Statement of
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House Agriculture Committee
United States House of Representatives

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Concerning

Challenges of Managing and Maintaining Forest Health

Mr. Chairman and members of the Subcommittee, thank you for the opportunity to appear before you today to provide an entomologist's view of the impacts and challenges of invasive pests on the health of our forests. I appreciate the Subcommittee's interest in a matter of great importance and that is the management and maintenance of the health of the nation's forests for future generations.

More than 400 species of invasive forest insects and diseases are currently established in the United States. Some of these insects are able to spread quickly and cause significant economic and ecological impact to our nation's forest and urban trees. An estimate of the management costs associated with invasive insect and mite pests in our nation's forest is at least $2.1 billion/year. The cost of insecticides applied against introduced pest insects is approximately $500 million/year in the United States. Suburban and urban areas of the Northeast through the years have been locations of first detection for many invasive forest tree pests. For many years scientists conducting basic and applied research and extension education activities in the disciplines of entomology and plant pathology have a long history of studying the biology and ecology of invasive forest pests and methods for effective management. Collaborative research between entomologists and plant pathologists at land grant institutions, state and federal governmental agencies, and others on tree diseases vectored by insects often leads to discoveries that result in the development of management strategies and decision-making tools for achieving the goal of healthy forest and urban landscape trees.

Some invasive species that impact the health of forest trees on which research and extension activities are currently being conducted include the emerald ash borer, hemlock woolly adelgid, Asian longhorned beetle, and gypsy moth. Some diseases in the forest that are caused by invasive plant pathogens include sudden oak death and butternut canker. Some insect-vectored tree diseases include elm yellows, oak wilt, beech bark disease, Dutch elm disease, and most recently thousand cankers disease on black walnut.

I would like to discuss a few invasive insect pests that impact the health of trees in our nation's forests. Additionally, I'd like to highlight some research that has been conducted on these pests by entomologists, plant pathologists, chemical ecologists, horticulturists, regulatory agency employees, and others. Some research priorities associated with these invasive pests will also be suggested that may lead to discoveries allowing more effective management and maintenance of the health of the trees in our forests and landscapes.

Emerald Ash Borer

Ten years ago the emerald ash borer, *Agrilus planipennis,* was discovered as the cause of extensive ash, *Fraxinus* spp. mortality and decline in southeastern Michigan. The emerald ash borer is responsible for killing more than 40 million ash trees throughout much of the Midwest and in some states in the Northeast. This beetle is a member of the insect family Buprestidae whose adults are commonly called metallic wood-boring beetles and the larval stages are referred to as flatheaded borers. What's really important to note is evidence suggests that *A. planipennis* first entered Michigan from China at least 15 years ago prior to its detection in 2002, presumably from solid wood packing materials used to ship manufactured goods. The emerald ash borer is now found in at least 15 states and Ontario, Canada. Research has demonstrated that spread of the emerald ash borer results primarily from the flight of this invasive pest and human transport of infested ash firewood, logs, lumber, and nursery stock. As an example in 2003 emerald ash borer infested nursery stock from Michigan was illegally sold to a nursery in Prince George's County, Maryland and sold in Maryland and Fairfax County, Virginia. In an attempt to limit the all too common human-assisted spread of this invasive pest from areas infested with the emerald ash borer, many states imposed orders of quarantines and regulations on the transport of ash trees and ash wood related products. Additionally, federal quarantines were issued by both the USDA Animal and Plant Health Inspection Service (APHIS) as well as the Canadian Food Inspection Agency.

Early detection of new infestations of the emerald ash borer is important for the success of any effective management efforts to protect the health of ash trees. Research has led to the development of sticky traps and associated lures that are being used to survey for this invasive pest. The emerald ash borer is very difficult to detect at low population densities. Continued research on the identification of an effective pheromone for the emerald ash borer should be supported. Further research on the identification of suitable natural enemies and biological control of this pest needs to occur.

The movement of ash and ash-related products from emerald ash borer infested areas continues to be prohibited by federal quarantines. One frustration is the unintentional movement of ash materials continues to occur due to the lack of awareness and understanding of the quarantine regulations and the impact this species has on forest products (baseball bats, etc.) and the green industries. An increase in cooperative extension education efforts that target the public and other stakeholders groups needs to be supported.

A survey of communities in Ohio found losses in landscape value for ash trees within community boundaries were estimated to be between $800 million and $3.4 billion assuming the complete loss of ash resulting from the emerald ash borer. Tree replacement costs in these communities would range between $300 million and $1.3 billion. The total losses for these Ohio communities, including ash landscape losses, tree removal and replacements, are estimated to range between $1.8 and $7.6 billion for a single insect pest in this one state. The potential total costs in Ohio were estimated to be between $157,000 and $665,000 per 1000 residents. It's suggested in this survey that communities can use these figures to begin developing contingency plans for the impact of the emerald ash borer on their budgets.

Ash should make up no more than 10 to 25 percent of the basal area of a forest. If ash exceeds that level and you believe that you have marketable ash trees in the forest, you may want to get estimates and consider selling the ash trees. The level of urgency will depend on how close your property is to sites known to be infested with the emerald ash borer, your overall objectives for the property, and the abundance of ash compared with other species on the site. If you think you have marketable ash trees, work with a professional consulting forester. Decisions about timber sales and stumpage values can be complicated and it's important to work with a professional forester. Consulting foresters can help identify the markets that are available in an area. They may also know of portable or custom sawmills that can be hired to saw ash trees into boards for your own use or sale. It may be important to work with neighboring forest landowners. They may be facing a situation similar to yours. Often the per-acre costs of setting up a timber sale decrease when larger areas are involved. Cooperating with neighbors may lead to lower costs and better timber prices for everyone.

Other tree species may be part of a timber harvest that removes ash. Many forests can benefit from a well-planned harvest in which ash reduction is only one of several landowner objectives. A mixed-species sale may be of interest to more buyers or result in higher profits for a forest landowner. Again, it is important to work with a professional forester to ensure that the productivity and the health of a forest are maintained or even enhanced by a harvest.

The emerald ash borer as an invasive, wood-boring pest has already placed tremendous economic pressure on both state and municipal budgets as well as their human resources. Scientists estimate the cost of treatment, removal, and replacement of ash trees due to the impact of the emerald ash borer will exceed $10.7 billion over the next 10 years.

Hemlock Woolly Adelgid

The hemlock woolly adelgid, *Adelges tsugae*, is a small, soft-bodied, insect that removes plant cell fluid with its piercing-sucking mouthparts. This forest health pest is closely related to aphids and has caused widespread decline and eventual death of hemlock trees in the forests and landscapes the eastern United States. The hemlock woolly adelgid is native to Asia and was first detected in the eastern United States in 1951 in a park in Richmond, VA. It was first observed in southeastern Pennsylvania during the mid-1960s. This pest species is believed to have been unintentionally introduced into the United States on Japanese hemlocks that were planned for use in landscapes. The hemlock woolly adelgid spread slowly until the late 1970s when this invasive insect pest reached forest areas and began to cause death of host trees. This key pest of hemlock has since spread into at least 17 states that include those in the Southeast to southern Maine. The hemlock woolly adelgid has few natural enemies in eastern North America, and our native eastern hemlock, *Tsuga canadensis* and Carolina hemlock, *Tsuga caroliniana* are highly susceptible to its attack. Currently, insect predators and an insect-killing fungus are the only known natural enemies of populations of the hemlock woolly adelgid. To date, it has no known parasitoids that reduce its populations on hemlocks. Research conducted by entomologists with the USDA-Forest Service, at land grant institutions, state governmental agencies, and their cooperators has been focused on identifying effective management options for the hemlock woolly adelgid on forest and urban trees. The hemlock woolly adelgid and an another non-native insect pest that was detected in New York in 1908 known as the elongate hemlock scale, *Fiorinia externa*, poses another health risk to our eastern hemlocks. This armored scale insect species is attacked by some parasitoids, but it is very difficult to effectively manage when it infests forest trees. The elongate hemlock scale and the hemlock woolly adelgid pose a very serious threat to the sustainability of hemlock. Research on the biological control and the ecology of these pests in our forests needs to be investigated to an even greater extent. The loss of hemlocks in our eastern forests will have an impact on both wildlife habitat and the survival of wild trout. The loss of hemlock will also cause change in the structure and biodiversity of our eastern forests.

There is often a desire to manage a forest in a way that is most “natural.” However, the current widespread outbreak of the hemlock woolly adelgid is not like any other form of natural disturbance known to affect hemlock trees in our forests. Harvesting options and related costs will differ depending on the size structure of hemlock in a particular forest and whether the management goal is aesthetics, wildlife habitat, water quality protection, future forest successional dynamics, timber revenue, or a combination of these management goals. Unless timber revenue is the main objective, pre-emptive cutting or pre-salvage of uninfested forests is not recommended, as the future interactions between hemlock and the hemlock woolly adelgid are uncertain, and cutting could remove potentially resistant hemlock.

There are a variety of silvacultural alternatives available to forest landowners with hemlock stands threatened by the hemlock woolly adelgid. The options range from doing nothing to directly influencing vegetation succession with a variety of cutting methods, depending on the forest landowner’s objectives, overall hemlock health, and stand conditions. All options and associated costs should be considered carefully when planning the appropriate management strategies.

Feeding by the hemlock woolly adelgid on susceptible hemlocks may cause rapid decline in tree health, followed by quick mortality. Hemlocks may die within four years of being infested. Stressed hemlock trees are more susceptible to attack by other insects, mites, or diseases. Eastern hemlock is an ecologically important species in our nation’s forests. Hemlock stands provide unique habitat to many forest species that are dependent on the dense canopy of hemlocks. Wildlife species such as ruffed grouse, turkey, deer, snowshoe hare, and rabbit are afforded cover by healthy hemlocks. Many songbirds use eastern hemlocks as nesting sites, food source, roost sites, and winter shelter. Many plant species also inhabit hemlock stands. The impact of feeding injury caused by the hemlock woolly adelgid on hemlocks affects and disrupts the entire ecosystem as well as the health of our eastern forests.

Gypsy Moth

The gypsy moth, *Lymantria dispar*, was accidentally introduced into Massachusetts in l869. By 1902 this pest was widespread in the New England states, eastern New York, and regions of New Jersey. The gypsy moth was first detected in Luzerne and Lackawanna Counties in northeastern Pennsylvania in l932. Heavy defoliation and subsequent tree mortality has occurred along mountain ridges in forests comprised primarily of oak. The gypsy moth is often considered the most important insect pest of forest and shade trees in the eastern United States.

Egg masses are light tan, and each mass may contain 400-600 eggs. A mature larva is 50-65 mm long with a yellow and black head. The thorax and abdomen have five pairs of blue spots (tubercles) followed by six pairs of brick red spots. The pupal stage is dark reddish-brown. Male moths are dark tan and fly readily during the day. Females are white with black, wavy markings; they have robust abdomens and do not fly, and their wingspan can reach 5 cm.

Egg masses deposited by females during July overwinter on trees, stones, and other substrates in the forest and landscapes. Eggs hatch from late April through early May with most eggs hatching by mid-May. Small first instar larvae do not feed right after they hatch and can be dispersed by wind. Young larvae feed on foliage and remain on host plants night and day. In late May when about half-grown, larvae change their behavior and usually feed in the trees at night, and move down to seek shelter in bark crevices or other protected sites during the day. Larvae reach maturity from mid-June to early July. Pupation takes place during late June and early July. The pupal cases may be observed attached to tree bark, stones, buildings, and other similar sites. Adults start emerging in late June with peak emergence in mid-July. The gypsy moth produces one generation a year.

This key invasive insect pest is indirectly responsible for causing mortality of susceptible host trees in forests. Heavy defoliation by the larval stage of this pest causes stress to infested host plants. Secondary organisms such as the twolined chestnut borer, *Agrilus bilineatus*, and shoestring root rot, *Armillaria* spp., successfully attack stressed trees causing mortality.

Preferred host plants for all larval stages of the gypsy moth in the forest include oaks, *Quercus* spp., alder, *Alnus* spp., aspen, *Populus* spp., gray birch, *Betula populifolia* , white birch, *B. papyrifera* , hawthorn, *Crateagus* spp., larch, *Larix* spp., linden, *Tilia* spp., mountain ash, *Sorbus* spp., Lombardy poplar, *Populus nigra* , willows, *Salix* spp., and witch-hazel, *Hamamelis* spp. Plants favored by older larvae but not by young larvae include beech, *Fagus* spp., red cedar, *Juniperus* spp., chestnut, *Castanea* spp., hemlock, *Tsuga* spp., plum, *Prunus* spp., pine, *Pinus* spp., and Colorado blue spruce, *Picea pungens*.

Light defoliation in the forest is defined as 0 to 30% loss of foliage and has little effect on the health of trees. Defoliation is barely detectable. Moderate defoliation is described as 31 to 50% loss of foliage. At this level caterpillars may be abundant enough to be a nuisance in an area if not managed. Trees will have enough foliage remaining to stay green and little mortality is expected. Heavy defoliation is when 51% or more of the foliage is removed from a tree. Tree mortality may result from one year's defoliation to hemlock, pine, and spruce in the forest. Deciduous trees can normally withstand one year of defoliation, but two or more successive years may result in moderate to high mortality. Around the 50% defoliation level, most deciduous trees produce auxiliary leaf buds and new foliage by mid-August. Refoliation in the same growing season creates a stress to an infested tree.

A normal outbreak pattern for the gypsy moth may be described as two years of light infestation with minimal defoliation followed by two years of moderate to severe defoliation with population collapse after the second year of heavy defoliation. Infestations may flare up in future years; however, caterpillar density and level of defoliation in the forest will probably not be as severe or widespread as encountered during an initial infestation.

Some people are dermally allergic to the caterpillars. The urticating hairs cause skin rashes on some humans. This is most noticeable in May when larvae are small. Children appear to be more prone to this problem than adults.

Air temperatures of minus 20°F or colder during the winter will destroy exposed eggs. Unfortunately, numerous egg masses are deposited on rocks, near the base of tree trunks and these may be covered with an insulating blanket of snow. Freezing temperatures in early May, after hatch, may also kill many larvae in the forest.

When gypsy moth larvae are half-grown, many of them feed at night and crawl down the tree in the morning to seek shelter during the day. Tree trunks may be encircled with a 14-18 inch wide piece of burlap or similar material. Place it at about chest height and arrange it so it hangs apronlike around the tree trunk. Tie off the center of the burlap band with string and fold the top portion down over the string. This burlap apron provides a place under which larvae rest and can later be killed. The apron must be checked daily, and all "trapped" larvae and pupae should be destroyed on valuable trees in a landscape. This technique works best in light to moderate infestations from late May through early July or until males begin to fly. This management method is usually effective enough to keep defoliation levels less than 50% of the tree's crown. A few shade trees can be well protected with this method. Do not expect this technique to be effective on trees that are part of a heavily infested forest.

Male moths readily respond to the female's sex pheromone. Males can be attracted to traps baited with a synthetic pheromone; however, such traps are not effective control measures. These traps do assist in monitoring an area for low level populations of this pest in the forest.

There are some native predators and parasitoids that attack life stages of the gypsy moth in the forest. Several introduced species of fly and wasp parasitoids of the gypsy moth are established in Pennsylvania and other states. Parasitoids and predators do not provide an immediate solution to a gypsy moth infestation. However, once a gypsy moth population collapses, the value of these natural enemies is exhibited by helping maintain populations in forests at low levels for extended periods of time. These parasitoids and predators appear to be contributing to stabilizing the gypsy moth population in several areas. Native predators, such as birds, white-footed mice, and ground beetles assist in keeping gypsy moth populations in the forest at tolerable levels.

A naturally occurring virus called the "wilt" has resulted in massive mortality of caterpillars causing populations to collapse in areas of severe defoliation. Although the virus is always present, it seldom affects the larval stage until they are under stress, due to overcrowding or reduced food availability in a forest. In recent years during wet spring weather, the fungal insect pathogen, *Entomophaga maimaiga*, has also caused collapse of heavy infestations of this pest in many areas.

Several insecticide formulations (microbial, insect growth regulators, etc.) are registered for effective management of this key pest. To maintain good plant health, applications should be made before serious defoliation occurs in the forest. When healthy egg mass densities are approximately 500/acre, aerial suppression of gypsy moth populations is indicated in forest stands with oak and other susceptible trees species. Aerial applications of registered formulations should be made according to label directions after the majority of eggs have hatched during early to mid-May, when larvae are small. Be sure that small larvae have dispersed and they have begun to feed causing the characteristic shothole injury to host plant foliage in the forest.

Asian Longhorned Beetle

The Asian longhorned beetle, *Anoplophora glabripennis*, is an unintentionally introduced, invasive species with the potential to become a major pest in the United States. This wood-boring pest is a member of the insect family Cerambycidae whose larval stages are called roundheaded borers. The Asian longhorned beetle was first discovered around New York City in

1996. Additional infestations were discovered in Chicago (1998) and Jersey City, NJ (2002), and Toronto and Vaughan, Ontario, Canada (2003). In 2008 a large infestation was found in Worcester, MA. A total of 66 square miles are now under quarantine with more likely to be added as the area is surveyed. As of 2009, established populations of the Asian longhorned beetle have been detected in Austria (2001), France (2003, 2004, 2008), Germany (2004, 2005), and Italy (2007).

In the United States, the USDA Animal and Plant Health Inspection Service (APHIS) has implemented an eradication program whereby all trees with signs of an Asian longhorned beetle infestation are removed and destroyed. The eradication program for the Asian longhorned beetle has greatly impacted the local areas where this invasive species has been found because of the removal of thousands of trees that cost states, municipalities, and residents millions of dollars. The United States has implemented stricter trade regulations to prevent further introductions of this wood-boring pest. The Asian longhorned beetle could pose serious economic and environmental threats to many important stakeholders such as the maple sugar industry, forest products industry, fall-foliage tourism, natural ecosystems, recreational areas, and many highly valued landscape and street trees. This is another invasive, wood-boring pest that has placed tremendous economic pressure on both state and municipal budgets.

Little was known about ALB when it was first discovered in the United States, however, scientists have since provided considerable new information on detection and control methods now used by USDA APHIS in their Asian longhorned beetle eradication program. Although APHIS is progressing in its goal to eradicate this pest that attacks maple, boxelder, buckeye, horsechestnut, birch, willow, and elm, additional improvements in control methods are still needed to reduce costs, improve efficiency, and ensure successful eradication of the Asian longhorned beetle.

Thousand Cankers Disease

Thousand cankers disease or TCD as it's known, was discovered in Bucks County, Pennsylvania in 2011. This insect-vectored disease poses a significant new threat to black walnut in Pennsylvania. Thousand cankers disease is a pest complex that is caused by the walnut twig beetle, *Pityophthorus juglandis*, and an associated fungus, *Geosmithia morbida*. Black walnut, *Juglans nigra*, is highly susceptible to this disease.

It has been estimated that the value of the walnut nut crop in California is approximately $500 million. The economic value of black walnut for use in many different types of wood products is estimated to be $580 billion. Since Pennsylvania is the top producer of hardwoods in the United States, thousand cankers disease is of great concern to forest health managers and hardwood products manufacturers.

The walnut twig beetle is native to North America. Its native range in the Southwest appears to coincide largely with the distribution of Arizona walnut, *J. major*, the likely original native host. Records from California suggest that the walnut twig beetle may be native to that state. The first published record of a cluster of black walnut mortality associated with the walnut twig beetle was in the Espanola Valley of New Mexico where large numbers of mature black walnut died in 2001. Similar widespread decline also occurred about this time in the Boise, Idaho area where the insect was first confirmed in 2003. Black walnut mortality and the walnut twig beetle have been noted in several Front Range communities in Colorado since 2004 and in most infested cities the majority of black walnut has since died. The walnut twig beetle was detected in Portland, Oregon in 1997.

Prior to these recent reports, the walnut twig beetle was not associated with any significant *Juglans* mortality. In most areas where the die-offs of black walnut have occurred, drought was originally suspected as the cause of the decline and death of trees, with the walnut twig beetle as a secondary pest. The widespread area across which *Juglans* spp. die-offs have been recently reported, combined with the documented presence of the associated canker producing fungal pathogen carried by the twig beetle, and the occurrence of black walnut death in irrigated sites not sustaining drought, all suggest an alternate underlying cause.

The first confirmation of the walnut twig beetle and fungus within the native range of black walnut was in Knoxville, Tennessee in July 2010. *Geosmithia morbida* was confirmed in samples under regulatory controls in August 2010. The potential damage of this disease to eastern forests could be great because of the widespread distribution of eastern black walnut, the susceptibility of this tree species to the disease, the capacity of the fungus and walnut twig beetle to invade new areas, and apparent ability to survive under a wide range of climatic conditions.

On *J. nigra*, the walnut twig beetle prefers to colonize the underside of branches in rough areas and prefers branches larger than 1 inch in diameter. Tunneling by the walnut twig beetle sometimes occurs in trunks and it prefers the warmer side of the tree. Winter is spent in the adult state sheltered within cavities excavated in the bark of the trunk. Adults resume activity by late April and most fly to branches to mate and initiate new tunnels for egg galleries; some may remain in the trunk and expand overwintering tunnels. During tunneling, the *Geosmithia morbida* fungus is introduced and subsequently grows in advance of the bark beetle. Larvae develop just under the bark and then enter the bark to pupate. Larval development takes 6-8 weeks to complete. Two overlapping generations were reported per season in Colorado. Adult beetles fly from mid-April to late October in Boulder, Colorado. The adult walnut twig beetle is estimated to fly one to two miles. Peak adult captures occur from mid-July through late August. Data suggest that two or more generations may be produced annually. Walnut twig beetle populations can reach levels of 30 per square inch; a single black walnut tree may produce tens of thousands of beetles.

Small, diffuse, dark brown to black cankers, caused by *Geosmithia morbida*, initially develop around the nuptial chambers of the walnut twig beetle in small twigs, branches and even the trunk. *Geosmithia* spp. are associates of bark beetles of hardwood and conifer trees but have not previously been reported as pathogens of *Juglans* or fungal associates of the walnut twig beetle. Branch cankers may not be visible until the outer bark is shaved from the entrance to the nuptial chamber; although a dark amber stain may form on the bark surface in association with the cankers. Cankers expand rapidly and develop more expansively lengthwise than circumferentially along the stem. On thick barked branches, cankers may at first be localized in outer bark tissue and extend into the cambium only after extensive bark discoloration has occurred. Eventually multiple cankers coalesce and girdle twigs and branches, resulting in branch dieback. The number of cankers that are formed on branches and the trunk is enormous; hence the name thousand cankers to describe the disease.

Potential movement of thousand cankers disease may occur on veneer logs, sawlogs, burls, stumps, firewood, wood packaging material, nursery stock, scion wood for grafting, and natural spread. However, the unexpected discovery of this disease deep in native black walnut range, over one thousand miles from the nearest known infestation has confirmed some assumptions while diminishing others. It is important to keep in mind that the Tennessee infestation has likely been present for 10-20 years. An important question is where else in the native range of black walnut could this disease be present but not yet detected. Drought, walnut anthracnose, and other symptoms may have masked thousand cankers disease from being readily detected.

Thousand cankers disease is scattered throughout western states and reports of walnut mortality are occurring simultaneously in areas that are connected by major highways. This distribution along major commerce routes suggests that movement of thousand cankers disease and its vector may be human assisted. Extension education programs on thousand cankers disease need to be developed and delivered by specialists and educators at our land grant institutions. Research conducted by scientists in both academia and state and federal governmental agencies should play a major role in disseminating applied research to stakeholders on this complex, insect-vectored disease of black walnut. Solving problems associated with thousand cankers disease will necessitate collaborative as well as interdisciplinary efforts to preserve the health of this important tree species.

Conclusion

Research priorities on invasive species that impact the health of our forest as well as landscape trees needs to be focused on the development of prevention, prediction, detection, monitoring, management, and genetic evaluation as well as restoration of trees in the forests of our nation. With the global movement of many different products, the sustained health of our forests is being placed at a higher risk for survival. We need to be even better stewards of the health of our forests for future generations.

This concludes my prepared statement, and I would be pleased to answer any questions you may have regarding the role invasive pests play in the challenges of managing and maintaining the health of our nation's forests.

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Committee on Agriculture

U.S. House of Representatives

Information Required From Nongovernmental Witnesses

House rules require nongovernmental witnesses to provide their resume or biographical sketch prior to testifying. If you do not have a resume or biographical sketch available, please complete this form.

1. Name:___**Gregory A. Hoover**_____________________________________

2. Organization you represent: **_The Pennsylvania State University**__________
3. Please list any occupational, employment, or work-related experience you have which add to your qualification to provide testimony before the Committee: _

   Ornamental Extension Entomolgist, The Pennsylvania State University__

   Forest Entomologist, Pennsylvania Dept. of Environmental Resources, Bureau of Forestry, Div. of Forest Pest Management___________________

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4. Please list any special training, education, or professional experience you have which add to your qualifications to provide testimony before the Committee: __

   _M. S., (equivalency) in Entomology, The Pennsylvania State University;

   _provide 40-60 lectures/year on arthropod pests of trees and shrubs –

   23 years at The Pennsylvania State University, Dept. of Entomology;

   write fact sheets on insect and mite pests of trees and shrubs, Dept. of Entomology, The Pennsylvania State University

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5. If you are appearing on behalf of an organization, please list the capacity in which you are representing that organization, including any offices or elected positions you hold: ____

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Educational Background

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Professional Experience

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1983-1989	Forest Entomologist, PA Bureau of Forestry, Division of Forest Pest Management
1981-1983	Laboratory Technician, PA Department of Agriculture, Veterinary Diagnostic Laboratory
1978-1981	Research Biologist, Ichthyological Associates, Inc., Three Mile Island Nuclear Station

Research Specialization

Integrated pest management and biology of arthropods attacking trees and shrubs; establishment of economic and aesthetic thresholds for arthropod pests of trees and shrubs; management of forest insect pests; systematics, ecology, and biology of aquatic insects, especially Ephemeroptera.

Publishing

Articles in refereed journals, 5

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Grants Received,

1994 - College of Agricultural Sciences, Pennsylvania State University, Integrated Pest Management, IPM on Woody Ornamentals, $20,000.00/yr.
1999 – Pennsylvania Department of Agriculture, Evaluation of the Monitoring and IPM Strategies Employed within the Nursery & Landscape Industry of Pennsylvania, $9,997.00
1999 - Pennsylvania Department of Agriculture, The Continuation of the Development of an IPM Monitoring System for Use by Pennsylvania Wholesale/Retail Ornamental Nurseries, $10,000.00/yr.
2001 - Pennsylvania Department of Agriculture, Using the Internet to Expand Distribution of a Landscape/Nursery IPM Arthropod Pest Monitoring Program for Pennsylvania's Green Industry, $8,500.00
2008 – Emerald Ash Borer Extension Education in Pennsylvania, Pennsylvania Department of Agriculture, $518,000.00 for 1 year.
2010-2011 - Elm Yellows Epidemiology and Management. The Pennsylvania State University, $61,500/yr. with Dr. Gary W. Moorman in the Department of Plant Pathology, Pennsylvania State University.

Honors and Awards

2001 - Pennsylvania State University, Outreach and Cooperative Extension Vice President's Award for Innovation.
2008 - Pennsylvania State University, College of Agricultural Sciences, Penn State Cooperative Extension Spirit Award for Outstanding Extension Associate.