaches to detecting, predicting, and assessing threats to forest health; the **Southern Global Change Program (SGCP)** team develops conceptual and functional bases for understanding and mitigating forest ecosystem responses to climate change; and the **National Forest Health Monitoring Research** team develops new monitoring protocols and analytical tools in addition to performing national scale analyses and reports on the health and sustainability of the Nation's forests. EFECTAC works closely with its counterpart center in Prineville, Oregon, the Western Environmental Threat Assessment Center (WETAC), coordinating approaches to common problems. EFECTAC differs from WETAC in its greater focus on private lands and a greater emphasis on hardwoods (See Appendix E)

### Problem 1. Forest Health Monitoring Research

Tracking the health of forest ecosystems is a legal mandate essential to effective management. Distinguishing symptomatic changes in forest structure, composition, and productivity from natural variation is a challenge at scales ranging from individual stands to regional landscapes. The Forest Health Monitoring Program is a national collaborative effort involving State and Federal agencies to monitor long-term trends in forest conditions and productivity. Continued improvement is needed to overcome key scientific obstacles and to demonstrate technical advances for implementation.

**Problem 1a.** Key elements are needed to improve existing monitoring systems and to develop new sampling and survey designs, measurement techniques, and estimation procedures for forest survey and inventory.
**Problem 1b.** Protocols are needed to integrate data, models, and interpretation techniques to assess forest health and conduct risk assessments and analyses at multiple scales.
**Problem 1c.** Protocols are needed to utilize spatial analyses and principles of landscape ecology in forest health monitoring and assessment, including interactions between nature and society.
**Problem 1d.** Protocols are needed to utilize data from long-term comprehensive monitoring of key ecosystem processes and components in forest health assessments.
**Problem 1e.** An automated system is needed for processing satellite imagery that detects disturbances in forested systems.

## Problem 2. Forest Ecosystem Responses to Global Change

Extensive burning of fossil fuels has increased atmospheric concentrations of carbon dioxide and other greenhouse gases well beyond historical levels. Such changes have accompanied increased global temperatures, suggesting a substantively altered world climate. Although the implications of climate change for forests are not fully understood, they are very likely to be profound and pervasive. Climate change can exacerbate threats from other sources, further confounding understanding and the search for solutions. Innovative mitigation strategies based on sound scientific principles are needed to reduce the negative consequences of climate change.

**Problem 2a.** Better documentation and quantification of climate-induced changes in forests and forest resources are needed (experimentation and observation).
**Problem 2b.** The ability is needed to project how climate change will impact forests and forest resources and interact with other threats (prediction).
**Problem 2c.** Knowledge is needed to develop and implement strategies that will reduce negative climate change impacts on forests and forest resources (mitigation and adaptation).

## Problem 3. Impacts of Biotic Invasion, Other Stresses, and Their Interactions

Although individual impacts of some stresses on forests are well known, many important stresses have received less attention. Furthermore, combinations of multiple stresses interact in complex ways, often defying efforts to experimentally measure cumulative effects. Further understanding can be gained by investigating important new stresses on forest ecosystems and by developing and demonstrating models that integrate effects of multiple stresses.

**Problem 3a.** Invasive species are progressively—and sometimes radically—altering the species composition and dynamics of forests; knowledge of species invasiveness and

habitat invasibility as well as development of user-friendly predictive tools for early warning/prevention/spread and effective control methods are critically lacking.
**Problem 3b.** Losses of forest cover through land-use conversion and changes in forest ownership have far-reaching influences on the susceptibility of forests to other threats and on management capacity to respond.
**Problem 3c.** Wildland fire is both a social and ecological issue that currently demands inordinate management attention, yet conflicts continue to escalate.
**Problem 3d**. Airborne pollutants such as nitrates, sulfates, and ozone interact with each other and other stressors, in ways that are poorly understood, to exacerbate effects on forests and forest resources.

## Problem 4. Integrated Risk Assessment

Managing forest threats is ultimately about managing competing risks, where risk is defined as the probability of loss. Quantitative risk assessment is a formal body of science that is becoming increasingly commonplace and important in forest management. In risk assessment, ecological and socioeconomic knowledge are combined with mathematical rigor to quantify risk and illuminate trade-offs inherent in alternative course of action.

**Problem 4a.** Adoption of formal risk assessment methods in forest management is hindered by the lack of training among managers and accessibility of easy-to-use tools and information.
**Problem 4b.** Risk can be difficult to quantify effectively or communicate to land managers and the public, especially when it involves multiple interacting components and conflicting values.
**Problem 4c.** A major challenge in environmental risk assessment is translating knowledge and quantifying risk across multiple spatial and temporal scales or ecological levels of organization (e.g., extrapolating effects on individuals to populations).

## Problem 5. Collaborative Science Delivery Efforts

Understanding and addressing forest threats effectively involves concerted efforts among multiple stakeholders. Thus, it is increasingly necessary to exchange information, technology, and resources among internal and external customers and partners quickly and efficiently. Technological innovation is needed to improve sharing of data and knowledge with individuals and organizations in a manner that is accurate, user-friendly, and beneficial.

**Problem 5a.** Web-based tools are needed to ensure widespread distribution of products and services.
**Problem 5b.** Improved forest health and sustainability reports are needed for national and international assessments.

**Problem 5c.** Continued publication development and presentation opportunities are necessary to maintain Center credibility and encourage long-term collaboration.
**Problem 5d.** Improved analytical tools need to be developed and transferred to analysts responsible for regional, national, and international assessments of forest health and sustainability.

**Appendix E**

**CHARTER**

**Eastern Forest Environmental Assessment Center**

**(Attached to Hardcopy Version Only)**