RESEARCH WORK UNIT DESCRIPTION Ref: FSM 4070	1. Number SRS-4505	2 . Station Southern Research Station
	3. Unit Location Athens, Georgia 30602	

4. Research Work Unit Title
Insects and Diseases of Southern Forests

5. Project Leader (Name and address)
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6. Area of Research Applicability	7. Estimated Duration
National	5 years

8. Mission

To sustain, protect and restore the productivity and health of forests in the South and the Nation by creating science and technology through research on insects and pathogens.

9. Justification and Problem Selection

Our mission as a unit is to conduct the research necessary to provide the scientific basis for management of insects and diseases in our forests to insure that we retain both their productivity and diversity and, when necessary, help restore forests that have been degraded by non-native invasive pests or past land use. We recognize that the forests of our region represent an important resource for our country's economic future and that those forests also contain unique species and habitats that are valuable as well. To accomplish our mission requires that we work together within our project and with our cooperators in other units within the Southern Research Station, other research stations around the country, state and federal agencies, and universities.

We have divided our research into three problem areas as a way to effectively convey our proposed work in the next five years. However, we recognize that much of the research crosses over problem area boundaries. For example, we have research planned on invasive non-native species under Problem 1 that will look at the impacts of those invasive species and their management (Problem 2) on native forest biodiversity (Problem 3). There are a number of other examples where this is also true. Likewise, we have not attempted to identify who will do what but to provide a broad overview of the proposed areas of research. Within each problem area there are likely to be several unit scientists working on the same or related projects at any given time.

Problem 1 will focus on the biology and control of non-native invasive species (insects, diseases and plants). Southern forests have undergone an onslaught of invasive species brought here from other countries. Starting with chestnut blight, Dutch elm disease, and white pine blister rust to the recent arrival of hemlock woolly adelgid (HWA), these invasions have significantly changed and continue to alter our forests by killing our trees and crowding out native vegetation.

In addition to hemlock woolly adelgid, sudden oak death (SOD), a disease killing trees in California, has been intercepted on ornamental nursery stock throughout the South. With the large amount of interstate plant

movement, it seems likely that it will eventually become established in our region. How will it behave? What species are susceptible? What portions of our forests are likely to be affected and to what extent, are all unanswered questions.

Like SOD, many assume that it is only a matter of time before the wood wasp, Sirex noctilio, arrives in Southern forests. Unlike SOD, the wood wasp attacks pines and is likely to be a major pest of overstocked pine plantations common in our forests. Add to these the emerald ash borer, the Asian longhorned beetle, and the pine shoot beetle, insects already established in the northeastern and north central portions of our country, and the potential exists for an escalation in damage to southern forests from invasive species.

Problem 2 will be focused on management of native insects and diseases that are pests in seed orchards, nurseries and managed stands. Insects and diseases are major factors that impact forest productivity. Seed orchards provide the genetically superior seeds that have allowed greater forest productivity on fewer acres. Those seeds are used in forest tree nurseries to produce the seedlings essential for reforestation in the South. These operations represent large investments to support regeneration and restoration of forests on lands managed by forest industry, family forest farmers, and state and federal agencies. Insects and diseases affect every step of this process. We plan to continue to work with industry, and state and federal agencies to conduct the research necessary to reduce the impact of these pests on our forests through integrated management.

Problem 3 will focus on the impacts of forest management activities on insects and fungi. Although insect and fungal pests get most of the attention, these groups of organisms are integral to the functioning of healthy forest ecosystems. Private forest lands in the south are increasingly managed on shorter rotations and with greater intensity. This combined with the increasing urbanization and conversion of our forests to other uses has resulted in reliance on public lands for maintenance of biological and genetic diversity. However, as these trends continue in the South public lands may not be able to meet all of the needs of our diverse flora and fauna. Information is needed on what species occupy our forests, what their habitat needs are and how forest management can be adapted to help conserve them.

Our forests have undergone considerable changes since Europeans first arrived in North America. They have been cleared, farmed and then returned to forests, prevented from burning, invaded by non-native invasive species, and often replanted with species not suited to the sites. Although these practices and changes have had profound visible effects on forest communities, we are only beginning to understand the more subtle changes that have taken place within these altered ecosystems.

Insects are the most diverse group of organisms on earth and fungal diversity is only beginning to be appreciated. Both play critical roles in forest ecosystems. However, the ways in which our changing forests and forest management practices have affected insect and fungal communities and their abilities to carry out these roles are not understood. Conservation on a species by species basis is neither practical nor desirable so understanding and conserving important habitats within our forests is our best hope of "saving the parts”

for future generations.

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

PROBLEM 1 -- Detection and Management of Exotic Invasive Insects, Diseases and Plants.

More information is needed on the impact of exotic invasives on native species and ecosystem processes, and natural enemies are needed to reduce their impacts. In addition, one way to prevent new introductions is to develop detection and mitigation procedures that can be used at foreign ports to reduce the risk or provide an early alert regarding potential new invasive species. We plan to work on five species or groups but we also realize that should a new introduction occur in our area we will need to respond rapidly and cooperatively to the new threat.

Hemlock Woolly Adelgid (HWA)

The HWA is a small sucking insect changing the face of eastern forests both aesthetically and ecologically. This insect is now found throughout most of the range of hemlock in the east. Most accept the fact that this insect is going to kill some of our trees. What effect will that have on species dependent on them for habitat is one of the questions we plain to address. The best long term solution for HWA control is the introduction of natural enemies that will prey on them and hold their populations in check. We will work with scientists in other areas that are conducting foreign exploration for new predators, assist in the release of those predators and assess their impact on HWA in the unique forest of the southeast. In the short term, insecticides offer a method of saving some of our hemlocks until natural enemies can be developed. Those insecticides can have negative effects on non-target organisms. We will work with the Coweeta Hydological Lab (SRS 4351), state and university cooperators to improve the efficacy, ensure ecological safety and minimize negative impacts.

Exotic Beetle/Fungal Associations

Exotic beetles have been noted with increasing frequency in the United States in recent years, and these beetles and their fungal associates can pose threats to forest ecosystems. Notable examples of these exotic beetle/fungal associations include Dutch Elm Disease in the United States, and the recent massive mortality

of oaks in Japan. Over the last several years many red bay (Persea borbonia) trees have died in the coastal plains of Georgia and South Carolina. An exotic beetle, Xyleborus glabratus, and an Ophiostoma sp. have been associated with the problem. In another case, an Orthotomicus sp.has been associated with mortality of Aleppo pine and Italian stone pine in the Central Valley of California. Native pine species in the USA such as Monterey pine, Coulter pine, shortleaf pine, eastern white pine, and loblolly pines are suitable hosts for this insect. We plan to conduct the research on pathogenic fungi that are potentially vectored by these insects. Developing methodology for determining fungal species on these insects will provide knowledge necessary for early threat detection for this and other similar invasive species. This knowledge will also allow further understanding of the impact of exotic beetles and their fungal associates on our forest ecosystems.

Detection of Bark and Wood Boring Beetles

Numerous species of exotic bark and wood boring beetles have been introduced into North America with considerable socioeconomic losses. A critical component in any program designed to intercept, monitor and/or control such introductions is the ability to detect these beetles. A lure and trap combination is an important asset in programs aimed at exotic insects. During the next five years, we will test the efficacy of new commercial trap designs, based in part on our past work on trap designs, as well as new lure combinations targeting a broad array of bark and wood boring beetles in North America and China. An efficient trapping protocol could be used to assess the current distribution of exotic wood boring beetles in North America as well as to intercept beetles at ports-of-entry and departure, and certified wood-processing centers. Additionally, the trapping protocol could be useful in assessing the benefits and risks of various management programs, such as biomass reduction and prescribed burns, by providing information on the threats from native bark beetles and reproduction weevils on tree survival, and the benefits of maintaining arboreal beetle biodiversity in ensuring efficient ecosystem processes.

Sudden Oak Death (SOD)

A new potentially destructive tree pathogen, SOD, is killing trees in California and has recently been intercepted on ornamental nursery stock throughout the South. The host range for this new disease is broad and encompasses many forest species found in the eastern U.S. What portions of our forests are likely to be affected, and to what extent, are unanswered questions.

Research on baiting and water sampling techniques to aid in the early detection of this forest pathogen will help government agencies respond rapidly to an introduction. In addition, environmental risk maps to predict where SOD may be a problem in the U.S. have knowledge gaps for our region. Our work will provide a better understanding of the microclimates in forests of the Southeast and whether those conditions will allow SOD to rapidly establish and spread in our forested landscapes.

Little is known about the biology of Phytophora ramorum. We plan to work with the organism in the laboratory to gain a better understanding of the conditions necessary for spore germination and sporulation on different host tissues. Also, what host factors favor growth of the fungus and what fungicides effectively kill it.

Exotic Plants

Exotic weeds are a slower but no less damaging threat to our forest ecosystems. Some, like kudzu, are well-known. Others, like Chinese privet and oriental bittersweet, are not widely recognized or they are assumed to be a natural part of the forest. However, without natural enemies to regulate their populations these plants grow unimpeded and often form dense thickets or mats that crowd out native species.

We will continue our cooperative efforts with the Chinese, Forest Health Protection and university partners to find and evaluate natural enemies of kudzu. Likewise, we see an expanding threat in Chinese privet. We will investigate the effects of this pest species on our forest ecosystems and how well those ecosystems can recover. In addition, we will work with colleagues in China to investigate natural enemies of this plant in its native habitat with the goal of testing the most promising for biocontrol of Chinese privet in the U.S.

PROBLEM 2 -- Insects and Diseases of Managed Forests

Insects and diseases are major factors that impact forest productivity. Seed orchards provide the genetically superior seeds that have allowed greater forest productivity on fewer acres. Those seeds are used in forest tree nurseries to produce the seedlings essential for reforestation in the South. These operations represent large investments to support regeneration and restoration of forests on lands managed by forest industry, family forest farmers, and state and federal agencies. Insects and disease affect every step of this process. We plan to continue to work with industry, and state and federal agencies to conduct the research necessary to reduce the impact of these pests on our forests through integrated management.

Cone and seed IPM programs

Seed orchards provide the seeds essential for reforestation in the south and throughout the nation. Seed production represents a large initial investment on the part of forest industry and public land management agencies to ultimately produce genetically superior trees for pulp and timber production as well as site-appropriate seedlings for restoration efforts. Forest Service scientists have made great gains in understanding and managing the potential losses to these investments arising from insects and pathogens. Many of the key components in the development of an IPM program for southern seed orchards are known. The biology of key pests in seed orchards have been identified for southern pine seed orchards along with lures suitable in detecting and monitoring these species. A variety of pesticides have been tested and approved for southern pine seed orchards and are currently in widespread use. A spray timing model for one key pest, Dioryctria amatella, has been developed in efforts to reduce pesticide use and costs. We plan to develop a spray timing model for another key species, D. clarioralis, as well as a method to detect and estimate populations of seedbugs, the third key focus group in the management of seed production. Once completed, the combined knowledge will be used in developing a functional and cost-effective IPM program for southern pine seed orchards.

Nurseries

Historically, a variety of fungal pathogens, plant parasitic nematodes, insects and weeds have impacted seedling production in forest-tree nurseries. The introduction of fumigation with methyl bromide in the 1950's provided a means for broad spectrum control of many soilborne pest problems. Methyl bromide has been identified as an ozone depleting chemical and it use is scheduled to be phased-out under the terms of the Montreal Protocol. In addition, nursery operations have changed considerably during the last 50 years. Numerous herbicides are presently available for weed control, and more is now known about practices that favor seedling production and development. Research is presently needed to develop alternative pest management practices, as well as specific management practices to reduce disease development in forest-tree nurseries. We plan to continue our work on the influences of nursery cultural practices on pathogenic fungi and plant parasitic nematodes to minimize subsequent disease development and increase seedling production. As methyl bromide is phased out we will continue to assess application methods, distribution, efficacy and fate of alternative soil fumigants and other pesticides.

Diseases of Managed Forests

A number of diseases have profound economic and ecological effects. The organisms that cause them are influenced by management practices and ecological conditions. We lack information on the ecological processes and interactions involved in disease susceptibility and severity under various management regimes. Additionally, little is known about pathogen population structure, interactions with tree-attacking insects, and what management actions may be undertaken to mitigate or prevent losses.

The Leptographum/Ophiostoma fungal complex is associated with decline and mortality in stands of longleaf pine after fire reintroduction and recently these disease organisms have been suggested as the cause of post-fire declines observed in loblolly pine. Other root pathogenic fungi in this group (Leptograpium wageneri) cause serious root diseases in east side ponderosa pine stands in the western United States. We plan to continue our research to understand the fungi involved in this disease complex, the insects responsible for their spread, impact of these organisms in conifer forests, and ways to reduce effects of more pathogenic types in our forests.

Other below ground root disease organisms such as Heterobasidion annosum cause a woody root disease affecting conifers worldwide. Because of changes in forest management, this disease is on the rise in southern forests and remains a problem in the western United States. The disease creates tree hazards in campgrounds and other recreational areas, losses in productivity, increases stand susceptibility to insect attack, and affects forest structure. Knowing its population structure allows development of management guidelines to minimize losses and such studies will permit development of a model format for study of other similar pathosystems, both native and exotics. We plan to continue our research on this important root disease by studying its population sub-structure, its response to various management practices (e.g.,

prescribed fire), and its spread dynamics within managed and natural stands.

There are also other below ground root-inhabiting organisms that are not destructive pathogens but may serve as indicators of ecosystem status. Among these are mycorrhizal fungi, which are beneficial, to certain of the Leptographium/Ophiostoma complex fungi that are mildly pathogenic but may also serve as indicators of ecosystem stress. We plan to study these organisms in the context of being potential indicators to develop tools to assess overall ecosystem health.

PROBLEM 3 -- Effects of Forest Management on the Diversity of Insects and Fungi in Southern Forests.

Insects are the most diverse group of organisms on earth and fungal diversity is only beginning to be appreciated. Both play critical roles in forest ecosystems. However, the ways in which our changing forests and forest management practices have affected insect and fungal communities and their abilities to carry out these roles are not understood. Conservation on a species by species basis is neither practical nor desirable so understanding and conserving important habitats within our forests is our best hope of " saving the parts" for future generations.

Dead wood in Southern Forests

Worldwide, dead wood in forests is recognized as one of three most important habitats for both insect and fungal diversity. Estimates range from one-fifth to one-third of forest species utilizes dead wood as part of their habitat. Despite this recognized importance little is known about dead wood dynamics in southern forests. We will continue research on the role of large dead wood in southern forests with emphasis on how this important resource contributes directly and indirectly to the diversity of southern forests.

Forest Pollinators

Pollinators are critical for the survival of many plant species inside and outside of the forest. Despite their clearly recognized importance they have not been well studied in forest ecosystems. We lack basic knowledge about their biology and effective tools for monitoring and assessing there abundance and diversity. Without this information it is difficult to know how forest management activities are affecting them. We will conduct research on the interactions of pollinators with forest plant community diversity, the biology and nesting habitats of pollinators, and work on development of effective tools for monitoring their abundance and diversity.

Insects in Southern Forest Food Webs

Insects are an integral part of the food webs that supports the diversity of organisms associated with southern forests. They are particularly important to many bird species including the endangered red-cockaded woodpecker (RCW), Picoides borealis. We will continue our investigations into the effects of stand conditions and forest management activities on the arthropod prey of RCW and other bird species.

Signature	Title	Date
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/s/ Mary Ellen Dix	Assistant to Staff Director	1/26/06
/s/ Jimmy L. Reaves	Staff Director	1/26/06
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Concurred: /s/ Ann Bartuska	Deputy Chief for Research	2/3/06