RESEARCH WORK UNIT DESCRIPTION Ref: FSM 4070	1. **Number** FS-SRS-4951	2. **Station** Southern Research Station
	3. **Unit Location** Gainesville, FL	

4. **Research Work Unit Title**
Human Influences on Forest Ecosystems:
The Southern Center for Wildland-Urban Interface Research and Information

5. **Project Leader** (Name and address)
Edward A. Macie, 408 West University Ave, Suite 306, Gainesville, FL 32601

6. **Area of Research Applicability**	7. **Estimated Duration**
Regional and National	5 years

8. **Mission**
To develop and communicate guidelines, models, and tools needed by natural resource managers, policymakers, planners, and citizens to reduce risks to ecosystems and human communities in urban and urbanizing landscapes.

9. **Justification and Problem Selection**
Today, approximately 80 percent of the Nation's population lives in urban or urbanizing landscapes. The South is the fastest growing region in the Nation with a 13.7 percent increase in population between 1990 and 2000. Current estimates place population growth at 815,000 individuals annually. By 2020, population projections add another 23.8 million individuals. Over 12 million acres of forestlands are projected to be lost to urban land-uses to accommodate this growth in the South. The consequences of this land use change threatens the sustainability of southern forests, challenges resource managers' and land owners' ability to manage forest resources, increases risks to communities and ecosystems, reduces critical natural habitats, and degrades ecosystem benefits and services to citizens.

Such areas of rapid urbanization are commonly referred to as the wildland-urban interface. The interface can be thought of as an area where increased human influence and land-use conversions change the availability of ecosystem goods and services, increase risks to human and forest communities, and alter the management options of natural resources.

The wildland-urban interface is not new, having existed since humans decided to expand their area of habitation. What is new is the rapid rate of land conversion to urban uses in response to population growth and the corresponding effects on ecosystem processes and disturbances. Increasingly forested areas are interspersed with human development, creating the obvious risk of wildland fires that threaten lives and property. However, there are other equally important issues. The graph in Appendix 1 depicts critical interface issues, which include both factors driving change and some of the resulting ecological changes.

(continued on page 2)

10. **Approach to Problem Solution** (Start at conclusion of item 9.)

Signature	Title	Date
Recommended:	Assistant Director for Research	
	Assistant to Staff Director	
	Staff Director	
Approved:	Station Director	
Concurred:	Deputy Chief for Research	

There are currently critical information gaps on the effects of urbanization on human and forest communities, particularly from a multi-disciplinary view that incorporates both social and ecological aspects of the interface. Some specific questions that remain largely unanswered for the southern region are: How are forest ecosystems and the goods and services they provide being affected by urbanization and other human influences? (Problem 1) How are disturbance regimes being altered by human influences and how do these alterations pose risks for human and forest communities? (Problem 2) How does public policy influence changes to ecological processes and disturbances? (Problem 3) How do we ensure that the best scientific information available about interface issues reaches decision makers, natural resource professionals, and citizens? (Problem 4) These four problem areas provide a hierarchical framework for addressing the changes, challenges, and risks to forest and human communities from increased urbanization.

With land conversions to urban land-uses, ecosystems are altered directly and indirectly. An understanding of how ecosystems are being altered by human influences and the ability to predict these alterations are critical for evaluating changes to ecosystem goods and services along urban-rural gradients (Problem 1). Examples of ecosystem goods include forest products, wild genes, medicinal plants, and recreation, while ecosystem services include clean air and water, soil production, and detoxification of pollutants. Direct effects alter the physical structure of a site and include deforestation, fragmentation, loss of wetlands, and stream alteration or modification. Indirect effects are secondary influences from human actions. Examples include increased nitrogen deposition, introduced non-native species (flora and fauna), changed microenvironments from the heat island effect, and altered hydrologic pathways.

Although extensive work has been done on direct effects, particularly fragmentation, there is more that still needs to known about how forests change in urbanizing landscapes and the resulting consequences to ecosystem goods and services. To date we know very little about how ecosystems in the South will respond to indirect effects of urbanization and how these responses vary across the region. To assess the effects of urbanization regionally, basic social attributes (e.g., housing and road densities) and ecological attributes (e.g., number and size of forest patches) need to be developed across urban gradients and linked at different spatial and temporal scales. Developing and monitoring indicators over time enables natural resource managers to assess the short- and long-term consequences of landscape and ecosystem changes by urbanization and provide scientific information to formulate natural resource policies. Applied research in this area must also develop adaptive management practices, such as small-scale forest management techniques, and tools necessary for management agencies to address challenges presented by urbanization and multiple small-scale land ownerships.

With changes to human and natural systems from urbanization, disturbance regimes also change and the risk to human communities and the ecosystem services subsequently increases. Floods, winds, and fire are natural disturbances, but urbanization is also a disturbance. Important risks associated with urbanization include fire, invasive species, groundwater contamination, forest health, and disruption of ecological processes. Urbanization affects disturbance regimes by altering the frequency, severity, and the types of disturbances seen in an area. By suppressing a disturbance, humans alter its characteristics. By doing so, humans place themselves and natural ecosystems at risk to catastrophic effects. For example, wildfire suppression has threatened the existence of fire-dependent communities and species, and has led to large-scale fires (increased size and severity) that have been numerous in many parts of the country over the past decade. Today, we understand that fire dependent ecosystems need periodic fires to regenerate and maintain ecological integrity and biological diversity. Undesirably, fuel loads have reached dangerous levels resulting in conflagrations that alter ecosystems and threaten human communities. Similar effects result from controlling floods and other natural events. By altering a disturbance, we also change the susceptibility of ecosystems to pathogen and insect outbreaks and change the spatial heterogeneity of a landscape. The effect of these changes still needs to be determined. For example, knowing how spatial heterogeneity changes is critical because it influences how disturbances and species move across a landscape. Consequently, urbanization increases susceptibility of forest remnants to insect and pathogen infestations and non-native species invasions, thus altering management options.

Controlled experiments and historical studies are needed to assess the synergistic effects of altered disturbance regimes. Because disturbances will occur, planners need to consider how local land use decisions affect the disturbance regime and how disturbances affect local planning objectives. Additionally, local decision makers lack information to make science informed decisions that can help reduce risks to humans and forest ecosystems. Reliable interdisciplinary models are needed for land use and natural resource decisionmaking at various scales. Research is needed to determine how disturbance regimes are altered through human influences along an urban-rural gradient and what the subsequent risks are to human and natural communities (Problem 2).

This kind of information is even more critical given the projected population increases in the South. As the population of the South increases, there are more people exposed to the aforementioned risk. There is also an increase in the diversity of the population. When compared to 1990, population projections for 2020 show shifts to a population that is better educated, more urbanized, wealthier, older and more ethnically and culturally diverse. As a result, there is a greater diversity of values, attitudes, and perceptions about natural resources and how they are managed. Biocentric uses of forest ecosystems (e.g., aesthetics, water quality) become more valued than economic and utilitarian uses (e.g. timber). Consequently, conflicts may arise over traditional management practices and result in the formulation of local ordinances that increase the cost of or inhibit future management opportunities. An understanding of the values, attitudes, and perceptions of this diverse public is required to assess how public policies affect the health, condition, and management of forest ecosystems.

Public policies are often developed independent of each other, which may lead to policies whose objectives conflict with one another, alter ecological processes and disturbance regimes, and increase risk. For example, local public policy may be crafted to encourage economic development, and subsequently encourage urbanization, which results in greater risks to ecosystems and human communities and significantly alters ecological goods and services. This example demonstrates the need to develop land use policies that take into account the potential effects of these policies on ecological processes and disturbances and the need to analyze the institutional arrangements that affect relationships among stakeholders in the interface. Additionally, because ecological processes (e.g. fire, water, nutrient, and carbon cycles) cannot be confined to a particular political or property boundary, effective resource-based policies must be coordinated across different jurisdictions and at multiple scales. However, local policy makers lack science based information, packaged in user-friendly formats that enable decisions that incorporate natural resource information into local land use planning processes. Policymakers require tools, such as computer-aided mapping and decision support systems that can demonstrate the consequences of their land use decisions for natural resources. Finally, the influence of public policy on ecosystem processes, disturbances, and subsequent risk to human and natural communities is not fully understood. In the absence of relevant scientific and technical data, environmental needs cannot be prioritized and long-term threats may not be identified. Thus, research is needed to better define the relationship of land use policies to ecological processes and disturbances in the wildland-urban interface (Problem 3).

An integrated multidisciplinary approach to understanding the social and ecological aspects of the wildland-urban interface is critical, as well as is the dissemination of both new and existing information. This approach will enable local decision makers to understand or mitigate the impact and risk associated with local land use policy and planning. It will also provide information and tools for natural resource professionals who have many new challenges managing natural resources in the wildland-urban interface. Policymakers and homeowners have limited understanding of the benefits that ecosystems provide and how their land use decisions affect ecological processes and disturbance regimes. Thus, policymakers, natural resource professionals, and citizens need scientific information, guidelines, and tools to address and minimize risks due to changes from urbanization and other human influences on forest ecosystems (Problem 4).

Building relationships across multiple disciplines enhances opportunities for addressing interface issues. The Southern Research Station (SRS) has an Urban Forestry/Wildland-Urban Interface (UF/WUI) cross-cutting theme (CCT) already in place to organize and manage SRS's research that addresses issues related to the

urbanization of southern forests. However, there is a need to coordinate studies across research work units (RWU) and with other cooperators and to package and deliver the findings of the other units that are relevant to the wildland-urban interface.

10. Approach To Problem Solution.

Problem 1 – An understanding of how ecosystems are being altered by human influences and the ability to predict these alterations are critical for evaluating changes to ecosystem goods and services along urban-rural gradients.
Through participatory research, which enables identification of research priorities by both scientists and user groups, this problem area will address critical knowledge gaps related to how urbanization alters landscape and ecosystem patterns and processes and how better to predict effects on ecosystem goods and services.

Accomplishments for the next 5 years include:

1. From a multidisciplinary perspective, characterize patterns of urbanization and the direct and indirect stressors that are active along the urban-rural gradient. Also, develop protocols for restoring or rehabilitating terrestrial and aquatic ecosystems altered by urbanization.

2. Develop and/or adapt a set of ecological and social indicators to assess changes over time that will be useful for land use planners and natural resource managers to minimize adverse effects and to monitor and predict human influences on landscapes and ecosystems.

3. Identify linkages among ecological, social, and physical components of the ecosystem across spatial and temporal scales to assess how social policies and socioeconomic contexts alter ecological and social processes.

4. Partner with SRS RWU's through the UF/WUI CCT, universities and federal, state, and local agencies to establish a series of permanent study sites by physiographic provinces for long-term monitoring of social and biophysical indicators.

5. Develop spatial-temporal models that integrate ecological, social, and physical components of an ecosystem to project the effect of proposed land use changes on landscape and ecosystem patterns and processes.

Problem 2 – Research is needed to determine how disturbance regimes are altered through human influences along an urban-rural gradient and what the subsequent risks are to human and natural communities.
The combination of increased population, changing land use patterns and urbanization, and altered disturbance regimes can produce risks that threaten human and forest communities. Given the projected land use change and population increase in the South, there is a critical need to understand, prevent, and mitigate risk through sound land use decision-making and resource management. Models will be developed to integrate urbanization and land use to predict the effects of disturbance and disturbance behavior.

Accomplishments for the next 5 years include:

1. Assess how urbanization alters the characteristics (e.g., extent, severity and frequency) of natural disturbances, such as fires and floods, and the subsequent effect on forest health, landscape and ecosystem patterns and processes, and human safety. Additionally, evaluate the synergistic effects of large- and small-scale natural disturbances and incremental land-use changes caused by urbanization on disturbance behavior.

2. Characterize and compare spatial heterogeneity patterns created by natural disturbances with those patterns created by urbanization and evaluate how different patterns affect the movement of energy, organisms, materials, and disturbances across landscapes and derived ecosystem goods and services.

3. Develop spatial models that integrate land use and fire models to predict potential effects of fire behavior, fuel loads, fire intensity and severity on ecosystems and human communities.

Problem 3 – Research is needed to better define the relationship of land use policies to ecological processes and disturbances in the wildland-urban interface.

This problem area will assess how state and local land use policy and decision making alters ecosystem goods and services, natural disturbance regimes, and results in subsequent risks to human and forest communities. Given the increased demands on natural resources from urbanization and changing land use patterns, we must be able to address the following question: How can we manage land use to assure mazimum benefits to communities while minimizing risk and ensuring the integrety of ecosystems on which these benefits are based? Models will be developed to enable local decision makers and resource managers to visualize and understand the effects of their decisions, to mitigate those effects, and to work across multiple jursidictions and scales to maximize ecological goods and services.

Accomplishments for the next 5 years include:

1. Determine what factors lead to various various land-use patterns, identify the rates of land-use change and parcelization for different regions in the South, and assess how these factors and rates affect natural resources, their management, community development, and collaborative planning. Some areas of specific analysis include:
    a. Public policies toward land use and influence of subsequent land uses on natural resources;
    b. Weaknesses in land use policies as well as options that are available to better address natural resource management and conservation issues in the interface;
    c. The value of strategically using forests to offset some of the negative environmetal consequences of urbanization and changing land use patterns in interface areas.

2. Develop policy scenarios to reduce deleterious risks to ecosystems and human communities.

3. Assess public policies and institutional structures across different jurisdictions and scales that influence ecosystem processes and natural resource management.

4. Identify conflicts between public policies and desirable ecological conditions and natural resources mangement.

5. Develop mechanisms that encourage and enable landscape-level management across ownerships and jurisdictions.

Problem 4 - Policymakers, natural resource professionals, and citizens need scientific information, guidelines, and tools to address and minimize risks due to changes from urbanization and other human influences on forest ecosystems.

Information, guidelines, tools, and technologies developed from this and other RWU's within the UF/WUI CCT must be packaged and delivered to natural resource professionals, policymakers, and citizens in order to make science-informed decisions for formulating natural resource and land-use policies. Building partnerships and collaborative efforts and approaches, as well as facilitating and creating linkages, are also critical.

Accomplishments for the next 5 years include:

1. Package and disseminate wildland-urban interface information developed from the other three problem areas plus relevant information from other RWU's to interested stakeholders. Potential methods include publications (e.g. brochures and fact sheets), electronic media (e.g. website), WUI training modules, decision-making tools, models, guidelines, distance learning opportunities, and model projects/demonstrations.

2. Establish a protocol for technology exchange within the SRS UF/WUI CCT. Also, build case studies with application of technology developed through this and other RWU's research.

3. Create a series of workshops and forums, in partnership with national forest and state forest personnel and other federal and state natural resource agencies, for scientists to provide information and learn the needs of managers and land-use planners in making adaptive management and land-use decisions.

4. Create adaptive management scenarios/guidelines to assist managers and land use decision makers in mitigating deleterious risks to ecosystems and communities caused by land-use changes.

5. Establish a set of guidelines by physiographic provinces or ecoregions for natural resource managers and landuse decision makers to follow when evaluating the effect of development on ecosystem services and risks to humans.

6. Develop spatially-explicit models that integrate ecological, social, and physical components of an ecosystem to project the effect of proposed development plans on landscape and ecosystem patterns and processes and to formulate alternative planning actions.

Environmental Consideration: The work described under these problem areas will have no significant effect on the human environment; use hazardous materials, nor present potential environmental problems. To collect data, the research work will use standard and established field methodologies or through collection of primary data using standard survey and interviewing techniques. Thus, the research described in this Research Work Unit Description (RWUD) falls under one of the categories of actions that do not normally have significant effect on the natural environment and are therefore excluded from the need for documentation in an EIS or EA (ref: FSH 1909.15, Chapter 30). Should extraordinary circumstances arise regarding a particular study described in this RWUD, these concerns will be evaluated within individual study plans or by EIS or EA prepared with and approved by relevant Station, District or Forest Staffs.

Primary beneficiaries of the research described in this RWUD will federal and state natural resource managers, community and regional planners, rural development specialists, local community leaders, and various user groups includes watershed associations, national and local non-governmental organizations, and citizens. Outcomes will be delivered through a various predictive models, outreach programs, and published materials. In addition, the science community will benefits from the proposed research.

11. - COOPERATION: The RWU will collaborate with researchers at other work units in the Southern Research Station or other Forest Service Stations conducting similar research. Some of the ways that we will collaborate with other units are to: (1) deliver the findings of the other units that are relevant to the wildland-urban interface; (2) validate selected key findings in the WUI; (3) identify critical scientific gaps and help frame research questions; (4) participate in cooperative joint ventures to address the problems; and (5) enlist the help of established scientists to set up studies in the WUI and serve as the coordinator of the network of studies.

We will likely coordinate with the following units to conduct Problem 1:

SRS-4106	Managing Upland Forest Ecosystems in the mid south
SRS-4251	Integrated Management of Wildlife Habitat and Timber Resources

SRS-4105	Integrated Vegetation Management for Sustaining Southern Forests and Longleaf Pine Ecosystems
SRS-4103	Ecology and Management of Forested Wetland Landscapes
SRS-4803	Forest Health Monitoring Program

We will likely coordinate with the following units to conduct Problem 2:

SRS-4104	Disturbance and Management of Southern Pine Ecosystems
SRS-4852	Southern Global Change Program
SRS-4351	Evaluation of Watershed Ecosystem Responses to Natural, Management and Other Human Disturbances of Southeastern Forests
SRS-4501	Bark Beetles and Invasive Insects

We will coordinate with the following units to conduct Problem 3

SRS-4802	Evaluation of Legal, Tax, and Economic Influences on Forest Resource Management
SRS-4901	Outdoor Recreation and Wilderness Assessment
SRS-4851	Economics of Forest Protection and Management

We will coordinate with all of the above units to conduct Problem 4

Likely cooperators at other Stations include:

NE-4952	Effects of Urban Forests and Their Management on Human Health and Environmental Quality
PSW-4952	Sustainable Urban Forest Ecosystems
NC-4902	Managing Forest Ecosystems for Urban Populations

The RWU will cooperate with the Resource Valuation and Use research staff in the Washington Office. The RWU also will cooperate with staff groups at both national and regional levels of State and Private Forestry and with public and private universities, non-governmental organizations, and other federal and state agencies.

12. STAFFING AND BUDGET

As of October 2003, the RWU is staffed with an acting project leader, a technology exchange coordinator, and an administrative support specialist. In addition, two temporary positions are filled for technical support, including a project intern and a web support specialist. Two permanent scientist positions may be filled if budgets are satisfactory. Additional scientist years will be contributed by academic and government cooperators through cooperative agreements and collaborative research.

Scientist and Technology Transfer Staff Years of the Research Work Unit Description

Problem	Year 1	Year 2	Year 3	Year 4	Year 5
1	1	1	1	2	2
2			1	2	2
3	1	1	1	1	1
4	1	1	2	2	2
Total SY	3	3	5	7	7

Initial implementation will require two scientist, technology transfer and support staff and a budget of $1 million. Full implementation of the research described for this RWU, including technology transfer/exchange,

would require four scientists plus the project leader, two technology transfer/exchange staff, support staff, and a budget of $1.5 million. An increase of 5 percent per year in the budget would be required to sustain research capacity and productivity. Absent increases in funding from current level—either from increase appropriation or sponsored funds—research on issues related to Problem 1, 2 and 3 and 4 will be reduced.

Appendix 1: Critical WUI Issues