Mr. Chairman and members of the Committee, my name is Frederick Stephen and I am University Professor and Interim Head of the Department of Entomology at the University of Arkansas, Fayetteville. I am here today representing the Society of American Foresters. The Society has nearly 17,000 members dedicated to advancing the science, technology, education, and practice of forestry in the United States for the benefit of society at large. One of our core values is sustaining forest resources by simultaneously meeting environmental, economic, and societal goals and constraints. I would like to thank the Committee for inviting me. I am pleased to have this opportunity to testify on the topic of forest insect infestations as they pertain to forest health.

The Society of American Foresters holds the view that forest health is a perceived condition involving consideration of such factors as age, structure, composition, function, vigor, and unusual levels of insect and disease activity. These attributes will vary depending on the values and uses determined for each forest ecosystem. Potentially, forest health involves considering the status of all ecosystem components. Insects and diseases are normal inhabitants of forest ecosystems, but at epidemic levels can have serious impact on the overall condition and resilience of such systems. The SAF believes that appropriate, science-informed, silvicultural treatments can be important in increasing forest biodiversity and health and thereby also reduce the likelihood of occurrence or severity of impact of many forest insect outbreaks and associated events such as devastating wildfire or blowdown, that often follows infestations.

Currently throughout our country, forests in all ownerships are affected by unprecedented and catastrophic insect outbreaks. These outbreaks can have certain dramatic consequences including economic loss, increased risk of wildfire in certain areas of the country, increased risk to human safety, and change in forest structure and composition that may diminish aesthetic and ecological values. I would like to provide a few brief highlights of forest insect outbreaks we currently are experiencing and suggest that additional support of research as well as the transfer of research into on the ground activity would help to mitigate their impact.

Indigenous Forest Insect Pests

BARK BEETLES
When considered as a group, bark beetles are the most significant forest insect pests in our country. Bark beetles include primary tree-killing species such as southern pine beetle, western pine beetle, mountain pine beetle and spruce beetle, plus other secondary species that can be devastating when trees are sufficiently stressed by drought or other factors. This complex of small, ubiquitous insects is responsible for the death of millions of conifer trees annually across forests of North America, more than are killed by fire, disease and storms combined. Although research and control efforts have been a paramount concern of foresters and entomologists for over a century, simple solutions to their management remain elusive.

In the southern US more than 46,000 bark beetle infestations in pine forests were reported in 2002. Conifer forests of the Rocky Mountain West are currently experiencing outbreaks of bark beetles at levels unprecedented in historical times. These massive outbreaks range from Alaska's Kenai Peninsula where over 90% of the spruce have been killed, through Canada which currently is experiencing the largest epidemic in its history, to the Southwest where the entire distribution of pinion pine has suffered severe mortality. The warm temperatures these

regions have experienced over the past several decades have contributed to the increasing devastation of these infestations. If warming continues, the environmental rules that govern forest outbreak insects could also change.

Although each of these forest landscapes across the country is unique, the bark beetle epidemics perhaps share some common features. Most of the devastating outbreaks occur in stands that are overstocked, with mature to over-mature trees, frequently of a single species, and whose normal mechanisms of resistance are challenged by drought conditions and in some cases sequential years of excessively mild winters.

Because of my own research experience I will highlight southern pine beetle (SPB) as an example. The economic, social, and ecological impact of this native beetle is catastrophic across the southern United States. Recent damage caused by this insect exceeds all historical records. The geographic range of the current epidemic continues to expand and new host tree species are being infested. Although previous research and application programs have greatly increased our knowledge base for the insect, is it still inadequate to fully explain the causes for the epidemic or provide acceptable solutions as to how it can be managed. Although SPB-caused tree mortality is always present within the South, it is often isolated and primarily of local concern. In 2002, however, more than 142 million acres of both public and private lands in the southern US were infested with high populations of southern pine beetle. Mild winter conditions, plus drought, continued to provide optimum conditions that favored outbreak of this native forest pest. The epidemic currently occurs across forests in Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia on federal, state and private lands. The southern Appalachian Mountains in eastern Tennessee, western North Carolina, South Carolina, north Georgia, and northwestern Alabama continue to be seriously affected. Significant bark beetle activity also occurred in central and southwestern Mississippi on national forest lands.

The duration and extent of the current outbreak throughout the South has generated unified concern and a call for an organized effort to protect the forests of the region. The technical expertise required to plan and to conduct a substantial SPB research and development program is dispersed among the land grant universities and a variety of federal, state, and private agencies and organizations. It is therefore essential that a representative cross-section of the stakeholder community participate in defining the agenda and formulating an action plan for multi-state research. A grant proposal to USDA CSREES, prepared by university scientists, in cooperation with Forest Service scientists, has recently been funded to enable a facilitated Needs Assessment Workshop on southern pine beetle research and implementation. This workshop, planned for August 2003, will address these issues.

Catastrophic population outbreaks of other conifer-infesting bark beetles, the western pine beetle, mountain pine beetle and spruce beetle are ravaging forest in the western US, Canada and Alaska. The overall damage from these insect outbreaks is greater than at any time in history.

It has been demonstrated that prudent forest management and stewardship can lower the risk of unacceptable loss of property and resource assets due to insect infestations through various silvicultural prescriptions. As mentioned above many of the conditions that favor bark beetle

outbreaks are those, which are associated with long periods of little or no management of forests. When stands are single-species, single-aged, overstocked and over mature, the bark beetle hazard becomes increasingly high. It has been cynically said of this condition in some of our southern forests "we don't have an outbreak of southern pine beetle, but rather an outbreak of pine... and the southern pine beetle is just doing its best to bring that under control." A healthy forest is a sustainable forest and one that generally is less subject to drastic outbreaks of insects or disease.

Forest entomologists have served as leaders in exploring ecological approaches to management of insect pests. University led teams of bark beetle researchers have made significant and pioneering discoveries on the role of behavioral chemicals in bark beetle biology. These studies have been accomplished with all of the major bark beetles throughout the United States. Research with bark beetle pheromone systems has yielded promising new tools for monitoring and managing these pests. More collaborative work of this sort, in partnership with federal and state agencies is needed. Other university and Forest Service scientists (including my research team at the University of Arkansas) have developed sophisticated computer-based population dynamics models to predict the course and impact of bark beetle infestations. Subsequent collaborative research among other universities and the Forest Service has extended this approach into GIS-based applications that use sophisticated equipment for information gathering and processing to enable data-rich decision-making in forest management situations. Another example of research that may lead to a novel pest management tactic for the southern pine beetle is research that we have conducted in partnership with private industry and Forest Health Protection. We have developed an artificial food supplement for bark beetle parasitoids, intended to augment natural food sources for these beneficial insects, to increase the natural control of bark beetle populations and minimize outbreaks.

OAK DECLINE AND THE RED OAK BORER IN THE OZARK MOUNTAINS

A variety of hypotheses exist for the cause of the current oak decline and mortality in the forests of the Ozark Mountains. Oak decline is a widespread disease complex in the southeastern United States that may affect well over 3 million acres of oak forest in 12 states. Predisposing factors apparently important in the Ozark Mountains are tree age, prolonged drought, poor soils and low site quality. Inciting factors are thought to be acute, short-term drought stress. Contributing factors have been postulated to include defoliation and boring from secondary insects, root diseases and cankers The relative importance of oak decline in the current red oak borer outbreak is at present unclear, although most 'opinion' seems to favor the idea that high densities of over-mature oaks in combination with recent drought conditions are most important. It seems evident, however, that conditions in the Ozarks are somewhat unique, as no other oak decline event has ever had red oak borer as such a primary cause of tree mortality.

The red oak borer is an insect species that is native to eastern North America. It attacks living oak trees and preferred hosts are those in the red oak group (i.e. northern red oak, black oak, scarlet oak, shumard oak, post oak, and pin oak). Until recently little attention was paid to this insect because red oak borer attacks normally occur at sufficiently low densities that tree mortality seldom results. However the current outbreak of this insect and the tree mortality of unprecedented magnitude now occurring throughout the oak forests of Arkansas, Missouri and

Oklahoma have quickly changed that.
Surveys on the Ozark National Forests of Arkansas and Missouri show that red oaks make up approximately 46% of the hardwood component. Extensive oak mortality was first detected in 1999, and preliminary estimates of the extent of damage are indeed sobering. Roughly 33 percent of the area in the Interior Highlands, where oaks that are 70+ years old dominate stands, is potentially at risk. We conservatively estimate that 33 percent of these trees are severely affected. The dollar value at risk, in timber value alone, exceeds $1.1 billion and certainly the impact on wildlife, tourism and other values would dramatically inflate that figure. The direct impact on the local economies would include losses of jobs in logging, mills and companies making hardwood products. There would also be losses to companies that provide equipment and supplies to these industries. A loss of 2,200 jobs in the logging and milling industries is anticipated. The oak decline - red oak borer complex is the greatest threat to the oak component in the Interior Highlands in recent history. And this is from a native insect never before considered anything other than a minor concern in forests!

Previous research conducted in the 1970's and 1980's that examined more than 1000 trees found that most trees experienced less than 5 attacks with only about 1 beetle emerging per tree. We currently are conducting research at the University of Arkansas, in cooperation with scientists at the University of Missouri, Arkansas Forest Resources Center and USDA Forest Service, on red oak borer infestations in the Ozark National Forests of Arkansas and Missouri. Our preliminary studies reveal an average of more than 2000 attacks per tree and from 200 to 300 emerging adults from each of those trees. The densities of attacks, and emerging adults we find are so dramatically higher than any published records that they suggest the most serious and visible problems from this insect outbreak are yet to be experienced.

In Arkansas our current red oak borer research is designed to produce a GIS-based on-line system housed at the University's Center for Advanced Spatial Technology that will enable real-time mapping of forest stands with highest probability of red oak borer damage. We also are developing sampling methods to permit evaluation of the current cause of the red oak borer population explosion and prediction of the course of the epidemic. We are working in partnership with the Forest Service to determine and map the extent of the infestations. Other studies we have initiated will examine the molecular genetics of this insect to see if the populations we have in Arkansas differ from those in other parts of the US where red oak borer outbreaks are not occurring. Further research will examine site, stand and ecological factors that influence the distribution and abundance of red oak borer in the forest, and the impact of those factors of oak resistance to attacking borer larvae.

The SAF believes that more information is needed to quantify the extent of damage and the effects upon the multiple and diverse forest resources that we value as a society. We need to discover what can be done to retain a red oak component in the current and future forest of the Interior Highlands. From a research perspective, we must determine what factors are most responsible for this unprecedented outbreak, and target activities related to utilization, restoration, salvage, effects on wildlife, watershed impact and fire hazard. Research by university and federal scientists that address these and related concerns might forestall the degradation and loss of a dominant species group in the Interior Highlands forest over the next

century. Currently resources are not adequate to address this crisis.

Exotic forest insect pests

Many forest insect pests that become significant disturbance factors in our forest ecosystems are exotics; species from other parts of the world that become established in our forests without the normally controlling factors that minimize their impact in their native habitats. Important examples of such introduced pests are smaller European elm bark beetle (the vector of Dutch Elm disease fungus) gypsy moth; hemlock woolly adelgid, and more recently pine shoot beetle, Asian long-horned beetle, and emerald ash borer. The catastrophic impact to our forests (ecologically and economically) that results from accidental introduction of such pest species cannot be minimized. Biological control of these exotic species may be possible but will require a significant research commitment, highlighted by careful search for effective natural enemies that can reduce pest populations without harm to our native flora or fauna. Control and mitigation of some of these species is often possible through various silvicultural practices aimed at improving forest stand conditions that will reduce the risk of insect infestations. Research partnerships among scientists from land grant universities and federal and state agencies have, and continue to contribute to successful biological control and silvicultural treatment projects that address these issues.

GYPSY MOTH

The gypsy moth is originally from Europe, and was introduced into the northeastern US well over 100 years ago. The range of gypsy moth has continued to spread, and every year isolated populations are discovered beyond the contiguous range of the gypsy moth. It is inevitable that gypsy moth will continue to expand its range in the future. Its host range is extensive and it will feed on the foliage of hundreds of species of plants in North America but its most common hosts are oaks and aspen. Gypsy moth hosts are located through most of the US but the highest concentrations of host trees are in the southern Appalachian Mountains, the Ozark Mountains, and in the northern Lake States.

Gypsy moth populations are typically eruptive in North American forests. When densities reach very high levels, trees may become completely defoliated. Several successive years of defoliation may ultimately result in tree death. In most northeastern forests, mortality is often less than 20%, but occasionally much greater tree mortality may occur, especially in areas where the oak component is much higher (e.g. the Appalachian region). A major concern is the potential loss of economically critical and ecologically dominant oak species. Most studies that relate changes in forest composition to gypsy moth defoliation indicate that less susceptible species such as maple will eventually dominate those forests. The long-term consequences of such change may be very undesirable.

In the past 25 years more than 65 million acres have been defoliated by gypsy moth, with suppression costs of at least $650 million dollars. This does not include costs for detection or eradication, which probably exceed $5 million per year.

HEMLOCK WOOLLY ADELGID

Hemlock woolly adelgid (HWA) is an exotic pest first found in the eastern U.S. in Richmond, VA in the early 1950's. It was an innocuous pest until the 1980's when populations exploded and started killing hemlock trees. The pest continues to spread (north, west, and south) and

now inhabits 35 - 45% of the range of eastern hemlock. HWA infestations most often result in tree death within 4 - 8 years. Some trees live longer, and some geographic areas have been less impacted, but overall tree mortality has been devastating. Hemlocks are a keystone climax species in many forest habitats, and an important association tree in 19 forest types when not the dominant tree. Hemlock was heavily logged until the 20th century and is now found in riparian areas, ravines, and north facing slopes, often in pure or mixed stands. It is also one of the few tree species in the East to have any trees older than 400 years, many of which have already died. Perhaps the most critical aspect of this tree's demise is that there is no tree species in the eastern forest that can fill the ecological niche that hemlocks provide. In forest ecosystems, the only hope for managing HWA is through biological control. Research pioneered by teams of scientists at universities and federal agencies are continuing to explore the intricacies of this system. A complex of predators is being imported from the native range of HWA in Asia and in western North America with hope of lowering HWA populations.

EMERALD ASH BORER

Another introduced species, the emerald ash borer (EAB), was detected in Michigan and Ontario in 2002 and in Ohio in 2003. This species, originating in Asia, has since killed over 6 million ash trees in Michigan and another 700 million are at risk. Michigan, Ohio, and Canada have now enacted quarantines aimed at stopping the human-assisted spread of EAB. Federal and university scientists, in both the U.S. and Canada, are cooperating to investigate EAB life history, biology, and management strategies. Additional research on survival in logs and chips, survival in firewood, and molecular comparison between North American and Asian EAB populations is underway. Given that EAB has successfully attacked all species of native ash growing within the infested areas of the U.S. and Canada, it would appear that the entire North American ash resource is at risk from EAB attack.

Conclusion

Obviously not all insect infestations are a result of introduction of exotic pest species. Forests are not static, and as stands change in tree species composition, density, age structure, and tree vigor the success and dynamics of insect and disease can be remarkable. These biotic changes may be coupled with the impacts of drought and temperature and serve to enable dramatic increases in insect abundance, often with serious consequences for forest health.

Research is also needed to determine the implications of certain management techniques on insect infestations. Some studies have shown that various silvicultural methods may be effective deterrents or mitigating agents but additional research is needed to determine how these tools can be used in the context of the differing insects that are infesting our forests. Prudent forest management leading to healthy, sustainable forests requires greater investments in research and monitoring. Increased research effort is critically needed to obtain new knowledge on how to develop and maintain healthy forests. Investments must be made to monitor suitable indicators of forest health to enable effective adaptive management.

A frequent concern of my colleagues in universities who seek and compete for research funds to develop effective management strategies for the forest pests discussed above is that all too often resources only become available when pest outbreaks reach catastrophic levels. This funding frequently is highly directed in scope and short-term in nature, instead, funding must

be allocated for coordinated projects of multi-year duration. Research that is effective in addressing the complex problems facing forest managers must be collaborative in nature and address basic underlying causes. This research will be inadequate if it is only conducted during insect population epidemics. We must be able to develop more long-term studies that permit a team approach to investigations that continues through cycles of high and low population, conditions. Too often, as soon as epidemics collapse, no money is available for research until the next outbreak. This is a primary reason research into forest pest problems is fragmented and scattered, despite the many fine scientists who devote their careers to such investigations.

In summary, I believe that we are facing insect outbreaks that may result from unhealthy forest conditions and which are further incited by such climatic factors as serious drought. It is essential that we realize the complexity and uniqueness of these insect epidemics as well as their commonality. To successfully manage such problems will require greater support of research by university and other scientists to effectively acquire knowledge of the basic causes and underlying reasons for these problems. Continued support will then be necessary to extend this knowledge into ecologically and economically effective integrated pest and forest management systems.

In addition to addressing research needs, there are certain actions Congress and the Administration can take to give forest managers the tools to improve conditions on the national forests and private lands and address these insect infestations and other forest health issues, while maintaining both environmental protections and public participation. Forest managers need to be able to apply the information and knowledge developed through research to manage and protect the nation's forests from such catastrophic, uncharacteristic outbreaks as we are currently experiencing. The Society of American Foresters is encouraged by the efforts taken to this date made through the 2002 Farm Bill and the Healthy Forests Initiative. However, a long-term solution that would change both regulations and laws is needed for both public and private lands. We will continue to offer our support to address questions and concerns.

Thank you again for the opportunity to speak here today. I'd be happy to answer any questions.