

Georgia
Invasive Species
Strategy
Final Draft

Georgia Department of Natural Resources, Wildlife Resources Division

Georgia Invasive Species Advisory Committee

2009

Citation: Georgia Invasive Species Strategy. 2009. Georgia Department of Natural Resources, Wildlife Resources Division: Social Circle, GA.

This document is available on the Georgia Department of Natural Resources, Wildlife Resources Division website at <http://georgiawildlife.dnr.state.ga.us/conservation.aspx>

Table of Contents

Executive Summary	6
Introduction	9
Problem Definitions	15
Pathways of Introduction	15
Invasive Species in Georgia	16
Framework for Invasive Species Management in Georgia	38
Federal Invasive Species Management Efforts in Georgia	38
State Invasive Species Management Efforts in Georgia	40
Nongovernmental Invasive Species Management Efforts in Georgia	46
Current Gaps in Georgia’s Authorities and Programs for Invasive Species	50
Goals, Objectives and Actions	52
Program Monitoring and Evaluation	56
Glossary of Terms	57
Literature Cited	60
Appendix A: Invasive Species of Concern in Georgia	65
Appendix B: Summary of Federal Laws Relevant to Invasive Species	73
Appendix C: Summary of Georgia Laws Relevant to Invasive Species	83
Appendix D: Survey Results of Invasive Species Management Activities in Georgia	93
Appendix E: Federal Noxious Weeds List	95
Appendix F: Invasive Species Pathways	97
Appendix G: Public Comments	102
Appendix H: Members of the Georgia Invasive Species Advisory Committee	103

Acknowledgements

Compiled and written by Margaret Myszewski, Carl Vinson Institute of Government, University of Georgia, and members of the Georgia Invasive Species Advisory Committee (Committee).

In addition to the research and deliberations of the Committee, many staff members of the Georgia Department of Natural Resources contributed their knowledge and experience to the development of this plan.

Thanks to:

Jon Ambrose –Wildlife Resources Division

John Biagi –Wildlife Resources Division

Sonny Emmert – Coastal Resources Division

Rusty Garrison –Wildlife Resources Division

Chuck Gregory – Parks, Recreation and Historic Sites Division

Ted Hendrickx – Environmental Protection Division

Patti Lanford – Wildlife Resources Division

Todd Nims – Wildlife Resources Division

Michelle Vincent – Environmental Protection Division

Keith Weaver - Wildlife Resources Division

Lisa Weinstein – Wildlife Resources Division

Dana Wright - Environmental Protection Division

Thanks also to Jim Kundell for facilitating the Committee meetings and providing invaluable advice and expertise throughout the planning process.

List of Acronyms

APHIS-PPQ	Animal and Plant Health Inspection Service – Plant Protection and Quarantine
CAES	University of Georgia College of Agricultural and Environmental Sciences
CDCP	Centers for Disease Control and Prevention
CRD	Georgia Department of Natural Resources – Coastal Resources Division
DPH	Georgia Department of Human Resources – Division of Public Health
EDDMaps	Early Detection and Distribution Maps
EPD	Georgia Department of Natural Resources – Environmental Protection Division
GDA	Georgia Department of Agriculture
GDA-PPD	Georgia Department of Agriculture-Plant Protection Division
GA DNR	Georgia Department of Natural Resources
GDOT	Georgia Department of Transportation
GFA	Georgia Forestry Association
GFC	Georgia Forestry Commission
GGIA	Georgia Green Industry Association
GIS	Geographic Information System
GNPS	Georgia Native Plant Society
GWF	Georgia Wildlife Federation
ISSG	Invasive Species Specialists Group
MAREX	University of Georgia Marine Extension Service
NISC	National Invasive Species Council
NISA	National Invasive Species Act of 1996
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	National Resources Conservation Service
OTA	Office of Technology Assessment

Draft 1/16/09

PRHSD	Georgia Department of Natural Resources – Parks, Recreation and Historic Sites Division
SARP	Southeast Aquatic Resources Partnership
SEAFWA	Southeastern Association of Fish and Wildlife Agencies
TNC	The Nature Conservancy
UGA	University of Georgia
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WRD	Georgia Department of Natural Resources – Wildlife Resources Division

Executive Summary

The variety of native species found in Georgia is in part a reflection of the range of landscapes that make up the state. From the mixed forests and woodlands of the North Georgia mountains, to the low rolling hills of Central Georgia, to the swampy lowland, marshes and barrier islands of the coast, the state's various ecosystems make Georgia the sixth most biologically diverse state in the Union. Existing along with all these native species, however, are many nonnative species that have been introduced into the state. While many of these species are relatively benign, a few of them cause significant negative impacts. Invasive species, also known as exotic, nonnative or introduced species, are plants and animals that have been introduced, either intentionally or accidentally, into areas outside their natural ranges and cause economic or environmental harm. These species are capable of having a negative effect on Georgia's economy, natural environment, and human and animal health.

In response to this challenge, the Georgia Invasive Species Advisory Committee (Committee), coordinated by the Georgia Department of Natural Resources, developed the Georgia Invasive Species Strategy (Strategy) to describe the nature and extent of the state's invasive species problem and propose specific management actions to minimize negative impacts. Given the tremendous scope and complexity of the invasive species problem in Georgia, the Committee members did not attempt to outline detailed management programs for various groups of invasive species. Rather, they sought to develop a document that could serve as a framework to facilitate such critical efforts in the future, by summarizing current activities and priorities relating to invasive species management, identifying gaps in programs and authorities, and providing recommendations for future additions and enhancements. This Committee also developed a more detailed Georgia Aquatic Nuisance Species Management Plan that will serve as the State's guiding document for aquatic invasive species control efforts in the coming years (GA DNR 2009).

Over a period of approximately one year, the Committee identified needs and existing tools for responding to invasive species problems within the state. As part of this process, groups on the committee identified 51 invasive or potentially invasive plant species, 107 animal species and 30 disease-causing organisms. Based on this information, the Committee set goals and objectives and proposed strategies for action.

The goal of this effort is to prevent and control the introduction of invasive species into Georgia and minimize the further spread and impacts of existing invasive species populations on native species, environmental quality, human health, and the economy. The Strategy endeavors to do this through eight objectives:

1. Coordinate local, state, regional, federal and international activities and programs pertaining to invasive species in Georgia
2. Control and manage the introduction and spread of invasive species in Georgia through education and outreach

3. Prevent the establishment of invasive species populations in Georgia through early detection and rapid response programs
4. Control or eradicate established invasive species in Georgia through cooperative management activities designed to minimize impacts to non-target species
5. Monitor the distribution and impacts of invasive species in Georgia to determine management priorities
6. Identify and implement needed research on impacts and control of invasive species in Georgia
7. Prevent the introduction and spread of invasive species in Georgia through legislative and regulatory efforts
8. Secure adequate long-term funding for invasive species programs in Georgia

There are 40 actions in the Strategy to address these objectives. Some of the first actions are anticipated to be the development of new educational materials relating to invasive species, funding of a statewide invasive species coordinator, and development of a rapid response plan to control or eradicate priority invasive species populations and coordinate responses with full partner participation.

The purpose of the Georgia Invasive Species Strategy is to coordinate support for all state invasive species efforts through collaboration and full communication among agencies and organizations. Not only does such a planning effort improve the effectiveness of field actions, it can also increase funding opportunities for the proposed actions. Cooperation among the Committee members (drawn from 15 state entities, seven federal agencies, and nine non-governmental organizations) was central to the development of this management plan, and will be critical to its execution.

Two groups will be very important for continuing this collaborative effort: the Georgia Invasive Species Task Force and the Georgia Invasive Species Council. The Georgia Invasive Species Task Force is comprised of the Georgia Department of Agriculture, the Georgia Forestry Commission, the Georgia Department of Natural Resources, and the University of Georgia. For more than 15 years, members of this group have worked cooperatively together in invasive species detection, control, and education. These state agencies have legislative authority and/or mandates for action for invasive species detection and response as well as long established relationships with other state and federal agencies. When exotic pests are detected, each agency has clear responsibilities within the Incident Command System (ICS). This group will serve as the primary interagency task force for detection and control of invasive species and coordination of education and outreach programs relating to invasive species in Georgia.

The Committee also supports the establishment of the Georgia Invasive Species Council. This interagency group will provide broad coordination and support for invasive species management and research programs. The Council will be composed of representatives from all state agencies involved in invasive species management. Representatives of federal agencies and nongovernmental organizations with invasive species management authority or expertise will be invited to participate as stakeholders. The Council will advise state agencies on prevention and control of invasive species, provide a forum for

Draft 1/16/09

discussion of invasive species issues and policies, facilitate development of a coordinated network among state agencies to document, evaluate, and monitor the effects of invasive species, and prepare and release a biennial report detailing progress toward attainment of the goals and objectives outlined in this plan.

Introduction

For the purposes of this document, invasive species refers to nonnative species that have been introduced, either intentionally or accidentally, into areas outside their natural ranges and that cause economic or environmental harm or impacts to human health. They are not a new phenomenon. Over the course of human history, over 50,000 nonnative species have been introduced into North America. Many of these species, such as wheat, rice, cattle, and poultry were introduced as sources of food and now provide more than 98 percent of the U.S. food system valued at approximately \$800 billion per year (Pimentel et al. 2005). Other exotic species were introduced for landscape restoration, biological pest-control, sport, or pets.

The introduction of nonnative species has a long history in Georgia. When the English first entered what is now North Carolina, South Carolina and Georgia, they found nonnative peach trees growing wild and in Native American orchards. This is probably because Spanish or French colonists had introduced peaches into Florida in the sixteenth century. From there, Native Americans spread peaches northward where they eventually became naturalized (Crosby 2004). Over time, more nonnative species were introduced into the state. For example, Benjamin Franklin sent upland rice and Chinese tallow tree seeds to Georgia in 1772. While attempts were made to cultivate these rice grains, upland rice was not grown with any great success in Georgia until it was reintroduced by Thomas Jefferson twenty years later (Bell 1966).

While many significant benefits have resulted from these nonnative introductions, over time, accidental or intentional dispersion of some nonnative species into new environments has resulted in negative impacts to the ecological communities of infested areas, or to commercial, agricultural, aquacultural, or recreational activities dependent on these areas. These nonnative species are considered to be invasive species. For a nonnative organism to be considered an invasive species in the policy context, the negative effects that the organism causes or is likely to cause must outweigh any benefits it may provide (ISAC 2006).

Invasive species have historically played an important role in Georgia. Two species that exemplify the environmental and economic damage invasive species can have are *Cryphonectria parasitica*, the causative agent of chestnut blight, and the boll weevil (*Anthonomus grandis*). Before 1900, the American chestnut tree (*Castanea dentata*) made up as much as one-quarter of the tree species in the Appalachian forest. In Georgia, chestnuts were particularly prominent in the Cohutta and Blue Ridge mountains, but were also frequently found in the Ridge and Valley ecoregion, the Piedmont region, and on the Cumberland Plateau. As well as being environmentally important, chestnuts had many economic uses. Due to their large crowns, spring flowers, and edible nuts, chestnuts were extremely popular and widely planted as shade and ornamental trees. Chestnut was the preferred wood for log house and outbuilding construction and later utility and telegraph polls due to its resistance to decay. Because of its high tannin content, chestnut bark and heartwood supplied more than half of the tannin produced for the U.S. leather industry. As late as the mid-1940s, dead chestnut trees were still being hauled out of the North Georgia Mountains for shipment to tannin extraction factories. The chestnut blight fungus entered the U.S. through New York City on Japanese chestnut stock imported as orchard trees in the late

1800s. The infection spread south at the rate of 200 miles every ten years, reaching Georgia in the early 1930s. Nearly every mature chestnut tree in the species' natural range (possibly three to four billion trees) was killed by chestnut blight by the 1940s. Today, American chestnut trees survive by resprouting from surviving root systems in the soil. However, they rarely mature or produce nuts before falling victim to the fungus (Merkle and Brown 1991). In 2006, a stand of 20- to 30-year-old American chestnut trees was found on Pine Mountain near Warm Springs, Georgia. These trees are able to produce flowers and nuts, and scientists are using their pollen in an attempt to breed chestnut blight resistant chestnuts (Merkle 2006).

The boll weevil is another invasive species that has had enormous effects on the state. The boll weevil is an insect that feeds on cotton buds and flowers, causing extensive damage to the plant. A native of Central America, the beetle entered Texas in 1892, and reached Thomasville, Georgia in 1915. Subsequently, state cotton production plunged rapidly from a historical high of 2.8 million bales in 1914 to 600,000 bales in 1923. Total state losses from boll weevil infestation were estimated at \$40 million by 1919. In 1920, some parts of South Georgia lost 50 to 75 percent of their cotton crop to boll weevils. Georgia experienced the greatest decline in cotton acreage of any cotton-growing state by 1934, when cotton acreage dropped to 45 percent of the total land farmed in 1910-1914. Cotton production in the state continued to decline for another 50 years until 1983, when Georgia produced only 112,000 bales on 115,000 harvested acres. Boll weevil infestation was considered by some to be the biggest disturbance of Georgia's economy since the end of the Civil War. In 1987, Georgia enrolled in the federal Boll Weevil Eradication Program, a cooperative effort involving USDA, state officials, and cotton growers. Consequently, the boll weevil was eradicated in the state by 1991. State cotton production has increased from 482 pounds per acre in the pre-eradication period (1971 to 1986) to 733 pounds per acre in the post-eradication period (1991 to 1995). In 1995, 2.0 million cotton bales were produced on 1.5 million harvested acres (59 percent more than in 1994 and the largest yield since 1919), with total revenues of about \$270 million (the highest in Georgia's history) (Haney et al. 1996). In Georgia elimination of the boll weevil has resulted in dramatic economic benefits, with average gross crop revenues increasing from \$70 million per year prior to eradication to \$400 million per year afterwards (USDA APHIS 2007).

Introduced nonnative species can presently be found throughout the state in each of its five major ecoregions: the Southwestern Appalachians/Ridge and Valley, Blue Ridge, Piedmont, Southeastern Plains, and Southern Coastal Plain. In the Southwestern Appalachians /Ridge and Valley ecoregions, the red shiner (*Cyprinella lutrensis*) is suspected of having a serious impact on the native blue shiner (*C. caerulea*) through competition and hybridization. Invasive species of concern in this region include cogongrass (*Imperata cylindrical*), Japanese climbing fern (*Lygodium japonicum*), Japanese stilt grass (*Microstegium vimineum*), Chinese privet (*Ligustrum sinense*), Japanese honeysuckle (*Lonicera japonica*), oriental bittersweet (*Celastrus orbiculatus*), princess tree (*Paulownia tomentosa*), silvergrass (*Miscanthus sinensis*), and autumn olive (*Elaeagnus umbellate*). These species, along with kudzu (*Pueraria montana*), are also a concern in the Blue Ridge ecosystem as is the hemlock woolly adelgid (*Adelges tsugae*), which is causing significant losses of eastern hemlock as well as the few populations of Carolina hemlock in the region. Asian clams (*Corbicula fluminea*) and feral hogs (*Sus scrofa*) are examples of invasive animal species of concern in the Piedmont ecoregion. In addition, most river floodplains and valleys in the

Piedmont are overrun with invasive plants such as Chinese privet and Japanese stilt grass. Hydrilla (*Hydrilla verticillata*), Japanese climbing fern, feral hogs, Chinese privet, cogongrass, and the Asian clam threaten habitats and species in the Southeastern Plains. Finally, the Southern Coastal Plain is facing significant negative impacts caused by flathead catfish (*Pylodictis olivaris*), feral hogs, Chinese tallow (*Sapium sebiferum*), tropical soda apple (*Solanum viarum*), water hyacinth (*Eichhornia crassipes*), alligatorweed (*Alternanthera philoxeroides*), parrotfeather (*Myriophyllum aquaticum*), giant reed (*Arundo donax*), and the channeled apple snail (*Pomacea insularum*) (GA DNR 2005).

While most introduced species pose little threat to the environment, many do constitute a significant risk. Invasive species rank second only to habitat destruction as a threat to biodiversity. Almost half of the species in the U.S. that are at risk of extinction are negatively impacted by invasive species. Invasive species threaten biodiversity in several ways. They may cause or spread diseases, for example, or act as predators or parasites of native species. Invasive species also impact native species by out-competing them for food and natural resources and/or by altering habitat in such a way that native species can no longer flourish. Finally, invasive species may hybridize with local species so that within a few generations, few if any genetically pure native individuals remain. Of the 26 animal species in the U.S. that have gone extinct since being listed under the Endangered Species Act, at least three were wholly or partly lost because of hybridization with invaders (McGinley and Duffy 2008).

The introduction of nonnative species poses a profound threat to the state's biodiversity. Georgia ranks sixth in the nation for overall biological diversity (4,004 species) and twelfth for number of endemic species (58 species). Nationally, Georgia ranks second in amphibian diversity (77 species), third in freshwater fish diversity (268 species), fifth in reptile diversity (83), seventh in vascular plant diversity (2,986 species), seventeenth in bird diversity (328), and eighteenth in mammal diversity (91). Unfortunately, Georgia also ranks eighth in the number of imperiled species (533 species), and fourth in number of known or suspected extinctions (24 species), due in part to the introduction and spread of nonnative species (Stein et al. 2000). Georgia currently has 239 native species that are in danger of immediate or foreseeable extinction in all or a significant portion of their range. Seventy-three additional native species occur rarely enough to need protection because of their scarcity (GA DNR 2007, O.C.G.A. §27-3-130).

In addition to environmental harm, invasive species can have large economic impacts in the areas where they have become established. The costs associated with fire ants in the U.S., for example, have been estimated at \$1 billion/year. In Texas, the agricultural economic losses caused by this ant are an estimated \$90 million annually, and Texas spent at least \$580 million in 2000 to control this insect (ISSG 2008). Nationally, invasive plant species cause a 12 percent reduction in agricultural crop yields, costing the industry \$24 billion in lost crop production annually. In addition, about \$3 billion a year in herbicides are used to protect U.S. crops from invasive plants (Pimentel et al. 2005). One recent study placed the U.S. benefit of controlling invasive aquatic plant species alone as being in the billions of dollars (Rockwell 2003). Hemlock woolly adelgid infestations in the eastern U.S. have cost \$9 million for research and suppression as of 2007. Likewise, the cities of New York and Chicago have spent \$180 million to eradicate the Asian longhorned beetle. Nationwide, infestation of this beetle could kill one third of urban trees valued at \$669 billion (GA ISTF 2007). Costs can be incurred through the loss of economic

output, such as reductions in agriculture, aquaculture, fisheries, timber, and tourism, and also through the direct cost of combating and mitigating the impacts of the species (e.g., clogged waterways). Hydrilla, for example, blocks irrigation and drainage canals, enhances sedimentation in flood control reservoirs, interferes with public water supplies, impedes navigation, and generally restricts public water uses. At high densities, hydrilla also reduces productivity of recreational fisheries (OTA 1993).

While the economic costs of invasive species in Georgia have not been adequately determined, their impact could be immense. The state's agriculture, forestry and tourism industries produce billions of dollars of revenue for Georgia each year. For example, the economic value of land-based agriculture exceeded \$8.8 billion in 2002, making it Georgia's single most productive industry. One out of five jobs in Georgia is related to agribusiness (Peabody 2003). Yet boll weevil eradication cost Georgia \$111.4 million between 1987 and 1999, and continues to cost the state \$2 million annually (Evans 2008). Likewise, the invasive plant, tropical spiderwort, costs cotton farmers \$1.2 million for extra herbicide annually (GA ISTF 2007). Within the agriculture industry, timber is the state's highest-valued agricultural product. Forestry is also Georgia's third-largest manufacturing sector, employing 11 percent of the manufacturing workforce at an annual payroll of \$2.1 billion while contributing billions of dollars to Georgia's economy (Daughdrill and Zickert 2001). However, sudden oak death threatens the state's 9.8 million acres of oak forests (15.6 percent of the state's trees) valued at \$33 billion for timber, wildlife, tourism and urban forests (GA ISTF 2007). In addition, Georgia spends in excess of \$200,000 a year on detection surveys and suppression for gypsy moth, hemlock woolly adelgid, *Phytophthora ramorum* (causal agent related to sudden oak death), emerald ash borer, *Sirex noctilio* woodwasp, various exotic wood borers and bark beetles and cogongrass detection and suppression). Tourism contributes \$26 billion to the economy and generates \$1.12 billion in state and local tax revenues (Barry 2006). Tourists include hunters, anglers, campers, and wildlife observers whose activities depend on healthy, abundant natural resources.

Another challenge facing Georgia is the potential habitat expansion of invasive species due to climate change. The accumulation of greenhouse gases such as carbon dioxide, methane, and nitrogen oxides is causing many parts of the world to experience changes in annual temperature, weather patterns, and sea levels (IPCC 2007). Although scientists differ in their predictions for what temperature changes are occurring and what may occur in the future, some climate change models predict an increase in July heat indexes across the Southeast U.S. from 8-15°F to as high as 20°F (Glick 2007). Higher average temperatures may enable invasive species to take advantage of weakened ecosystems and out-compete native species. It is estimated that global warming will allow 48 percent of currently established invasive plants and animals to expand their northern distributions if temperatures warm. This can already be seen as warming winter temperatures permit species such as kudzu and garlic mustard to survive in areas much farther north than in the past. In addition, it is expected that global warming will contribute to more severe infestations and habitat damage from invasive insect species, including the gypsy moth (*id.*). Studies have also shown that increased carbon dioxide levels appear to stimulate the growth of invasive plants. Additionally, herbicides may be less effective as carbon dioxide increases in the atmosphere (Ziska and George 2004). Tests found common agricultural weeds like Canada thistle and quack grass to be more resistant to herbicides when grown in higher CO₂ concentrations, making them harder to control. In addition, ragweed plants grown at elevated CO₂ levels produce twice as much

pollen as plants grown at lower levels. Studies have also shown that poison ivy grows more vigorously at higher levels of CO₂ and produces a more virulent form of urushiol oil, the cause of allergic reactions in many people (Christopher 2008).

Because of the potential negative impacts that can result from invasive species, it has become an official public goal in the U.S. to reduce the environmental and economic damage done by harmful, nonnative species. This was articulated in the National Invasive Species Act of 1996 (NISA) (16 U.S.C §4701 *et seq.* 2006) which established a national objective of preventing new invasive species introductions and limiting the dispersal of existing invasive species in all of the states. In 1999, Executive Order 13112 (Order) established the National Invasive Species Council (NISC), which was charged with providing coordination, planning and overall leadership for federal invasive species programs and outreach to state, local and private partners. The Order also required the Secretary of the Interior to establish the Invasive Species Advisory Committee, a group of 30 nonfederal stakeholders from diverse constituencies (representing state, local and private concerns) around the nation, to advise NISC on invasive species issues. In addition, the Order called on NISC to prepare and issue a national plan to deal with invasive species. The National Invasive Species Management Plan was completed in 2001 and revised in 2008.

As a complement to this federal response, and in recognition of the complex natural resource management issues posed by invasive species, the Georgia Invasive Species Strategy identifies and characterizes the scope of this problem in the state and outlines a coordinated set of actions towards the following eight objectives:

1. Coordinate local, state, regional, federal and international activities and programs pertaining to invasive species in Georgia
2. Control and manage the introduction and spread of invasive species in Georgia through education and outreach
3. Prevent the establishment of invasive species populations in Georgia through early detection and rapid response programs
4. Control or eradicate established invasive species in Georgia through cooperative management activities designed to minimize impacts to non-target species
5. Monitor the distribution and impacts of invasive species in Georgia to determine management priorities
6. Identify and implement needed research on impacts and control of invasive species in Georgia
7. Prevent the introduction and spread of invasive species in Georgia through legislative and regulatory efforts
8. Secure adequate long-term funding for invasive species programs in Georgia

The purpose of the Strategy is to coordinate and support all invasive species efforts in the state in order to improve the efficacy of field actions, and open the doors to funding opportunities for the proposed actions.

Draft 1/16/09

Due to the multifaceted nature of invasive species issues, the Committee decided to define the problem by breaking it down by both pathway and species. Species were then prioritized and summarized in tabular form, and existing authorities and jurisdictions were researched and documented. Management actions were detailed according to eight objectives (listed above), and summarized in an implementation table. The plan concludes with a glossary, literature cited section, and appendices.

The draft Invasive Species Strategy was made available for public review from January 16 to February 16, 2009, and a public meeting was held on February 12. Copies of the Strategy were available in electronic form on the Wildlife Resources Division, Georgia Department of Natural Resources (WRD) website and were also distributed to interested groups and individuals.

Participants in the planning process included state and federal agencies, universities, trade associations, private industries, port authorities, non-governmental organizations, and research centers. Representatives of these entities, listed in Appendix H, were invited to serve on the Committee, which met six times throughout 2007-2008 to help assemble the Strategy. GA DNR staff oversaw the planning process and assembly of the Committee, assisted by the Carl Vinson Institute of Government, UGA. Funding for this effort came from GA DNR.

Problem Definitions

Pathways of Introduction

Invasive species are introduced to new environments in a number of different ways. Understanding the mechanism, or pathway, by which invasive species enter Georgia is important in order to prevent or minimize additional introductions. Species can be introduced either accidentally or intentionally. Intentional introductions occur through deliberate human action. Many invasive plants, for example, were originally introduced as ornamentals or forage crops. Kudzu and Japanese honeysuckle for example, were both introduced as flowering vines from Japan in the nineteenth century (Reilly 2007, Lewis 2004). Others, like autumn olive and bicolor lespedeza, were introduced to control erosion or provide food for wildlife (Britton et al. 2004). Some nonnative fish species were imported intentionally to enhance sport fisheries or for aquaculture purposes, while other nonnative species were brought into the state for sale by pet and aquarium dealers. These species may become invasive when they are either intentionally released or escape into the wild and are able to establish viable populations.

Accidental introductions arrive through pathways such as horticulture, aquaculture, commerce, tourism, or travel. Invasive species can be unintentionally transported as hitchhikers by air, water, railways, or roads to new sites on people and their products. Invasive species can enter and spread throughout the state by being carried on construction and farm equipment, airplanes and helicopters, and boats and boat trailers. By not thoroughly inspecting, washing, or rinsing such vehicles, users can easily transport invasive species from one place to another. Contaminated plant nursery stock can also act as a vehicle to transport many invasive insect and pathogen species.

Accidental introductions of aquatic invasive species can occur through the transportation and release of live bait by fishermen and anglers. When live bait or the bait's packing material is discarded, invasive species may inadvertently be introduced into a new water body. By lodging in nets and other equipment used to harvest baitfish, species can unintentionally be transported into non-infested waters. Stocked fish are another source of invasive species. Though the fish stocks themselves might not be invasive, the water used to transport them could be contaminated with invasive plants, invertebrates, or viruses. Fish stocking by unqualified individuals increases the chance of biological contamination, especially as these individuals are less likely to adhere to regulations and standards regarding transport methods and equipment.

Another prominent pathway for invasive species has been the trade in wood and wood products. In the U.S., 35 percent of all softwood consumed is imported, and up to 70 percent of all international cargo arrives supported by solid wood packing material (SWPM). This material is usually constructed of poor-quality wood, often from trees damaged or killed by pests. Bark inclusions increase the likelihood of the presence of insects, and boards with bark attached can be hidden in middle layers of products such as wooden spools, pallets, or wooden pieces attached directly to the cargo. The recent arrival in Georgia of the redbay ambrosia beetle (*Xyleborus glabratus*) in solid wood packing material has focused attention on this pathway (GFC 2004). Other non-native insects such as the emerald ash borer, Asian Longhorn Beetle, and Sirex noctilio woodwasp are all thought to have been introduced to North America via

SWPM. The transportation of firewood from one place to another is another way invasive insect species are unintentionally moved to new environments. A person hauling infested firewood from home to campsite can move a species hundreds of miles in a single day. Wood from infested or dying trees is often is packed as firewood. The emerald ash borer is being spread from state to state by campers, as well as through the movement of plant nursery stock and green lumber such as ash logs with bark (Tirrell-Wysocki 2007).

Ballast water transport and hull fouling transfers by commercial ships are two pathways for invasive species introductions in Georgia. Ballast water is pumped into a ship's hull to keep it stabilized and upright. This water is sometimes discharged at the receiving port when the cargo is being loaded or unloaded. Ballast water taken on in any port may include an abundance of live plants, animals, and pathogens not native to Georgia. The organic fouling communities that grow on the hull, rudder, propellers, anchor, anchor chain or any other submerged structure of seagoing vessels that are not properly cleaned or maintained are also an important source of invasive species. This growth provides an opportunity for worldwide transport of fouling organisms, particularly on towed barges and other structures like mothballed ships and exploratory drilling platforms. (See Appendix F for a comprehensive outline of invasion pathways.)

Invasive Species in Georgia

The Committee developed a list of invasive species that are of concern to the agencies and organizations that work on invasive species management issues in Georgia. These species were prioritized based on the amount of time and money a participating agency or organization currently devotes to management of the species. The Committee also developed a Watch list of species that may represent future threats in Georgia based on occurrence and impacts in other states. Descriptions of selected species from all three priorities and the Watch List are provided below (See Appendix A for complete lists). These lists do not imply that extensive research has occurred to prioritize species based upon economic impacts, potential harm to native ecosystems, risk of likelihood of establishment in Georgia, distribution in the U.S., or the likelihood of eradication of the species. It is recommended that the Georgia Invasive Species Task Force determine such priorities, and develop appropriate response plans for the highest ranking species.

Priority 1 Species

Priority 1 species are those that an agency/organization in Georgia that participates in invasive species management currently spends a significant amount of time and/or money on for some aspect of invasive species management OR that the organization definitely plans to spend time and money on in the next five years. Examples of Priority 1 species identified by the Committee include the following:

Plants

Tree of heaven (*Ailanthes altissima*)

Tree of heaven is a rapidly growing tree that can reach up to 80 feet in height and six feet in diameter. It is an aggressive plant that is readily established in agricultural and urban areas and in disturbed sites

such as railroad embankments, highway medians, fencerows, and roadsides. In naturally forested sites, this plant may become established in places disturbed by storms or infestations. Tree of heaven grows in full sun, thrives in poor growing conditions, and is well adapted to heavy clays and other soils with low nutrient and oxygen content. Tree of heaven was first introduced into the U.S. in 1748 by a Pennsylvania gardener and was widely planted in cities because of its ability to grow in poor conditions. The tree escapes from cultivation and spreads easily due to its rapid growth and prolific seed production. Native to Northern China, parts of East Asia, and Australia, tree of heaven has been introduced throughout the U.S., including the Southeast where it is most abundant in Virginia, and Alabama. In Georgia, it occurs primarily in the northern part of the state (Evans et al. 2005, ISSG 2008). Because its seedlings and root suckers grow rapidly and spread prolifically, tree of heaven quickly out-competes many native species for sunlight and space. The tree also produces a toxin in its bark and leaves which can inhibit the growth of other plants as it accumulates in the soil, and its root system is capable of damaging sewers and foundations (ISSG 2008).

Mimosa (*Albizia julibrissin*)

Mimosa is an umbrella-shaped tree with an open canopy that allows sunlight to penetrate and grass to grow near the base of the trunk. These trees prefer full sunlight, are salt and drought tolerant, and can thrive in a wide range of soil types. Mimosa is found in disturbed areas, such as roadsides, vacant lots, and urban and riparian areas. Occasionally it is found in forested areas but seldom in forests with full canopy cover. Mimosa is commonly used as an ornamental tree because of its appealing fragrance, showy flowers, and low maintenance requirement. While Mimosa's native range extends from Iran east to Japan, it has invaded most of the U.S. except the Pacific Northwest and New England (ISSG 2008). Mimosa is common throughout the Southeast and is most abundant in Mississippi, Alabama, and Georgia (Britton et al. 2004). Mimosa is a strong competitor with native trees and shrubs in because it can grow in a variety of soils, produce large seed crops, and resprout when damaged. Dense stands of mimosa also reduce the sunlight and nutrients available to native plants (ISSG 2008).

Garlic mustard (*Alliaria petiolata*)

Garlic mustard is a biennial herb that prefers shade but has been found in areas with full sunlight. It favors moist, rich soil but is also found in sand, loam, clay, limestone, and sandstone substrates. Garlic mustard mostly occurs in deciduous forest areas, and is one of the few invasive plants that can invade and dominate the forested understory. Invasion is more likely in floodplain forests, forest edges, stream banks, and other disturbed areas, such as trail edges and road sides. Garlic mustard was introduced by European settlers for food and medical purposes. A native of Europe, this species has been introduced to New Zealand, Canada and the United States (ISSG 2008). In North America, garlic mustard was first recorded on Long Island, New York in 1868, and has spread throughout the Northeast and Midwest. In the South, garlic mustard occurs mostly along the major river systems, and has been recorded as far south as Cobb County, Georgia. Garlic mustard can form dense stands that shade and compete with native understory vegetation, lowering native species diversity. It has little or no value as a wildlife food and white-tailed deer preferentially avoid garlic mustard to feed upon the other species, possibly aiding in the dominance of garlic mustard in the landscape (Evans et al. 2005).

Water hyacinth (*Eichhornia crassipes*)

Water hyacinth is a free-floating aquatic plant that may form dense floating mats, especially in waters that are rich in nitrogen, phosphorus and potassium. The plant grows in shallow temporary ponds, wetlands and marshes, sluggish flowing waters, lakes, reservoirs and rivers. Water hyacinth probably originated in the Amazon basin of western Brazil and is now distributed nearly worldwide (ISSG 2008). In Georgia, populations of water hyacinth have been found in 15 counties mostly in the southern and eastern regions of the state but also as far north as Hall County (SE-EPPC 2008). Water hyacinth is an attractive ornamental plant, and much of its spread can be attributed to deliberate planting in ponds or dams for use as an ornamental or in aquariums. Unwanted plant material may be discarded into creeks, rivers and dams which is also a major mode of dispersal. Water hyacinth can be spread by contaminated boating and water equipment and seeds may be carried by water flow, mud, hikers' boots, birds, winds, and boat traffic (ISSG 2008).

Water hyacinth is one of the most serious aquatic weeds in the world. In slow-moving to still water bodies the plant is especially problematic as it forms dense mats. These mats compete with other aquatic species for light, nutrients and oxygen, shade out native submersed plant species, and uproot native emergent species. Lower oxygen levels harms native fish populations and fish spawning areas may be reduced, as well as critical waterfowl habitat degraded. Mats also deposit large amounts of organic matter, which increases the organic content of sediments. Water hyacinth also has a detrimental impact on water use by humans. In drainage canals mat growth reduces the water flow, which can result in flooding and damage to canal banks and structures. In irrigation canals water hyacinth impedes the flow and clogs intakes of irrigation pumps. Water hyacinth interferes with navigation of both recreational and commercial craft, negatively impacting fishermen and recreational waters users.

Hydrilla (*Hydrilla verticillata*)

Hydrilla is a submersed aquatic perennial that can grow from depths of 20 feet. This plant is found in freshwater but tolerates salinities of up to seven percent. It is found in springs, lakes, marshes, ditches, rivers, and tidal zones. Plant fragments are dispersed by river flow as well as by boats, trailers, kayaks, and fishing equipment. Hydrilla has also been sold as an aquarium plant. A native to Asia and northern Australia, hydrilla is now found on every continent except Antarctica (ISSG 2008). It has been present in Georgia since 1967 where plants are found primarily in the southwestern drainages of the state (Benson et al. 2001). The plant has been problematic at Lake Seminole for over a decade. Hydrilla is also found at a few smaller water bodies in Georgia's upper Ocmulgee drainage and at the Strom Thurmond Reservoir on the upper Savannah River (Jacono and Richerson 2006).

Hydrilla competes with native plants by growing to the water surface and forming dense mats that totally exclude sunlight from other plants, which in turn can significantly reduce aquatic plant and animal biodiversity. Large populations of hydrilla may affect fish size and population levels where predatory fish cannot hunt effectively within the dense mats. These mats also affect recreational activities. Along with interfering with fishing, hydrilla can become tangled in boat motors and choke swimming areas. Hydrilla often slows or clogs rivers, irrigation ditches, and flood control canals, creating

stagnant water that is prime mosquito breeding habitat. Dense stands can also cause flooding, and alter water quality by decreasing oxygen levels and increasing pH and water temperature (ISSG 2008). Hydrilla serves as a substrate for a species of cyanobacteria that is associated with avian vacuolar myelinopathy (AVM), a neurologic disease that has been shown to be lethal to several species of birds in Georgia, including coots and bald eagles (Wiley et al. 2007).

Cogongrass (*Imperata cylindrical*)

Cogongrass is an erect, perennial grass that has a reddish tint to the leaves that accounts for the grass' name and ornamental value. Cogongrass occurs in a wide range of habitats, including forests, grasslands, arable land and young plantations. It can be found growing in almost all eco-types from the driest flatwoods to the margins of permanent bodies of water; it invades sandhills, flatwoods, hardwood hammocks, sand dunes, grasslands, river margins, swamps, scrub and wet pine savanna communities. Cogongrass is very successful in areas that are frequently burnt, overgrazed or intensively cultivated. Because of its success following fires, this grass is often associated with slash and burn forestry practices (ISSG 2008). Cogongrass first arrived in the U.S. accidentally in 1911, through the port at Mobile, Alabama, as a packing material in shipments from its origins of Southeast Asia (Jackson 2008). The grass was also intentionally introduced for soil stabilization and use as forage in the early 1900s (Britton et al. 2004). Cogongrass is currently sold by plant nurseries in parts of the U.S. and over the internet under the names Japanese blood grass and Red Baron grass (GDA 2008a). In addition to seeds, cogongrass is spread by seeds and rhizomes which are very hard to kill, have a long dormancy period, and are resistant to fire because of their location in the upper six to eight inches of soil. In addition, cogongrass rhizomes are highly regenerative. Rhizomes can also spread to new locations on farm equipment and mowers moving from one area to another (ISSG 2008). Cogongrass is widespread and extremely problematic in Mississippi, Alabama, and Florida. It is currently sparsely located in Louisiana, South Carolina, Tennessee and Georgia where it is found in 28 known locations, over a wide variety of sites and all are currently under eradication treatments (GFC 2008).

Once established, cogongrass forms dense mats that choke out native vegetation while providing little or no value for game animals such as whitetail deer, wild turkeys, doves, squirrels, and rabbits. Cogongrass is also highly flammable. Dense infestations can dry out and catch fire in the winter and burn at temperatures as hot as 800°F. Temperatures this hot can kill even fire-resistant trees such as pine and pose a significant risk to the timber industry (Jackson 2008). Because of the severity of the threat posed by established cogongrass populations, the plant is listed as a noxious weed by the USDA, making it illegal to transport across state lines. In April 2008, Georgia's Department of Agriculture issued a statewide ban on the sale of cogongrass, making it illegal to grow, cultivate, or sell this plant within the state of Georgia (GDA 2008a).

The GFC has taken a leadership role with the education, detection and eradication of cogongrass in Georgia, and all known sites are being treated. In 2004 when this program began, there were 14 known sites, and there are now in excess of 220 sites in 28 Georgia Counties under treatment. The GFC executed a memorandum of understanding between 23 state, federal, and private partners in May 2008 with the cogongrass effort and all of these partners are now combining forces with this focused effort.

Chinese privet (*Ligustrum sinense*)

Chinese privet is a perennial shrub, commonly used for hedges that can grow up to 30 feet in height. Privet often grows along roadsides, in old fields and in other disturbed habitats, and can be found in agricultural areas, coastland, disturbed areas, natural forests, scrub/shrublands, urban areas, water courses, and wetlands. A native of China, Vietnam, and Laos, privet has been widely cultivated and developed into several horticultural varieties, which were introduced to North America as a common hedge for landscaping in the early to mid-1800s (ISSG 2008). It is found throughout the Southeast and is widespread and common throughout all of Georgia (Evans et al. 2005). Privet grows readily from seed or from root and stump sprouts. The plant can escape from cultivation when its fruits are consumed by wildlife, which often excrete the seeds at distant locations where they may germinate and become established. Privet can form dense stands in the understory of bottomland hardwood forests and will generally expand along fencerows, windbreaks and roadsides. Privet can dominate the shrub layer of an invaded habitat, thus altering species composition and natural community structure by choking out native plant species and shading out all herbaceous plants (ISSG 2008).

Kudzu (*Pueraria montana*)

Kudzu is a semi-woody vine capable of reaching lengths of over 100 feet. It is found agricultural areas, natural forests, planted forests, range/grasslands, riparian zones, ruderal/disturbed land, scrub/shrublands, and urban areas. Kudzu can grow in a wide range of soil types with little or no special nutrient requirements, except it does not grow in periodically flooded soils (ISSG 2008). A native of Asia, kudzu was introduced into the U.S. as an ornamental in 1876. Kudzu was also planted extensively for erosion control and forage in government-sponsored programs from 1920 to 1950 (Britton et al. 2004). In the U.S. kudzu occurs as far west as Oregon, Washington, and Hawaii, but is concentrated in the Great Plains and eastern areas of the country where it occurs as far north as Long Island, N.Y. (USDA, NRCS 2008). Kudzu is most prolific in the Southeast, however, where it is reported to infest about seven million acres and results in an estimated lose of \$500 million per year in land productivity and control costs (Shearer 2007, ISSG 2008). It is widespread and common in Georgia (Evans et al. 2005). Kudzu forms dense infestations that exclude native plants, halting forest productivity and changing the habitat on millions of acres of land (Britton et al. 2004). Kudzu may also play an important role as an additional host in the new epidemic of soybean rust in the U.S. The combination of widespread soybean plantings and invasive kudzu stands may also have significant effects on native legumes susceptible to the soybean rust fungus (Garrett and Cox 2008).

Giant salvinia (*Salvinia molesta*)

Giant salvinia is a floating aquatic fern that thrives in slow-moving nutrient-rich warm freshwater including ditches, ponds, lakes, slow rivers and canals. Because growth is greatly stimulated by an increase in nutrient levels, the weed is particularly fast-growing in areas where the hydrological regime has been altered by humans, encouraging an increase in nutrient levels (for example by increased runoff or fertilizer leaching). Giant salvinia is a native of Southeastern Brazil and northern Argentina. Since the 1940s, humans have dispersed this plant to various tropical and subtropical regions in Africa, Asia, the Australasia-Pacific region and, more recently, the U.S. (USSG 2008). It has been present in Evans and

Bryan counties in Georgia since 1999, and has the potential to infest large areas of the state (Benson et al. 2001, SE-EPPC 2008). The introduction of giant salvinia has been linked to the cultivation activities of botanical gardens and commercial horticulture sites. Giant salvinia may be spread over long distances (within or between water bodies) on anything entering infested waters, including boats, trailers, vehicular wheels, engine intakes, fishing gear, recreational gear and boots. Animals may also contribute to spread (ISSG 2008).

The stagnant, shallow, dark environment created by infestations of giant salvinia negatively affects the biodiversity and abundance of freshwater species including native fish and submersed aquatic plants. Giant salvinia can degrade water quality, alter wetland ecosystems and cause wetland loss. Heavy infestations of giant salvinia have the potential to negatively impact industries that depend on clean water bodies, such as boating. Both local and commercial fisheries can be affected by restricted access to fishing spots, decreased fish densities, and the difficulty of using long lines and nets created by large mats of the plant. Giant salvinia may increase the level and spread of some human diseases due to the dense vegetative mats and the development of stagnant shallow water, which provide an ideal breeding ground for disease-carrying species of snails and mosquitoes. Finally, by blocking drainage channels and dams, giant salvinia may increase flood water levels, amplifying the amount of damage caused by floods (ISSG 2008).

Chinese tallow (*Sapium sebiferum* = *Triadica sebifera*)

Tallow is a shade-tolerant tree that can grow as high as 50 feet. This tree is adapted to a variety of disturbed sites and a wide range of soil conditions. It is commonly found in disturbed areas, natural forests, planted forests, range/grasslands, and wetlands, as well as along rivers, creeks, and ponds. Tallow typically grows in thickets and tolerates droughts and flood conditions. Tallow tree was introduced from China and Japan to the Gulf Coast in the early 1900s when the Foreign Plant Introduction Division of the USDA promoted tallow planting in Gulf Coast states to establish a local soap industry. The Agency also encouraged tallow as a seed oil crop between 1920 and 1940. Birds disperse tallow seeds, sometimes flying great distances to new locations. Tallow has been extensively planted and propagated for ornamental purposes, and is also grown for its high biomass and energy value (ISSG 2008). Tallow tree was first introduced to South Carolina in the late 1700s, and is now found in all the Southern States except Tennessee, Kentucky, and Virginia. There are also severe infestations in the coastal areas of Texas, Louisiana, Mississippi, and Alabama (Britton et al. 2004, Stein and Flack 1996). Tallow is common in South Georgia (Evans et al. 2005).

Tallow aggressively displaces native plants and forms monospecific stands within decades of its appearance. In the Gulf Coast, much coastal prairie has been converted to tallow woodland thickets. Tallow is able to alter nutrient cycles by shedding leaves that contain toxins that alter soil chemistry and make it difficult for native vegetation to become established. The presence of tallow also seems to favor nonnative arthropods that may negatively impact the native ecosystem. Tallow will grow through existing canopies and can overtop and suppress the growth of native understory species (ISSG 2008).

Tropical Soda Apple (*Solanum viarum*)

Tropical soda apple is an aggressive shrub that can be found in agricultural and disturbed areas, riparian zones, pastures, ditch banks, citrus groves, and waterways. The plant is spread by movement of contaminated hay, seeds, and bags of manure, as well as by livestock and wildlife (i.e., cattle, raccoons, deer, feral hogs, birds) (ISSG 2008). A native to parts of South America, tropical soda apple was introduced into Florida in 1988. This plant now covers over one million acres in Florida and occurs sporadically elsewhere in the Southeast. The Georgia Department of Agriculture has documented tropical soda apple on nearly 15,000 acres in Georgia, and this plant has the potential to become widespread and very problematic (Evans et al. 2005). Tropical soda apple is listed on the USDA-APHIS Federal Noxious Weed List and is a nuisance to livestock, rangeland, and row crop management. This plant rapidly colonizes new areas threatening agricultural and native ecosystems. Tropical soda apple quickly chokes out forage grasses causing ranchers to incur additional production costs by having to feed forage to livestock rather than allowing them to graze (GDA 2008b).

Disease causing organisms

Sudden oak death (*Phytophthora ramorum*)

The fungus *Phytophthora ramorum* is the causal agent of sudden oak death, a disease that could have severe environmental and economic impacts if it reaches Georgia. *P. ramorum* has an extensive host range, covering many plant genera and several families and includes trees, shrubs, and woody and herbaceous perennials. It causes canker development, shoot drooping and leaf blight. *P. ramorum* can be spread to new locations by the sale of infected plants in garden centers. Infections could potentially spread from public/private gardens into the surrounding environment (as has already occurred in Oregon). The movement of green waste, soil, water, debarked untreated wood, logs or firewood may all spread the pathogen. Soil attached to hiker's boots, animal feet and car tires have been implicated in the spread of *P. ramorum* as has pruning equipment such as shearers and gloves. Insect vectors such as the rhododendron leafhopper, the western oak bark beetle, oak ambrosia beetle, and minor oak ambrosia beetle are often associated with trees infected with *P. ramorum* as are vertebrate vectors such as rabbits, deer, and humans (ISSG 2008). *P. ramorum* has existed in Europe for many years and was probably introduced into California in the early 1990s. The disease has since spread to British Columbia and the state of Oregon. A total of 59,000 potentially infested plants were shipped to Georgia during the 12 months preceding March 2004, of which 49,000 were sold before Georgia was informed of the infected shipment. While several Georgia nurseries have been identified as having received infected plants, all have been checked and certified as free from the fungus, the GDA nursery inspectors remain vigilant in testing imported plants, and the GFC continues to sample at the watershed level via stream-baiting to detect the pathogen (Price 2008, GFC 2005).

P. ramorum spreads by air, soil, and root contact with spores, and generally infests trees and plants above the soil line (including leaves, shoots, woody stems and bark). Fungal infections on the bark develop into cankers on oak trees, which produce a red/brown/black sappy exudate. Cankers can be over seven feet in length, can occur on the trunk at the root crown up to 65 feet above the ground, but do not enlarge below the soil line into the roots. Thin black lines in the inner bark delimit individual

cankers. Cankers eventually girdle the tree, resulting in starvation and death. Mortality may occur as quickly as two years. Fungal infections on the leaves will cause spotting and browning. Infections on the twigs cause branch drooping and dieback. Tanoak, coast live oak and black oak in American hardwood forests infected with the fungus die in a short period of time following the onset of symptoms. Other possible effects include loss of biodiversity and a negative impact on tourism, cultural history, urban forests, tree species which provide a major food source for wildlife and local woodland economies (ISSG 2008).

The Georgia Department of Agriculture, the Georgia Forestry Commission, the University of Georgia, USDA-APHIS-PPQ, USDA Forestry Service and members of the Georgia Green Industry Association have worked cooperatively since 2004 to detect this pest. Although it has been found in retail establishments where plants were shipped from California, it has not been found in Georgia's environment. The GDA and GFC have surveyed numerous plant retail centers; GDA surveying the interior and GFC surveying the environs and streams. GDA has collected over 7,000 samples since 2004 and overseen the destruction of several thousand plants. The GFC has also collected numerous samples and provided information to foresters and other groups.

Fishes

Red shiner (*Cyprinella lutrensis*)

Predominantly a resident of creeks and small rivers, red shiners have adapted to a wide range of environmental conditions, including seasonal intermittent flows, degraded habitats, poor water quality and natural physiochemical extremes. Red shiners were initially introduced as a bait minnow with recent introductions occurring through the aquarium trade. Bait release is the primary mechanism by which red shiners spread into rivers and streams outside their native range in the Midwest (ISSG 2008). In the southeastern U.S., nonindigenous populations of red shiners occur in Alabama and Georgia (Mobile and Apalachicola river drainages), and North Carolina (Pee Dee and Roanoke River drainages). Red shiners were discovered in northwest Georgia in the upper Coosa River system in the early 1990s, and have since spread from the lower Etowah River throughout the Ostanaula River and into the lower Conasauga and Coosawattee rivers (Burkhead and Huges 2002).

Red shiners are formidable competitors when introduced beyond their native range, capable of establishing populations wherever they have been introduced. This is particularly the case if the new environments are degraded and have low fish diversity. They are known to eat small invertebrates and spawn in the mid-summer months (ISSG 2008). Introduced red shiners have become one of the most abundant species found in degraded streams in Georgia. In the upper Coosa River the red shiner is hybridizing with the blacktail shiner, *Cyprinella venusta*, a native *Cyprinella* species, and there is concern the red shiner may hybridize with the threatened blue shiner *Cyprinella caerulea* as well (Benson et al. 2001).

Flathead catfish (*Pylodictis olivaris*)

Flathead catfish are one of the largest members of the catfish family, and are found in large rivers, streams, and lakes, usually over hard bottoms. They prefer deep, sluggish pools, with logs and other

submerged debris that can be used as cover. The native range of flathead catfish includes a broad area west of the Appalachian Mountains encompassing the large rivers of the Mississippi, Missouri, and Ohio basins. Its native range extends north to North Dakota, west to New Mexico and south to the Gulf including eastern Mexico. Flathead catfish have been introduced east of the Appalachian Mountains and into several western states (ISSG 2008). In Georgia, the species has been reported in the Altamaha River drainage, the Flint, Ochlockonee, and Savannah Rivers, and Lake Hartwell on the Savannah River (Fuller 2008). While they can be spread by unintentional stock contamination of channel catfish shipments, in most cases they have been intentionally stocked (ISSG 2008). Flathead catfish were stocked in the Savannah and Altamaha Rivers in the 1970s, and the Ochlockonee River introduction was possibly caused by illegal stocking by anglers with fish from the nearby Apalachicola river, where the fish had also been introduced (Fuller 2008).

Introductions of flathead catfish are among the most biologically harmful of all fish introductions in North America. Flathead catfish prey heavily on sunfish, and can also reduce the number of common carp and bullheads in a water body (ISSG 2008). The introduced flathead population in the Flint River system preys largely on crayfish, and young-of-the-year flathead catfish feed on darters, clupeids, catostomids, ictalurids, and centrarchids (Benson et al. 2001). Declines in native fish species, particularly native bullhead species, have been observed in Georgia (Thomas 1995). The flathead catfish is also seriously affecting the fish fauna of the Apalachicola River in Florida, where it consumes young Gulf sturgeons, a federally listed threatened species (Stein and Flack 1996). Georgia is currently trying to control flathead catfish in the Satilla River, and as of 2007, 4,400 flatheads weighing a combined total of 25,357 pounds were removed (Morrison 2008).

Insects

Hemlock woolly adelgid (*Adelges tsugae*)

Hemlock woolly adelgid is a small, aphid-like insect that has become a serious pest of eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*). The insect is found in natural forests, riparian zones, and urban areas. A native of Japan and China, hemlock woolly adelgid is currently found in the eastern U.S. from Georgia to New Hampshire and is moving north at a rate of about 19 miles/year (ISSG 2008). Hemlock woolly adelgid has spread throughout Georgia's 250,000 acres of native hemlocks which provide shade and soil stabilization for the state's 4,000 miles of trout streams (GFC 2007). Hemlock woolly adelgid was first detected in the eastern U.S. in the 1950's, and has spread primarily through birds contacting and transporting the woolly egg masses, but has been detected on infected nursery stock. The insect's eggs and nymphs are also easily dispersed by deer and other mammals, and the wind (ISSG 2008).

Hemlock woolly adelgid damages both eastern and Carolina hemlocks by sucking sap from the twigs. Infected trees lose their vigor and start dropping needles prematurely, to the point of defoliation. If left uncontrolled, these insects can kill a tree within four to seven years. Trees of all sizes and ages are attacked, but natural stands of hemlock are at greatest risk for death. To date, about 25 percent of the 3.2 million acres of hemlock forest in the U.S. has been infested, and the country's entire range of eastern hemlocks is at risk within the next 20 to 30 years. The white woolly masses that attach to twigs

or needles of trees infested with hemlock woolly adelgid lowers the value of ornamental hemlocks which are economically important in many parts of the eastern U.S. Hemlock trees are also ecologically important. The lifespan of an eastern hemlock can reach 900 years, thus, this tree is a component of many old growth communities. The hemlock forest also provides nesting sites and foraging habitat for migratory bird species, and several threatened or endangered species of flora and fauna require hemlock forests to survive (ISSG 2008).

Emerald ash borer (*Agrilus planipennis*)

The emerald ash borer is a metallic colored, wood-boring beetle that infests and kills ash trees in the genus *Fraxinus* including white, green, and black ash (*F. americana*) (ISSG 2008). A native of Asia, the emerald ash borer is found in agricultural areas, natural forests, planted forests, and urban areas, with an American range that is currently limited to Michigan, northern Ohio, Indiana, Illinois, Wisconsin, Missouri, and Virginia (and Canada). Based on surveys conducted in 2003 by the Georgia Forestry Commission, most of the ornamental ash trees sold in Georgia originate from local or southern nurseries thus reducing the risk of having the insect in Georgia (Price 2008). The GFC, in cooperation with USDA APHIS, is trapping for this insect throughout the state (2008-09) but it is not known to occur in Georgia at this time. However, if this exotic pest spreads throughout the entire range of ash in North America, including Georgia, it could cause considerable economic and environmental damage. Human activities are the primary cause of this insect's dispersal and include moving infested trees, logs, firewood, and infested nursery stock. After two to three years of continuous emerald ash borer infestation, the insect's population becomes abundant, and eventually the tree's nutrient and water transport system is disrupted, culminating in wilting and eventual tree death. In the most severe cases, entire ash tree stands may be destroyed (ISSG 2008).

Asian longhorned beetle (*Anoplophora glabripennis*)

Found in natural and planted forests, disturbed areas, scrub and shrublands, and urban areas, Asian longhorned beetles infest deciduous trees which they kill over a three to five year period. In the U.S., the beetle prefers maple species (*Acer* spp.), such as boxelder (*A. negundo*), Norway (*A. platanoides*), and sycamore (*A. pseudoplatanus*) maples (ISSG 2008). Native to China and Korea, these beetles entered the U.S. in solid wood packaging material from Asia in the 1990s. The Asian longhorned beetle has been intercepted at ports and found in warehouses throughout the U.S., including Georgia. The Georgia Forestry Commission identified over 100 warehouses in Georgia that have received solid wood packaging material from Asian markets, and this number keeps increasing (Price 2008). As of 2008, New York City, Chicago and Worcester, Massachusetts are the only areas where infestations of live trees have been found. Since 1996, at least 10,000 trees were destroyed in these cities at a cost of \$180 million (GA ISTF 2007, USDA, APHIS 2008). The beetle can spread to new environments through self-propelled flight, infested firewood, containers, pallets, dunnage, and adult beetles hitchhiking on vehicles (ISSG 2008). Tunneling by the beetle larvae girdles tree stems and branches, impeding water and nutrient transport within the infested tree. Repeated attacks lead to dieback of the tree crown and, eventually, to tree death. Because not all hosts are known and because the beetle has been restricted to urban forests thus far, it is difficult to predict its potential effects on natural forests. It appears, however, that Asian

longhorned beetles may kill up to one third of urban trees nationwide, and have the potential to seriously alter many eastern forest ecosystems (Britton et al. 2004, GA ISTF 2007).

Boll weevil (*Anthonomus grandis grandis*)

The boll weevil is an insect that feeds on cotton buds and flowers. A Central America native, boll weevils crossed the Rio Grande near Brownsville, Texas to enter the U.S. from Mexico in 1892 and reached Thomas County, Georgia in 1915 (Haney et al. 1996). By the mid 1920s boll weevils had entered all cotton growing regions in the U.S., traveling 40 to 160 miles per year (MS Boll Weevil Management Corp. 2008). The beetles were eradicated in Georgia in 1991, an effort that cost Georgia \$111.4 million between 1987 and 1999, and continues to cost the state \$2 million annually (Evans 2008). Current boll weevil eradication program activities (monitoring of boll weevil pheromone traps, insecticide application when necessary, etc.) are performed by the Boll Weevil Eradication Foundation of Georgia, Inc., which is administered through the Georgia Department of Agriculture, Plant Protection Division. Boll weevils cause extensive damage to cotton by feeding on the fruiting forms, leaf petioles and terminal growth of the plant. Females deposit their eggs in squares and bolls. Squares containing eggs are aborted, and infested bolls often fail to open properly or may rot. Adult beetles feeding on leaf petioles in young, presquaring cotton causes "black flags", wilted leaves on the damaged petioles (Ellis and Horton 1999). Boll weevils are the most destructive cotton pest in North America. One study estimated that the boll weevil infestation in the U.S. has resulted in agricultural expenditures of around \$13 billion. Boll weevils continue to cost cotton producers \$300 million per year (MS Boll Weevil Management Corp. 2008). In Georgia, boll weevils have decreased cotton production from 2.8 million bales/year to 112,000 bales/year (GA ISTF 2007).

Gypsy moth (*Lymantria dispar*)

The European gypsy moth is one of the most destructive pests of shade, fruit, and ornamental trees throughout the northern hemisphere. It is also a major pest of hardwood forests in the eastern U.S. While they will feed on over 500 varieties of trees and shrubs, the moths prefer oak, alder broadleaf trees, Douglas fir, and western hemlock needle trees (Britton et al. 2004). Gypsy moth egg masses are able to tolerate temperature and moisture extremes and so travel well on logs, lawn furniture, nursery stock, pallets, shipping containers, and on the hulls and riggings of ships. Caterpillars can attach to travelers and their possessions, and newly hatched caterpillars will travel to the top of their host tree, where winds carry them to other trees (ISSG 2008). The gypsy moth is native to southern Europe as well as some parts of Africa, Asia, and Japan, and was introduced into the U.S. in 1869 by a French scientist living in Boston. The first outbreak occurred in 1889. Since then, the gypsy moth has spread to all or parts of 17 states, mostly in the Northeast and the Great Lakes region. In the Southeast, gypsy moths have dispersed across northern North Carolina through southwestern Virginia and eastern Kentucky (Britton et al. 2004). Since 1991, the Georgia Forestry Commission, in cooperation with the US Forest Service, has eradicated three gypsy moth infestations in Georgia that occurred in White, Rabun and Fannin counties. The Georgia Forestry Commission along with the USDA APHIS conducts an annual comprehensive trapping program to detect the presence of the moth in Georgia, and as of 2008, no further infestations have been discovered (Price 2008).

In most areas and in most years, gypsy moths remain at low densities and cause no discernible damage. But occasionally, populations reach high densities and these abundant populations may completely defoliate host trees. Severe infestations can result in nearly 100 percent tree mortality and may occur over large areas. Gypsy moth defoliation can reduce tree seed production and root sprouting, resulting in poor regeneration. The natural diversity and species composition of native insects, birds, and other animals may be altered during outbreaks through reductions in shelter, food, and other benefits provided by host trees (ISSG 2008).

Sirex woodwasp (*Sirex noctilio*)

The sirex woodwasp is currently found in natural and planted pine forests in New York, and Pennsylvania. The insect is attracted to stressed, sick, and suppressed trees, and most softwoods (conifers) and all species of pine, including slash and loblolly pine, are believed to be at risk of infestation. A native of Europe and parts of Asia, this insect has been introduced to North and South America, New Zealand, Africa and Australia through transportation of the adults and larvae in timber, logs, and untreated lumber. Sirex woodwasps are strong flyers and can migrate anywhere between 25 and 50 miles/year (ISSG 2008). These wasps were first detected in New York in 2005, and have since blanketed that state and dispersed as far south as Pennsylvania. Trapping surveys are being conducted in several southeastern states, including Georgia, but as of 2008, no wasps have been detected (Price 2008). Sirex woodwasps, along with its obligate symbiotic fungus *Amylostereum areolatum*, pose a serious threat to the pine industry as well as natural forests in its invasive ranges. Approximately one-half of Georgia's 24.8 million acre forest is comprised of pine-type species which could serve as a host to this pest (GFC 2004). The sirex woodwasp lays its eggs in conifers primarily *Pinus* species along with its symbiotic fungus *A. areolatum* and mucus that facilitates the growth of the fungus. Outward tree symptoms include wilting and yellowing of the foliage. The fungus causes a vascular wilt disease to develop within the tree which disrupts water movement. These effects combined with larvae boring through vascular tissue often kill trees. Even if the host tree survives, the value of its wood is often diminished because of resin accumulations or dead zones (ISSG 2008). The GFC continues to trap for this insect (2006-2009).

Red imported fire ant (*Solenopsis invicta*)

Fire ants are aggressive generalists that occur in high densities in disturbed habitats, including the edge of forests or agricultural areas (ISSG 2008). Introduced into the U.S. from South America, recent research has concluded that the entire U.S. population of imported fire ants likely descended from anywhere between six to nine ant queens brought to Mobile, Alabama in the mid-1930s. The ants spread to Georgia by the 1950s, and are currently found north to North Carolina and west to Texas (Canerday 1988, ODA 2007). Fire ants are found near areas of permanent water, such as dams, rivers, ponds and aquaculture containers. Fire ants often establish themselves in potted plants in contact with the ground, in stored topsoil, mulch and potting mixes and under landscaping materials. The movement of agricultural equipment or associated plants and planting material from infested areas also spreads fire ants (ISSG 2008).

Red imported fire ants reduce biodiversity among invertebrates and reptiles, and may also kill or injure frogs, lizards or small mammals. In the U.S., they have been found to negatively impact at least fourteen bird species, thirteen reptile species, one fish species and two small mammal species (through predation, competition and/or stinging). Agricultural impacts may include damage to crops, interference with equipment and the stinging of workers in the field. They may also infest electrical equipment (such as computers, swimming pool pumps, cars or washing machines) becoming a nuisance, or even a danger, to people. The current economic impact of fire ants on humans, agriculture, and wildlife in the U.S. is estimated to be at least half a billion, if not several billion, dollars per year (ISSG 2008).

Redbay ambrosia beetle (*Xyleborus glabratus*)

The redbay ambrosia beetle is a small beetle which is responsible for spreading *Raffaelea lauricola*, the fungus that is the causative agent of laurel wilt disease, to redbay trees (*Persea borbonia*) and other plant species in the family *Lauraceae*. The disease has also been discovered in individual plants of the federally endangered pondberry (*Lindera melissifolia*), the threatened pondspice (*Litsea aestivalis*), sassafras (*Sassafras albidum*), and avocado (*Persea americana*) (Price 2008). Redbay ambrosia beetles may have been introduced into the U.S. from its native Asia in solid wood packing materials, such as crates and pallets. They were first detected in the U.S. in a survey trap near Port Wentworth, Georgia in 2002 (Cameron et al. 2008). All of Georgia's coastal counties now have confirmed cases of laurel wilt and the disease is moving northward to South Carolina, southward to Florida, and inland at the rate of about 15 miles per year. Movement of infested firewood, wood chips and logs may be a major factor in spreading the disease into new locations not contiguous with main areas of infestation (Price 2008).

When redbay ambrosia beetles introduce *R. lauricola* into a tree, mortality results when the fungus causes a vascular wilt disease, causing it to wilt. This beetle and its associated fungus have the potential to seriously affect redbay populations in the southeastern United States. At the site of the initial beetle detection in Florida, redbay mortality increased from 10 percent to nearly 60 percent in a period of only nine months. Areas near Hilton Head, South Carolina have experienced nearly complete mortality of the local redbay population (Mayfield and Thomas 2006). The GFC conducted a two year survey and redbay infection levels in plots sampled in the 2006 and 2007 were compared to demonstrate the increase in rate of infection over a one-year time frame. A total of 47 plots were compared in 15 counties and infection rates more than doubled from an average of 21 percent infection in 2006 to 46 percent in 2007 (Cameron et al. 2008). Redbay is important to wildlife as its fruit seed and/or foliage are eaten by several species of songbirds, wild turkeys, quail, deer, and black bear. Larvae of the Palamedes swallowtail feed primarily on species of *Persea*, and require its leaves for development into its adult form (Mayfield and Thomas 2006).

Mammals

Feral swine (*Sus scrofa*)

Feral swine are large omnivorous mammals with powerful bodies and coarse hairy coats. They are found in agricultural areas, coastland, disturbed areas, natural forests, planted forests, range/grasslands, riparian zones, scrub/shrublands, urban areas, and wetlands. The native range of wild swine extends

throughout Europe and continental Asia, as well as the islands of Sumatra and Java. However, they are now extinct over much of their former range. Originally released as a food source, expansion into new areas can result from transport for hunting, escape from confined facilities, dispersal of feral populations, and escape of domestic swine from free ranging commercial ranches. Hogs introduced by early seafarers have often been displaced by domestic swine that have become feral. Feral swine are very mobile animals and may disperse considerable distances (ISSG 2008). They are present statewide in Georgia.

Rooting by feral hogs disturbs the seed bank, reduces surface vegetation, alters the soil, and damages cultivated crop species. In addition, rooting creates large unattractive open spaces, reduces perennial cover and increases the growth of nonnative annual grasses. This results in habitat alteration, a change in plant succession and composition, and a decrease in native fauna dependent on the original habitat. Rooting accelerates soil erosion and increases siltation in rivers. Feral swine are capable of transmitting brucellosis, psuedorabies, leptospirosis, foot-and-mouth disease and Japanese encephalitis. They may threaten human health by carrying helminth parasites that are passed to humans through the consumption of improperly cooked meat (ISSG 2008). Feral hogs also represent a significant threat to a number of rare plants, including the federally endangered relict trillium. On Georgia barrier islands, feral hogs are a major predator of loggerhead sea turtle eggs.

Mollusks

Asian clam (*Corbicula fluminea*)

Asian clams have a yellowish to black shell with concentric, evenly spaced ridges on the shell surface. They are found in lakes and streams of all sizes, and prefer fine, clean sand, clay, and coarse sand substrates. Asian clams are usually found in moving water because they require high levels of dissolved oxygen and are generally intolerant of pollution. These clams are native to southeastern China, Korea, southeastern Russia, and the Ussuri Basin, and in the U.S. can be found in 38 states and the District of Columbia (ISSG 2008). They are so widespread in Georgia that specimens can be found in most counties (Benson et al. 2001). Asian clams are used as live bait throughout the U.S. and can sometimes escape into the water alive. They are also spread by the aquarium trade where they are known as “pygmy” or “gold” clams. Juvenile clams can be carried in ballast water all over the world. Researchers have also sometimes inadvertently released Asian clams into non-native waters. Asian clams can out-compete many native clam species for food and space. The introduction of Asian clams into the U.S. has resulted in the clogging of water intake pipes, affecting power, water, and other industries (ISSG 2008). The costs of managing Asian clam populations amount to nearly \$1 billion annually (OTA 1993).

Zebra mussel (*Dreissena polymorpha*)

Zebra mussels are found in estuaries, lakes, urban areas, and waterways. They are native to the Caspian, Azov, and Black Seas, but since the 1700s their range has expanded westward to include most of Western Europe, the U.K. and North America. In the U.S., these mussels are found in the Great Lakes and in all of the major river drainages east of the Rocky Mountains. While Zebra mussels are not yet present in Georgia, they are a major concern to natural resource management agencies due to the

costly negative impacts that have resulted in states where they are established. Zebra mussels were introduced between continents and among the Great Lakes in ballast water. They have also been introduced to smaller lakes by overland transport on boat hulls and trailers. Larvae may be transported during fish stocking, on scuba diver's wetsuits, or in scientific equipment. Adults may attach to anchors and boat hulls and be transported. Zebra mussels have also possibly been spread by aquarium dumping. Zebra mussels compete with zooplankton for food, thus affecting natural food webs. They also settle in large numbers on native mussels, causing suffocation, starvation, and energetic stress leading to death. Spawning reefs of fishes such as lake trout can be negatively affected by zebra mussel colonies. Zebra mussels cause great economic damage by fouling water intake pipes, beaches, boat hulls, docks, sinking navigation buoys, and clogging condenser pipes (ISSG 2008).

Priority 2 Species

Priority 2 species are those that an agency/organization in Georgia that participates in invasive species management deals with infrequently or attempts to control in selected high-priority areas either because these species are thought to be lesser threats, or because they are widespread and difficult to control. Examples of Priority 2 species identified by members of the Committee include the following:

Plants

Giant reed (*Arundo donax*)

Giant reed is a perennial grass that grows up to 20 feet in height (Evans et al. 2005). Giant reed is found in the riparian zones of low-gradient rivers and along ditches, wetlands, coastal marshlands, range and grasslands, natural and planted forests, and agricultural, disturbed, and urban areas. A native of India, giant reed now occurs worldwide in tropical to warm-temperate regions, including tropical islands (ISSG 2008). In Georgia, giant reed is present in four watersheds: the Upper Oconee, Broad River, Turtle River, and the Upper Ochlockonee (USDA, NRCS 2008). The grass has been widely planted throughout the warmer areas of the U.S. as an ornamental, and is available through the nursery trade. Fragments of giant reed stems are often carried by water to new colonization sites. Once established, giant reed forms dense, homogenous stands that easily displace native plant species. Giant reed provides poor habitat for terrestrial insects and wildlife, and is both a fire and a flood hazard (ISSG 2008).

Oriental bittersweet (*Celastrus orbiculatus*)

Oriental bittersweet is a deciduous, woody, perennial vine that can occur as a trailing shrub. The plant is found in agricultural areas, coastland, natural and planted forests, range/grasslands, riparian zones, scrub/shrublands, and disturbed and urban areas (ISSG 2008). Oriental bittersweet was introduced as an ornamental to the United States from Asia in 1736. Fruits are disseminated primarily by birds, but are also used as decorations in winter and, when discarded, can contribute to the plant's spread (Britton et al. 2004). Oriental bittersweet is moving south and west from the Northeast and presently is found in four Georgia counties (Butts, Harris, Lumpkin, and Union) (SE-EPPC 2008). Once established, the plant can overtop and girdle native trees and shrubs resulting in severe forest degradation. Oriental bittersweet invasions are facilitated by land disturbances, which increase the availability of resources such as germination sites, light, and water (ISSG 2008).

Purple loosestrife (*Lythrum salicaria*)

Purple loosestrife is a perennial herb with a woody stem and whorled leaves. Plants are capable of invading a variety of riparian and wetland habitats, including marshes, river and stream banks, pond edges, lakes, road site ditches, and reservoirs. Disturbed areas are more prone to invasion because exposed soil is ideal for germination. Purple loosestrife is native to Europe, Japan, China, southeastern Asia, and northern India. The plant has invaded Canada, the U.S., Ethiopia, and Australia through floating vegetation and debris, garden escapes, and landscape improvement escapes. In the U.S., purple loosestrife has been recorded in 46 states, including Alabama, North Carolina, South Carolina, and Tennessee. While this plant is not yet present in Georgia, purple loosestrife is a major concern to natural resource management agencies due to the costly negative impacts that have resulted in states with established populations. Purple loosestrife forms dense homogeneous stands that restrict native wetland plant species out-competing and replacing native grasses, sedges, and other flowering plants that provide a higher quality food source and habitat for wildlife. The plant also diminishes the recreational and aesthetic value of overrun wetlands and waterways, and almost entirely eliminate open water habitat if left untreated (ISSG 2008).

Chinaberry tree (*Melia azedarach*)

Chinaberry tree is a small to medium-sized shrub or tree that can reach heights up to 50 feet. The tree is found along roadways, fencerows, and other disturbed areas as well as upland grasslands, woodlands, pastures and riparian areas. Chinaberry is native to Southeast Asia and northern Australia, and was introduced to North America around 1830 as an ornamental in South Carolina and Georgia. The tree, cultivated as a shade or reforestation tree, is common throughout the Southeast. It is especially abundant in Alabama, Florida, South Carolina and Georgia (Britton et al. 2004, ISSG 2008, SE-EPPC 2008). Chinaberry invades disturbed and relatively undisturbed areas, resulting in lower native biodiversity. The tree has numerous defenses against insects and other plant pathogens, giving it a competitive advantage over many native species, and its leaf litter can increase the pH of soils and add nitrogen, significantly altering soil chemistry (ISSG 2008).

Common reed (*Phragmites australis*)

Common reed is a tall, warm-season, perennial sod-forming grass that grows in disturbed areas, estuaries, lakes, riparian zones, coastland, urban areas, water courses, and wetlands. Common reed is found on every continent except Antarctica, and is widespread in the United States (ISSG 2008). Although common reed is found in every state of the U.S., as of 2008, Glynn County is the only area in Georgia where this grass has been sited (SE-EPPC 2008). Common reed has been used in many wetland rehabilitation and stabilization projects, and is also used to revegetate disturbed riparian areas, control shore erosion, stabilize river and canal banks, and reduce wave action on watershed structures. Common reed can be spread by machinery carrying seeds and rhizome fragments which are also dispersed by wind, floodwaters, and birds. Many Atlantic coast wetland systems have been invaded by this grass as a result of tidal restrictions imposed by roads, water impoundments, dikes and tide gates. Common reed becomes a problem when and where grass stands grow and spread at the expense of native grass species. Such growth may threaten wildlife because common grass alters the structure and

function of invaded areas. Common reed growth also increases the potential for marsh fires during the winter when the above ground portions of the plant die and dry out. In addition, monitoring and control of mosquito breeding is very difficult in dense common reed stands (ISSG 2008).

Birds

Monk parakeet (*Myiopsitta monachus*)

The monk parakeet is one of the world's most successful parrot invaders. Monk parakeets prefer open habitat. In its native range, in subtropical and temperate South America, it populates savannah woodlands, farmland, plantations, orchards and cultivated forests in low elevations up to one mile above sea level. In its introduced range it lives almost exclusively in urban areas, preferring open habitats including parks, planted urban areas, golf courses, farms, gardens and orchards. Monk parakeets have been a popular pet, especially in North America since the 1960s. Nearly 65,000 monk parakeets were imported into the U.S. from 1968 to 1972. Upon import, some monk parakeets escaped from damaged shipping crates; some birds were also intentionally released by pet owners and sometimes zoos (ISSG 2008). Over the past 35 years, monk parakeets have been recorded on U.S. Christmas Bird Counts in 14 states including Georgia. Two of the largest established populations of monk parakeets exist in Florida and southern Connecticut (Russello et al. 2008). In its native range, monk parakeets are considered to be a significant agricultural pest, often causing damage to field crops and orchards. There have also been reports of transmission lines short-circuited by nesting birds. In its introduced range, impacts are uncertain. Monk parakeets have not caused the agricultural devastation predicted, nor have there been any solid evidence that native fauna are negatively affected by their establishment (ISSG 2008).

Crustaceans

Chinese mitten crab (*Eriocheir sinensis*)

The Chinese mitten crab is a migrating crab that has invaded Europe and, more recently, North America. These crabs are found in estuaries, lakes, riparian zones, waterways, and wetlands, and have the ability to survive in highly modified aquatic habitats. A native of China, the Chinese mitten crab is now found throughout Europe and Russia. The crab has also been found in North America with reports from the Detroit River and Great Lakes (without establishment) as well as an isolated occurrence in Hawaii, and a growing population in San Francisco Bay. The mitten crab is a delicacy and live crabs have been illegally imported to food markets. Another likely method of introduction is accidental release via ballast water. While Chinese mitten crabs are not yet present in Georgia, they are a concern to natural due to the costly negative impacts that have resulted in states with established populations (ISSG 2008).

Chinese mitten crabs contribute to the local extinction of native invertebrates and cause erosion through intensive burrowing activity. The crab may cost fisheries and aquaculture industries several of hundreds of thousands of dollars per year by stealing bait and feeding on trapped fish. Chinese mitten crabs may also block water intakes in irrigation and water supply structures. In California, the Chinese mitten crab has disrupted water diversion plants with large numbers of downstream-migrating crabs becoming trapped in holding tanks meant to keep fish out of turbines. This has caused fish mortality and

warrant expensive enclosures to prevent the crabs' entry. Chinese mitten crabs may also carry the Oriental lung fluke, a parasite that can be passed onto humans by eating raw or poorly cooked crabs (ISSG 2008).

Green porcelain crab (*Petrolisthes armatus*)

Green porcelain crabs are found in rocky rubble, oyster reefs, and other shallow sub-tidal and inter-tidal habitats. They are native to the waters off of Central and South America, the Gulf of Mexico and the Pacific Ocean. These crabs are currently invading Florida and are a threat to coastal Georgia waters. Green porcelain crabs are established throughout the Duplin River adjacent to Sapelo Island (USGS 2005c). They may have been brought to the Atlantic and Gulf coasts by transport in ballast water and among cultured mollusks. While the full biological impacts of established green porcelain crab populations are unknown, they are thought to displace native bottom-dwelling crabs (ISSG 2008).

Priority 3 Species

Priority 3 species are those that are generally dealt with only in unusual circumstances, either because they represent minor threats or are essentially naturalized and impossible to control with current methods. Examples of Priority 3 species identified by members of the Committee include the following:

Plants

Skunk vine (*Paederia foetida*)

Skunk vine is an aggressive, competitive vine that can grow high into the canopy of trees in a variety of habitats including natural forests, wetlands, and disturbed areas. The vine was introduced by the USDA before 1987 as a potential fiber plant. Skunk vine is spread by humans who grow and cultivate the plant for ornamental or other purposes, and who accidentally transport rooted plant fragments. Skunk vine seeds may also be dispersed by birds (ISSG 2008). A native of Asia, skunk vine has been introduced to North and South America. In the U.S., the vine is present in the southeastern states of Texas, Louisiana, and Florida (USDA, NRCS 2008). Skunk vines climb over shrubs and trees, weighing them down and impeding regeneration. Skunk vine also invades pastureland and can be a nuisance along roads and on power lines (ISSG 2008).

Amphibians

Cuban treefrog (*Osteopilus septentrionalis*)

During the day, Cuban treefrogs hide in moist areas such as cisterns, drains, cellars, and on the trunks of plants. They thrive in altered habitats and are most abundant around ornamental fish ponds and well lighted patios where they are often found on walls, glass windows, porches and potted plants. This species naturally occurs in Cuba, the Isla de Pinos, the Bahamas Islands, and the Cayman Islands, and has been introduced into a large part of southern Florida including the Keys where it is well-established, invasive, and dispersing northward along both coasts (ISSG 2008). A single adult Cuban treefrog was collected in a backyard pond in Savannah in 2004, and the frog is currently present in the Coastal plain of Georgia (Somma 2006). Original introduction into the U.S. probably occurred accidentally on

vegetables imported from Cuba earlier in the century. The treefrogs continue to expand their range in Florida by hitchhiking on crates and transplanted shrubs. Cuban treefrogs are voracious predators, feeding on any small animals they can catch, especially insects, spiders, and other smaller native frogs. Thus, they may negatively effect native treefrog populations both through competition and predation (ISSG 2008).

Birds

House sparrow (*Passer domesticus*)

The house sparrow is a small, non-migratory bird closely associated with humans and is found in agricultural, suburban, and urban areas. A native of Eurasia and northern Africa, house sparrows have been introduced and are now common in populated areas throughout the world. House sparrows are serious agricultural pests, willing to feed on a variety of farm products including grains, vegetables, and fruits. Additionally, house sparrows are a pest on poultry farms where they can consume fairly large quantities of chicken feed. House sparrows are also known for displacing native sparrows by out competing them for natural resources. In rural areas they may evict native birds such as Carolina wrens, bluebirds, woodpeckers and martins from their nests (ISSG 2008).

Fishes

White perch (*Morone americana*)

White perch is a semi-anadromous fish that in its native range migrates from the saltier areas of bays and coastland into tidal-fresh portions of streams and rivers to spawn in spring. White perch are found in coastland, lakes, marine habitats, and waterways. While white perch are native to North America's Atlantic Slope drainages from the St. Lawrence-Lake Ontario drainage in Quebec, south to the Pee Dee River in South Carolina, they were also introduced to 20 states through the Erie and Welland canals in the 1950s, and are present in the Savannah River system in Georgia. White perch have also been legally and illegally stocked in some areas for sport fishing, where they compete for food with native fish species and consume the eggs of walleye, white bass, and perhaps other species as well. They are believed to be a potential cause for declines in walleye populations. Collapse in certain fisheries have coincided with increases in white perch populations and are believed to be a result of egg predation and resulting lack of native fish recruitment. In addition, white perch have hybridized with native white bass (*M. chrysops*) in western Lake Erie. Hybrids capable of backcrossing with parent species as well as crossing among themselves could dilute the gene pool of both parent species (ISSG 2008).

Mammals

Nutria (*Myocastor coypus*)

Nutria are large semi-aquatic rodent that prefer habitats near the water, and are found in riparian zones and wetlands. Native to South America, nutria have been introduced into many areas of North America, Europe, Asia and Africa for breeding in fur farms. This rodent is established in all of the Southeastern states except for Kentucky and South Carolina, and populations may be on the increase in Alabama,

North Carolina, and Tennessee (Benson et al. 2001). Historically, they have escaped and established independent populations. Nutria are voracious herbivores, capable of causing extensive damage to native wetland plants, reducing food and cover for migratory waterfowl, degrading water quality, displacing muskrat populations, and encouraging the spread of purple loosestrife. They also harbor a parasite that causes an itchy rash in humans. Because nutria prefer tubers, they rip up the matted roots that support banks and shorelines, promoting erosion and damaging wetlands. As a result, marshes turn to open water while riverbanks and beaches slip away (ISSG 2008).

Invasive Species Watch List

The Advisory Committee determined that certain invasive species are considered to be future threats if (1) they are not known to be present in the state (and there is not a formal program to prevent their occurrence) but they have been documented in other southeastern states as causing significant ecological, economic, or health impacts; or (2) the species is present in Georgia and is currently not considered a serious pest, but may become one based on its history in other states.

Plants

Chinese yam (*Dioscorea oppositifolia*)

Chinese yam is a fast-growing, perennial, twining vine commonly found in natural forests, riparian zones, wetlands, and disturbed and urban areas. Initial infestations are generally associated with human-caused disturbances, such as areas near old home sites and along roadways. A native of China, India, and Sri Lanka, yams were introduced into North America in the 1800s for food and are still cultivated for ornamental or medicinal use. The Chinese yam has become naturalized in most of the Eastern and Midwestern U.S., and is found in several southeastern states including Georgia (SE-EPPC 2008). Chinese yams significantly lower native species diversity by outcompeting native herbs and seedlings, thickly blanketing all adjacent vegetation, and competitively excluding light. They may also weigh down and break branches of large trees and shrubs (similar to kudzu) (ISSG 2008).

Chinese silver grass (*Miscanthus sinensis*)

Chinese silver grass is a perennial plant that can reach up to 10 feet in height. It is shade intolerant but can be found in sparsely forested areas and small sunlit openings. Common in many natural, urban, and disturbed areas, Chinese silver grass is often found on abandoned home sites, roadsides, forest edges, sides of reservoirs, and in old fields following fires. The grass is a native of Russia, China, Japan, Korea, Philippines, Taiwan, and Indonesia and has been introduced into the U.S. and Australia as an ornamental plant (ISSG 2008). In the U.S., Chinese silver grass is found in California, Colorado, the Midwest, and most states east of the Mississippi River including Georgia, where populations have been documented in Clarke, Echols, Elbert, Rabun, and White counties (USDA, NRCS 2008). This grass reduces the photosynthetic capability of surrounding plants by reducing the light available at the soil surface. Chinese silver grass is also known to carry several pathogens, including barley yellow dwarf luteovirus-MAV and PAV and cereal yellow dwarf luteovirus (ISSG 2008).

Itchgrass (*Rottboellia cochinchinensis*)

Itchgrass is an erect annual grass that is found in agricultural areas, range/grasslands, and disturbed areas. It grows along roadsides and in other open, well-drained sites and is a prevalent species in old field succession, but can also be found in wet places, including shallow water. Itchgrass seeds are spread by birds, flood water, rodents, and farm machinery. A native of Africa, Asia and Australia, it is thought that itchgrass entered the U.S. in plant material or on equipment imported from the West Indies. Itchgrass is now present in seven southern states including Georgia where a population in Tift County has been documented (USDA, NRCS 2008). Itchgrass is a very competitive plant and is considered to be a serious agricultural problem in soybean, corn, cotton, peanut, rice, and sugarcane fields where they are capable of reaching densities that could prevent crop harvest (ISSG 2008).

Johnsongrass (*Sorghum halepense*)

Johnsongrass is an extremely invasive perennial grass with a worldwide distribution. Johnsongrass thrives in fertile lowland areas, especially where land has been disturbed or cleared, and is found in agricultural areas and ruderal/disturbed areas. Originally planted in the 1800s as a forage crop, Johnsongrass can rapidly colonize new environments and is moving northwards into Canada from the U.S. Seeds may be transported via wind and waterways, in agricultural machinery, and in the coats of livestock. Native to the Mediterranean region of Europe and Syria, this species is now present around the world, and is regarded as a serious problem in 53 countries. Johnsongrass is found in every state of the Union except Minnesota, Alaska, and Maine, and has been reported in 32 Georgia counties (ISSG 2008, SE-EPPC 2008). This plant's extensive spreading rhizome, shoot system, and high rate of seed production make it extremely invasive and a serious agricultural pest. The grass' height and size allow it to shade out surrounding plants and decrease the amount of moisture and nutrients available to them. Under very hot conditions, dried out plants can become a fire hazard. Johnsongrass can also be toxic to grazing livestock, act as a host for crop pathogens, reduce soil fertility, and is a known allergen (ISSG 2008).

Disease Causing Organisms

Dogwood Anthracnose (*Discula destructiva* Redlin)

The cause of dogwood anthracnose is a fungus named *Discula destructiva* Redlin. A native of Asia, the disease was first detected in North America almost simultaneously near two port cities, on opposite coasts, shortly after trade with China was reopened in 1975. The fungus produces only asexual spores, but these grow in great numbers in pustules with a slimy matrix, mostly on the underside of the leaf. They are well adapted to spread in splashing rain. The wet period necessary for infections is unusually long (24 to 48 hours), which partially explains why the disease is more severe in the mountains, at higher elevations, on north-facing slopes, and near streams and waterfalls where moist conditions are common. Since dogwood anthracnose was first reported in the southern U.S. in 1986, its main host has been the eastern flowering dogwood (*C. florida* L.). Flowering dogwoods in western North Carolina have incurred 56 percent mortality since 1991 (Britton et al. 2004).

Dutch Elm Disease (*Ophiostoma novo-ulmi*)

The causative agent of Dutch elm disease, *Ophiostoma novo-ulmi*, has killed hundreds of millions of elms in the U.S. since its introduction. The original causal fungus, *O. ulmi*, was likely of Himalayan origin and reached the Netherlands by way of the Dutch East Indies. It was introduced from there into North America in the 1930s. All North American elm species and particularly the historically significant street tree American elm (*Ulmus. Americana*) are susceptible to Dutch elm disease. The spores are carried from tree to tree in the south by *Scolytus multistriatus*, the smaller European elm bark beetle. The beetles become infested with spores as they feed on dying elms, and when they emerge as adults they spread the spores to healthy trees while feeding in twig crotches. The fungus spreads within the tree by spores transported in the xylem, and by mycelial growth through other tissues. Leaves on infected branches wilt, curl, turn yellow, and die. Sometimes the tree dies within a few weeks, its vascular tissue blocked by fungal mycelium, tyloses, and gums. This is particularly true in cases where the fungus has spread through root grafts. In other cases, the tree may die one limb at a time over a period of a year or more. The cost of removal of dead elms is estimated at \$100 million per year. Although *U. Americana* was not planted as widely in the South as in the northern U.S., elms are gradually losing their place in southern landscapes, as well as in native forests (Britton et al. 2004). Resistant varieties of American elm have been developed for the landscape industry and have been planted for several years now.

Fishes

Black carp (*Mylopharyngodon piceus*)

The black carp is a bottom-dwelling molluscivore that has been used by U.S. fish farmers as a biological control for disease-carrying snails in their farm ponds and, more recently, the introduced zebra mussel. Black carp was first brought into the U.S. from Asia in the early 1970s as a “contaminant” in imported grass carp stocks. Subsequent introductions of black carp occurred in the early 1980s. During this period, it was imported as a food fish and as a biological control agent to combat the spread of yellow grub (*Clinostomum margaritum*) in aquaculture ponds. The first known record of an introduction of black carp into open waters occurred in Missouri in 1994. The black carp has been reported in Arkansas, Illinois, Mississippi, and Missouri (ISSG 2008). While this fish is not yet present in Georgia, it is a concern to natural resource management agencies due to the costly negative impacts that have resulted in states with established populations.

Black carp could potentially negatively impact native aquatic communities by feeding on and reducing populations of native mussels and snails, many of which are considered endangered or threatened. Black carp could restructure benthic communities through direct predation and removal of algae-grazing snails. Mussel beds consisting of smaller individuals and juvenile recruits are probably most vulnerable to being consumed by black carp. Because the life span of black carp reportedly exceeds 15 years, sterile triploid black carp in the wild would be expected to persist many years and therefore have the potential to harm native mollusks by predation. In addition, Black carp are host to parasites, flukes, and bacterial and viral diseases that could possibly be transferred to other fish species (Crosier and Molloy 1996, Nico 2008).

Framework for Invasive Species Management in GA

Federal Invasive Species Management Efforts in Georgia

The growing challenges posed by invasive species and the role of the federal government in coordination and regulation of activities that span state or international borders have prompted Congress to authorize a number of specific actions concerning invasive species management. While no single federal agency has authority over all aspects of invasive species management, many agencies have programs and responsibilities that address aspects of the problem, such as importation, interstate transport, prevention, exclusion, control, and eradication.

Federal Agency Activities

U.S. Army Corps of Engineers (Corps): Through its Civil Works Program, the Corps carries out a wide array of projects that cover coastal protection, flood protection, hydropower, navigable waters and ports, recreational opportunities and water supply. The Corps' Engineering Research and Development Center (ERDC) operates the Aquatic Nuisance Species Research Program with the goal of minimizing adverse impacts and maximizing control opportunities with respect to aquatic invasive species. The ERDC also has an Aquatic Plant Control Research Program, which is the only federally authorized research program in the Nation directed to develop technology for the management of nonnative aquatic plant species. The Corps interacts with the public through numerous boating facilities at all of the reservoirs under its jurisdiction by posting educational signs at public access points (e.g., boat ramps) warning boaters to check for aquatic invasive species hitchhikers. The Corps educates and informs marina employees, boaters, and the general public about problems associated with improper sewage disposal and encourages the use of pump out stations. It uses a variety of outreach tools, including displays, publications, workshops, promotional items, education programs and websites to reach target audiences. Surveys of Corps reservoirs are conducted to monitor existing aquatic invasive species populations and to detect new infestations. Members of the Corps' natural resource management staff are also trained to recognize and report the occurrence of aquatic invasive species. In Georgia, the Corps' involvement in aquatic invasive species management is primarily related to the occurrence of nuisance populations of aquatic plants in Corps-operated navigation and multi-purpose reservoir projects including Lake Seminole and the Walter F. George Reservoir.

U.S. Department of Agriculture (USDA) – Animal and Plant Health Inspection Service - Plant Protection & Quarantine (APHIS PPQ): APHIS-PPQ safeguards agriculture and natural resources from risks associated with the entry, establishment, and spread of animal and plant pests and noxious weeds. APHIS-PPQ has a broad, active program in invasive species detection in Georgia, including cooperative agreements with several state agencies. The National Cooperative Agriculture Pest Surveys (CAPS) identifies the top foreign insects, diseases and plants that pose a high-risk to agriculture and natural communities. The local CAPS committee then selects which of these are appropriate for Georgia, and sets traps, inspects materials that would provide an entry pathway, and develops outreach information for the public regarding identification of exotic pests and how to report any suspects to state or USDA personnel. APHIS-PPQ has a Plant Inspection Station at the Hartsfield-Jackson International Airport and identifies

invasive species found in cargo and passenger baggage. APHIS-PPQ personnel at the cargo container port in Savannah inspect agricultural products for invasive species and monitor traps around the port environs for earliest possible detection of new species. APHIS-PPQ also develops and implements response plans, along with state cooperators, for eradicating, controlling or managing new invasive species when they are discovered. Its Smuggling Interdiction & Trade Compliance group in Georgia monitors the marketplace (e.g., food markets) for harmful, prohibited products.

U.S. Department of Agriculture - Forest Service: The Forest Service manages 191 million acres of federal lands for many purposes, including protection from invasive weeds, and is the USDA's lead agency for nuisance weed control. The Service's Invasive Species Program uses experimental forests and research field stations to study the reproductive biology, dispersal rates, and distribution of invasive forest species. Current projects focus on a number of topics, including the use of herbicide in controlling nonnative forest plants, understanding and managing exotic forest pathogens and diseases, and assessing the effects of invasive amphibians in natural wilderness areas. Working with state forestry agencies in conjunction with land grant colleges and universities, the Forest Service conducts herbicide efficacy trials on cogongrass, privet, Japanese climbing fern, and wisteria in South Georgia. The Service, together with the Natural Resources Conservation Service, also conducts invasive species control demonstrations using various herbicides, rates, and timing. Along with state partners or professional organizations such as the Society of American Foresters and the Georgia Vegetable Manufacturers Association, the Forest Service provides training in the identification, control, and biology of invasive plants.

U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS): The NRCS considers environmental, social, cultural, and economic conditions when recommending management options for invasive species, and encourages the use of native species for a given location and conservation practice in correlation with restoration or containment goals. The NRCS also uses agency programs, such as the Environmental Quality Incentives Program, the Wildlife Habitat Incentives Program, and the Wetlands Reserve Program, whenever appropriate to help private landowners recognize, inventory, and control invasive species. In Georgia, NRCS conservationists: provide training, guidance and assistance to field personnel regarding invasive species management; ensure that all conservation plans and contracts, where relevant, contain appropriate clauses concerning the prevention, spread, and management of invasive species; participate in state (and equivalent) rapid-response teams and efforts; and stay abreast of state and local species of concern.

U.S. Department of Commerce - National Oceanic and Atmospheric Administration (NOAA): NOAA funds research, education and outreach, and control activities on aquatic invasive species issues primarily through the National Sea Grant Program, with some activities funded through the National Ocean Service and National Marine Fisheries Service. Its aquatic invasive species management efforts focus on marine systems and the Great Lakes. Research efforts include monitoring the impacts of aquatic invasive species on coastal and other ecosystems, developing control and mitigation options, and preventing new introductions by, among other things, developing new technologies for ballast water management. NOAA performs economic evaluations of the costs of aquatic invasive species and conducts control programs to eradicate and prevent their spread. NOAA also has regulatory authority to prevent the

introduction of aquatic invasive species that may affect marine sanctuaries, such as the Gray's Reef National Marine Sanctuary, endangered or threatened species, coastal areas, and essential fish habitats.

U.S. Department of the Interior – U. S. Fish and Wildlife Service (USFWS) and USFWS Region 4: The USFWS is responsible for preventing introductions of potentially harmful, invasive species on land and in waters under the Department of Interior's jurisdiction. The USFWS is working with the State of Georgia and the National Park Service to reduce the threat of Asian swamp eels in the Chattahoochee River. Additionally, the agency's Partners for Fish and Wildlife Program provides funds for private landowners to manage invasive species, primarily plants, on their property. Specific projects have focused on privet and tallow tree removals and research on red shiner/blue shiner interactions. The USFWS also created grant agreements with The Nature Conservancy regarding invasive plant control in the Altamaha basin, and funded projects to remove invasive plants and research to increase understanding of how invasive species might out-compete native fish. In order to increase public awareness of aquatic invasive species, the USFWS's Regional Aquatic Nuisance Species Coordinators have developed informational websites, conducted workshops, and created outreach materials for national distribution, including traveling displays, exhibits, pamphlets, aquatic invasive species identification cards, fact sheets, and videos.

U.S. Department of the Interior – National Park Service (NPS): The NPS has a program to control and eradicate invasive species in lands and waters within agency boundaries. One of the NPS's largest efforts is through Exotic Plant Management Teams, which are field-based teams of NPS employees and student interns that travel to various parks and apply herbicides and mechanical treatment to rid areas of invasive terrestrial plants. The NPS cooperates with partners to respond to newly detected invasive species. In some instances, depending on funding and authority, local park staff and partners will actively respond to newly detected invasive species and work to restore impacted areas to natural communities. Public education and outreach varies depending on local park units. The agency also maintains a number of websites related to invasive species, particularly terrestrial plants, and works with partners to compile, manage, and distribute data on specific occurrences of invasive species.

U.S. Department of Transportation – U.S. Coast Guard: The Coast Guard is responsible for developing and implementing a ballast water management program to minimize the likelihood that aquatic invasive species can be introduced into the U.S. in the ballast water of long-distance ocean vessels.

State Invasive Species Management Efforts in Georgia

Georgia has a number of programs, agencies, and organizations that address both established and potential invasive species, and combine education, regulation, prevention, detection, and control actions as the needed basis for managing all invasive species.

State Agency and Organization Activities

Georgia Department of Agriculture (GDA): The Georgia Department of Agriculture provides services and regulatory functions, protects and promotes agriculture and consumer interests, and ensures an abundance of safe food and fiber for Georgia by using state-of-the-art technology and a professional workforce. The Georgia Department of Agriculture (GDA) is the primary state agency given statutory

authority to protect the state's agriculture resources from invasive pests. Enabling statutes include the Entomology Act of 1937 (O.C.G.A. §2-7-1), the Georgia Boll Weevil Eradication Act of 1985 (O.C.G.A §2-7-150), the Georgia Bee Law (O.C.G.A. §2-14-40), the Bird Dealers Licensing Act (O.C.G.A §4-10-1), and the Prevention of Disease in Livestock Act (O.C.G.A. §4-4-1). Georgia Department of Agriculture employees are authorized to inspect; survey for, and treat for pests which may be injurious to livestock, agricultural, horticultural, or other interests of the state. The GDA actively inspects establishments for the presence of livestock and plant pests and cooperates with other agencies in conducting additional surveys for exotic invasive pests.

Georgia Department of Agriculture - Plant Protection Division (GDA-PPD): The GDA-PPD conducts over 8,000 inspections of plant growers and plant retail centers each year with a portion of each inspection devoted to exotic pest detection. Eight hundred insect and plant disease samples are collected and submitted for identification. GDA-PPD personnel work with plant nurseries to keep their production premises free from federal noxious weeds. Additionally, The GDA-PPD participates in the Cooperative Agriculture Pest Survey program for detection of harmful agriculture pests.

Georgia Department of Human Resources: Division of Public Health (DPH): The DPH's Zoonotic Disease Team works with mosquito control agencies to reduce the impact of some vector-borne diseases through proper mosquito control measures. Mosquito surveillance is performed in July-October for arboviral disease testing purposes. Because mosquitoes are identified by species, the DPH is able to document the presence of invasive mosquito species in the state. Educational efforts are focused at reducing the breeding sites of *Aedes albopictus*, an aggressive invasive mosquito species that has been implicated in arboviral disease transmission. The DPH also keeps a database of mosquito species that have been tested for arboviral diseases through its West Nile Virus surveillance program.

Georgia Department of Natural Resources: Coastal Resources Division (CRD): The CRD manages Georgia's coastal natural resources. The CRD partners with scientists and resource managers to determine the level of potential risks and impacts that introduced aquatic invasive species could have on coastal natural resources. The CRD's Coastal Management Program has funded a survey of Georgia's ports for aquatic invasive species, and is currently funding an education and outreach campaign for aquatic invasive species found in the port areas. The CRD also funds mapping and distribution of aquatic invasive species in the ports. Because the impact of known aquatic invasive species has not been determined in coastal waters, the CRD is currently funding assessments of introduced aquatic invasive species along the coast. The CRD also funds boater education to prevent the transportation of aquatic invasive species as well as educational brochures targeting aquatic invasive species distribution.

Georgia Department of Natural Resources: Environmental Protection Division (EPD): The Watershed Protection Branch of the EPD works indirectly with nonnative plants and invasive species. Guidance developed or policies used by EPD incorporate information regarding the use of native plant species for re-vegetating land disturbances, stream buffers, stream restorations, and general erosion prevention/treatment. The removal of invasive species is encouraged as a means of restoration and/or preservation. The EPD is currently promoting education and outreach regarding invasive species identification and removal, and also publishes guidance documents regarding land disturbance and mitigation. The Coastal Adopt-A-Wetland program includes outreach on aquatic invasive species and has

a series of posters that are distributed throughout the Georgia coastline that ask people to report occurrences of aquatic invasive species.

Georgia Department of Natural Resources: Parks, Recreation and Historic Sites Division (PRHSD): The PRHSD initiated an invasive species program in 2005, originally funded by federal grants. Five state priority sites were identified and a five-year management plan was developed for each site. Focal species could include any invasive species found in Georgia, but the plans usually focused on privet, kudzu, wisteria, English ivy and microstegium. The PRHSD is also working at a number of other sites that have ongoing invasive plant species control work but do not require the intensive professional management of the five priority sites. PRHSD staff has received invasive plant species identification training and is the PRHSD's primary source of detection. A staff forester, parks biologist and division resource manager are assigned to manage each park and historic site and are knowledgeable about the invasive species issues at each site. The Georgia Botanical Society, Georgia Exotic Pest Plant Council, and other groups participate as volunteers and visitor monitors who provide the PRHSD with updated information about invasive species threats. In addition, the PRHSD operates a number of restoration projects, including river corridor, longleaf pine, wiregrass, and natural bog communities. The Division has combated turf and pasture grass for over a decade at Panola Mountain in an effort to restore native grass communities. This project is now a statewide model for native grassland restoration.

Georgia Department of Natural Resources: Wildlife Resources Division (WRD): The WRD is charged with acting on invasive species threats on behalf of the state's wildlife and citizens. Control efforts for terrestrial invasives are focused primarily on state-owned lands, while those for aquatic invasives may include both public and private waters. Among other activities, the WRD conducts assessments of flathead catfish, Asian swamp eels, and channeled apple snails. Other efforts include the prevention of the introduction of chronic wasting disease through enforcement of regulations relating to importation and transport of deer. The WRD has recently undertaken control and management activities involving flathead catfish in Southeast Georgia, funded a risk assessment for tilapia, and established control management activities on feral hogs on Ossabaw Island. In addition, WRD contributes funding to the interagency effort to propagate predator beetles to control the hemlock wooly adelgid. The WRD's Fisheries Management Section has the responsibility of documenting exotic fish and aquatic invasive species reports. After receiving an aquatic invasive species outreach grant from USFWS in 2004, WRD staff developed a freestanding display, brochures, and other materials highlighting aquatic invasive species. Division staff members participate in numerous outreach efforts related to invasive species, including presentations at conferences, workshops, outdoor festivals, and trade shows with the goal to educate the public about the dangers of invasive species and to prevent their release into the environment. WRD biologists also work with the Georgia Native Plant Society, the Georgia Wildlife Federation, and other groups to promote landscaping with native plants and provide information on native plant nurseries and other sources of native plant materials.

Georgia Department of Transportation: Office of Environment and Location (GDOT): GDOT ecologists, landscape architects, maintenance crews and construction personnel survey for invasive plant species on all transportation construction projects throughout the state. The survey reports are catalogued and are reviewed by the Federal Highway Administration, USFWS and WRD. In situations where protected

plant species are in proximity to project corridors, special provisions are used to target specific nuisance plant species with herbicide. Construction vehicles and equipment are required to be inspected for invasive plant species and removal of such species must occur before vehicles and equipment are transferred between project locations. GDOT is preparing to work with the UGA Bugwood Network and the Georgia Exotic Pest Plant Council by contributing GPS data on the location of invasive plant species throughout the state. GDOT owns and operates over 30,000 acres of stream and wetland mitigation banks in which restoration and preservation activities are conducted. These mitigation sites are monitored for plant success, species composition and water table fluctuations. Additionally, GDOT reports any cogongrass and hydrilla sightings to the WRD. GDOT is treating numerous cogongrass sites on State and Federal right-of-ways in conjunction with the GFC's eradication effort.

Georgia Forestry Commission (GFC): GFC is the primary state agency in charge of detection and suppression of invasive species within the state's 24.7 million forested acres. GFC is actively involved with suppressing southern pine beetle infestations and responsible for selecting predator insects release sites to combat the hemlock woolly adelgid on state and privately-owned lands. In addition to monitoring or surveying for several tree diseases, GFC deploys a series of early detection insect traps at multiple locations in an effort to trap a variety of non-native insects that could impact the state's forests and trees (sirex woodwasps, gypsy moths, and emerald ash borer). GFC conducts terrestrial surveys for *Phytophthora ramorum* (the causative agent of sudden oak death), and is conducting stream baiting to detect its presence within specific watersheds identified as high risk. The GFC surveys warehouses that receive cargo with solid wood packing material from high risk regions of the world for exotic bark beetles (i.e., Asian longhorn beetle). GFC also promotes detection and suppression of non-native plants where practical and possible. Cogongrass has become a priority invasive species for GFC and efforts are underway to educate the public to recognize and report species occurrences. GFC and USDA-APHIS personnel are treating and eradicating all known cogongrass infestations in Georgia. GFC forest health staff conducts or participates in over 150 public speaking opportunities each year to various organizations including foresters and other resource managers, fire fighters, loggers, civic groups, environmental groups, school and college groups, state and county public works departments, hunting and fishing organizations and farm organizations. In all, GFC personnel expend over 50,000 hours annually on invasive forest pest issues.

UGA – Center for Invasive Species and Ecosystem Health (Center): The Center was established at UGA in order to address issues on invasive species and ecosystem (agricultural, forested and natural system) health. The Center evolved from the Bugwood Network, a project that developed through faculty cooperation between the College of Agricultural and Environmental Sciences and the Warnell School of Forestry and Natural Resources at the University of Georgia. The Center's goals include: becoming a preeminent national and international public service and outreach center; developing collaboration between UGA and state, university, federal and international partners; integrating and developing information and programs; serving as a clearing house for information, applied research and training; and promoting public awareness, education and applied research. The Center is currently developing and administering 20 educational web systems, seeking and archiving digital images in four topic-based web systems to support educational activities, managing the Georgia Cooperative Agricultural Pest Survey Program, developing policy and protocols for early detection and rapid response of invasive

species, developing and administrating the Early Detection and Distribution Mapping System for the Southeast Exotic Pest Plant Council and the Everglades Cooperative Invasive Species Management Area, applying herbicide research on emerging invasive plants, and facilitating and extending program development in Europe and Central America. The Center also assumed management of the Georgia Invasive Species Task Force. The Task Force was created in collaboration with the Georgia Forestry Commission, USDA Forest Service, USDA APHIS-PPQ, Georgia Department of Agriculture, the Bugwood Network, and the Warnell School of Forestry and Natural Resources to expand involvement and cooperation of state agencies, non-government organizations and other interested parties to address invasive threats in Georgia.

UGA - College of Agricultural and Environmental Sciences - Aquaculture Unit (CAES): The CAES provides research, teaching and extension (or public service) at the undergraduate and graduate levels in a variety of specialties, including Agriculture and Environmental Sciences. The Aquaculture Unit is specifically charged with providing information regarding aquaculture, fisheries, and fresh water pond issues (including aquatic plant management, fish population management, and fish disease diagnostics). Through Cooperative Extension, CAES is often the first point of contact when a member of the public observes an aquatic invasive species. CAES also provides training to county extension agents, fish farmers, fish hobbyists, county governments, and others regarding invasive species issues, and has direct contact with private individuals involved in interstate transportation of fish and invertebrates through its extension programs. CAES conducts pesticide testing for effective control of aquatic plants and snails. Faculty members work with the CAES, the Warnell School of Forestry and Natural Resources, and the Georgia Department of Agriculture to provide training for aquatic pesticide applicators several times each year in several locations across the state. This training involves private applicators, biologists for the GA DNR and cooperative extension agents. Public education is conducted in conjunction with aquatic pesticide applicator training. Faculty members also act as advisors to the Georgia Aquaculture Association.

UGA - Department of Horticulture (Department): Members of the Department's faculty serve on the Board of the Georgia Exotic Pest Plant Council (GA-EPPC) and the Invasive Plant Task Force of the Georgia Green Industry Association. The Department works with these organizations to develop educational materials, including a table-top exhibit on aquatic and terrestrial nuisance plant species, a PowerPoint presentation on invasive plant species and a list of alternative plant choices, both native and non-native. These resources are used by organizations at trade shows and other events. They are also available on-line from the GA-EPPC web site, and are used by county extension agents across the state in local programming. The Department is preparing and disseminating educational materials across the state in concert with GA-EPPC and the Georgia Green Industry Association. The Department promotes educational workshops offered by GA-EPPC for landowners, green industry professionals, and consumers. These workshops focus on identification as well as management options and techniques.

UGA - Marine Extension Service (MAREX): MAREX conducts research programs to monitor coastal aquatic invasive species and documents their biology and ecology. MAREX also conducts outreach efforts to increase public awareness and modify behaviors in order to prevent new introductions and reduce the further spread of existing problem species. MAREX's restoration activities include the

formation of GEORGIA: Generating Enhanced Oyster Reefs in Georgia's Inshore Areas, a hands-on volunteer based oyster shell recycling program that broadens public awareness of oyster ecological functions, promotes a sense of stewardship, and restores lost oyster acreage. MAREX's public education and outreach activities include: the Aquatic Invaders program; public surveys to gauge understanding of aquatic invasive species issues; "Have You Seen Me?" sheets; aquatic invasive species fact sheets; Camden County 4-H officer training, development of an aquatic invasive species volunteer monitoring manual; future incorporation of aquatic invasive species prevention best practices into the Georgia Clean Marina program; development of educational rack cards, booklets, and posters on aquatic invasive species; and work on a public service announcement to highlight aquatic invasive species and prevention tips. In addition, MAREX will conduct a volunteer monitoring program for coastal fouling communities that will operate through the existing Adopt-A-Wetland program. MAREX conducts port surveys, participates in *Mytella* dock sampling, and hosts the Aquatic Invaders Zoo & Aquarium program, and also compiles volunteer monitoring data and public reports from "Have You Seen Me?" flyers and publishes the data in peer-reviewed research papers. MAREX conducted a literature review for fish, mollusks, crustaceans and polychaetes in the South Atlantic Bight, and created a regional GIS database as part of port surveys. In all, the database now contains information from a total of 104 publications, representing locality information for 2,533 species.

UGA – Odum School of Ecology (Odum School): In addition to having several faculty members who actively research invasive species, the Odum School participates in UGA's Species Invasions Science (SIS) group and also hosts the Drake Research Group. These groups bring together individuals interested in the study of invasive species. The SIS group is interested in all aspects of the scientific study of species invasions. This includes the study of species-specific strategies for management, the search for general patterns and laws of species invasion, and the effort to use invasions as a source of insight to better understand the ecological and evolutionary processes that govern the natural world. SIS is an interdisciplinary and interdepartmental group comprised of individuals from the Odum School, the Warnell School of Forestry & Natural Resources, the Department of Genetics, and the Department of Crop and Soil Sciences. One of the primary functions of SIS is to provide a forum for the exchange of knowledge and expertise among invasion science practitioners. Research by the Drake Research Group is devoted to integrating theory, statistical modeling, and conducting experiments to solve basic and applied problems in population ecology. Applied projects have focused on invasive species to answer such questions as how many individuals of a species it takes to establish a viable population, what characteristics predispose species to being good colonizers or having strong impacts on ecosystems, and where and how fast invading species will spread.

UGA - Warnell School of Forestry and Natural Resources (Warnell School): The Warnell School conducts extensive programming to train professional resource managers, extension agents, landowners, and the general public on invasive species issues, identification, and management. The Warnell School developed the Early Detection & Distribution Mapping system (EDD-Maps) for use by the eight Southeast Exotic Pest Plant Council state members. EDD-Maps has now expanded to projects in the Florida Everglades for all taxa mapping of invasive species and is being considered for implementation on additional regional and national projects. The Warnell School conducts extensive invasive species outreach programming along with development and publication of identification and management

guidelines, control recommendations, and web resources. The Warnell School is also part of the Species Invasions Science group and the Center for Invasive Species and Ecosystem Health.

Interagency Efforts: The Georgia Invasive Species Task Force

The Georgia Invasive Species Task Force is comprised of the Georgia Department of Agriculture, the Georgia Forestry Commission, the Georgia Department of Natural Resources, and the University of Georgia. For more than 15 years, members of this group have worked cooperatively together in invasive species detection, education, and control. These state agencies have legislative authority and/or mandates for action for invasive species detection and response as well as long established relationships with other state and federal agencies. When exotic pests are detected, each agency has clear responsibilities within with the Incident Command System (ICS) and their actions depend upon the invasive species detected and their role within the task force.

The Georgia Department of Agriculture is given statutory authority under various statutes to oversee survey and control activities that involve pests that primarily impact Georgia's agricultural crops, commodities, and livestock. The Georgia Forestry Commission is enabled to oversee activities that involve pests that primarily impact Georgia's forests and authority to establish boundaries and zones of infestation whenever pests are found. The authority to protect state wildlife resources, state parks and management areas from invasive species rests with the Georgia Department of Natural Resources. The University of Georgia is the state's Land-Grant Institution providing resident instruction, research and outreach to the citizens of the state. The Warnell School of Forestry and Natural Resources and the College of Agricultural and Environmental Sciences and the Cooperative Extension Service provide a network of specialists who deal with commodity-based pest issues, research, and management.

These agencies have been active participants in the Cooperative Agricultural Pest Survey program (CAPS). This program is a combined effort by state and federal agricultural or forestry agencies to conduct surveillance, detection, and monitoring of exotic plant pests of agricultural and natural plant resources and biological control agents. Survey targets include plant diseases, insects, weeds, nematodes, and other invertebrate organisms. Such survey activities foster early detection and rapid response to invasive pests that are not established or have limited range in the U.S.

Nongovernmental Invasive Species Management Efforts in Georgia

Interest generated from state and federal policy also stimulates action by non-governmental organizations. This section describes actions and programs involving invasive species management activities carried out by various organizations in Georgia.

Nongovernmental Organization Activities

Georgia Aquarium: As of 2008, the Aquarium's involvement in aquatic invasive species is limited to educational programs where the impact of aquatic invasive species on biodiversity is discussed with middle and high school students. While the Aquarium exhibits flathead catfish, the exhibit does not include a discussion on aquatic invasive species. The Aquarium is considering setting up a discussion of

lionfish and their introduction to Grays' Reef National Marine Sanctuary. The Aquarium also has a handout that it developed on aquatic invasive species for the general public.

Georgia Exotic Pest Plant Council (GA-EPPC): GA-EPPC is a nonprofit group that concentrates exclusively on existing and potential invasive exotic pest plants in Georgia. GA-EPPC is a chapter of the regional Southeast Exotic Pest Plant Council and a member of the National Association of Pest Plant Councils. First organized in 1999, GA-EPPC's stated mission is to focus attention on the adverse effects exotic pest plants have on the diversity of Georgia's native plants and animals; the use of exotic pest plant management to prevent habitat loss; the socioeconomic impacts of these plants; changes in the seriousness of the different exotic pest plants over time; and the need to exchange information which helps land owners and managers set priorities for exotic pest plant management.

GA-EPPC developed the Invasive Non-native Plants in Georgia list, which is currently the most comprehensive such list for the state. The organization provides an annual educational meeting, several workshops and other educational programs in a wide variety of venues throughout the state. GA-EPPC regularly collaborates with other organizations such as the Georgia Green Industry Association and the Georgia Native Plant Society to provide educational programs and materials. In addition, GA-EPPC has close working relationships with state and federal agencies that are involved in invasive plant management.

Through its programs, GA-EPPC reaches a wide audience that ranges from professional land managers to the general public and provides an important network for information and assistance with invasive plants. GA-EPPC members participate in volunteer work parties to control and remove invasive plants, add to the EDDMaps database, and assist with education by distributing materials provided by the organization.

GA Forestry Association (GFA): The GFA is the leading advocate for a healthy business and political climate for Georgia's forest environment, forest landowners and forest-based businesses. GFA promotes invasive species awareness through communication, education and programs to its membership and other interested sectors. Target audiences include forest landowners, industry leaders and experts, foresters, elected officials, and the conservation community. GFA has run several articles in its bi-monthly publication, *Georgia Forestry Today*, focusing on identification and the control and risk management of invasive species, such as cogongrass and red bay disease. In affected areas of the state, GFA also has provided speakers at regional meetings to give presentations in an effort to educate its membership, primarily forest landowners, of the dangers associated with invasive species. GFA attends the NRCS's State Technical Committee meeting where cost share programs can/could be developed to target invasive species.

Georgia Green Industry Association (GGIA): GGIA supports self-regulation and phasing out use of invasive species through public education about desirable alternatives. It also hopes to self-regulate in the area of new introductions through the development of screening protocols. GGIA is presently working with the Georgia Exotic Pest Plant Council and the Georgia Native Plant Society to develop a list of alternative plants for cultivation, both native and nonnative. The goal of this effort is to have a single list of accepted and prohibited plants that will be agreeable to all and a unified message that can be

conveyed to the gardening public. GGIA has worked with the Center for Applied Nursery Research in Dearing, Georgia to solicit help from the research community with problems associated with invasive species and ways to combat invasiveness in ornamental plants. GGIA has also adopted the Voluntary Codes of Conduct for Nursery Professionals per the St. Louis Declaration on Invasive Plant Species, and provides assistance with productions of educational brochures in cooperation with UGA and the State Botanical Garden.

Georgia Native Plant Society (GNPS): The GNPS is involved with neighborhood restoration projects that encourage training in aquatic invasive species identification, removal, and replanting with natives. Specific areas include Grant Park, Piedmont Park, and the Heritage Trail in Cobb County. The Society features at least one yearly lecture on invasive plants out of six general membership meetings a year. GNPS hosts a kiosk at the Southeastern Flower Show that includes an invasive species poster, and has the GA-EPPC invasive brochure prominently displayed and available to the public. GNPS mails the GA-EPPC invasive brochures to Master Gardener groups on request. The GNPS also has a small research grant program that funds invasive research along with other topics.

Georgia Ports Authority (Ports Authority): The Ports Authority monitors ships while they are at berth and reports any detected ballast water discharge to the Coast Guard. The Ports Authority does not conduct ongoing monitoring for aquatic invasive species, but has worked with researchers in the past conducting a baseline survey of terminals in the ports of Savannah and Brunswick.

Georgia Power Company: Georgia Power manages aquatic invasive species in their 15 reservoirs across the state. Georgia Power manually removed and treated hydrilla found at its Lake Sinclair Little River Park marina during a routine aquatic plant management project at one of its operating plants. It also has a reservoir marina operator notification program and issues occasional notes to residents regarding aquatic invasive species. In addition to the marina operator network, Georgia Power surveys Lakes Jackson, Juliette, Oconee, and Sinclair for aquatic nuisance plant species. Personnel involved in water quality work are also looking for aquatic invasive species and the Company's reservoirs are surveyed on a quarterly basis. While Georgia Power personnel are trained to identify aquatic invasive species, the Company also relies on local residents for aquatic invasive species control requests, and has alerted resident marina operators to look out for aquatic invasive species, especially hydrilla. Georgia Power does routine herbicide applications for a number of aquatic plants in its reservoirs including giant cutgrass, water hyacinth, spiny leaf naiad, Brazilian Elodea, and Eurasian water milfoil. In 2006, Georgia Power made 44 herbicide applications to reservoirs and generating plant sites for aquatic plant management covering 270 acres. Georgia Power has accumulated annual end-of-growing-season point intercept sampling data for Lake Juliette since 2001 showing native and aquatic invasive plant species percentage occurrence. These data could be used to evaluate the impacts of stocking a small number of grass carp and follow up with additional point survey data to show effects of grass carp on the plant populations.

Georgia Wildlife Federation (GWF): The GWF is Georgia's oldest and largest member-supported conservation organization and the state affiliate of the National Wildlife Federation. GWF's primary involvement with invasive species has been public outreach and education. Its quarterly member newsletter, *The Call*, and the semi-annual *Sportsman's Connection* contain information about invasive

species such as hemlock woolly adelgid and flathead catfish. GWF partners with other nonprofit organizations such as the Satilla Riverkeeper and the Georgia River Network to educate the public about aquatic invasive species. While the GWF monitors invasive species on its own property and through its involvement in Adopt-A-Stream, it also coordinates with the Teaming with Wildlife Coalition in Georgia, and looks for projects using volunteers to promote the control and management of invasive species. The GWF is also currently considering a Cooperative Agreement with the USFWS Partners for Wildlife program that will have a habitat restoration component at the Alcovy Conservation Center and possibly at the Wharton Conservation Center.

The Nature Conservancy: The Nature Conservancy is the world's largest conservation organization. In Georgia, the Conservancy has worked for years to abate the threats that invasive species, both plants and animals, pose for Georgia's natural resources through partnerships, planning, and management action. Conservancy conservation planners in Georgia have long recognized the threat that exotic species pose for biodiversity, and appropriate strategies have been devised and implemented which abate those threats. These include working at the ground level as well as the state and U.S. policy level to effect changes in laws and regulations that control deliberate and accidental importation of potential invasive species. On-the-ground management activities include removals of invasive plants from Conservancy-owned preserves and priority lands and waterways by Conservancy personnel and volunteers. On the Georgia coast, the Conservancy is mapping and treating infestations of aquatic invasive plants including common reed, water hyacinth, and the wetland invasive Chinese tallow. The Conservancy also pursues communication strategies related to exotic invasive species. The Conservancy has sponsored invasive plant species workshops for land managers and other resource personnel in which participants are trained in the impact, identification, and control of exotic pest plants.

Trees Atlanta: Trees Atlanta is a non-profit citizens' group dedicated to protecting and improving the urban environment by planting and conserving trees. It also educates the public about the value of trees and is involved with tree issues in the entire metropolitan Atlanta area. Trees Atlanta sponsors many volunteer clean ups and nature walks in parks, greenspaces, and woods where invasive plants are removed, native plants are installed, and public education about invasive species takes place. The group conducts species rescues for native plants at its Heritage Trail, Piedmont Park and Grant Park projects, and, through a grant from the Urban Resources Partnership, Trees Atlanta received funding to remove kudzu, honeysuckle, and privet from the Oakhurst Green Space in Decatur and re-establish the stream bank and surrounding area with native trees and plants. Trees Atlanta also supervised the volunteer clean up of Connally Nature Park during which volunteers were educated about invasive plants such as privet, poison ivy and poison oak.

Current Gaps in Georgia's Authorities and Programs for Invasive Species

Although the programs and associated jurisdictions listed above are essential for the management of invasive species in Georgia, they contain some gaps that reduce their effectiveness. Some of the known gaps and impediments include the following.

Coordination: Although a certain degree of coordination exists between state and federal agencies, industry groups, and economic development groups on invasive species issues in the state, this coordination needs to be greatly improved. The current situation consists of particular agencies focusing on specific species, with few to no invasive species management protocols or priorities in place within said agency or among cooperating agencies and organizations. Georgia has no full-time invasive species coordinator position, which, if it existed, could act as an important coordinating factor for planning and response programs. The state is currently lacking a mechanism such as a comprehensive invasive species management Memorandum of Understanding between agencies, an important first step for coordinating responses to new invasive species introductions and managing existing invasive species populations. Finally, there is a need for greater regional coordination of invasive species programs, since many invasive species issues should be addressed at the regional as well as the state level.

Education and Outreach: Currently, the public at large is generally unaware of how their activities can create or exacerbate problems with invasive species. Most boaters, anglers, and campers are not aware of the problem with invasive species and do not employ measures to prevent their spread. Likewise, most individuals involved with plant nurseries, landscaping, construction, and pet stores, both consumers and merchants, are not aware of invasive species problems. There is also a lack of awareness of existing regulations that pertain to invasive species. To address this concern, the state needs a broadly focused education and information effort geared toward preventing introductions and spread of invasive species. Targets would include the general public, agency staff, landowners and volunteers. Technical assistance for landowners is needed to teach invasive species management on private property. Outreach partnerships need to be developed or expanded with university groups, industry groups, such as horticulture, aquarium trade, shipping firms, and marina operators, and a marketing strategy is needed to increase the effectiveness of invasive species programs statewide.

Early Detection and Rapid Response: Georgia currently has limited inspection programs focused on invasive species detection. The ones that do exist are primarily the state and federal agencies with jurisdictional authority to perform this work, such as GDA (for agricultural pests), GFC (for forest pests), and USDA APHIS-PPQ (for federally regulated pests). There is no institutionalized regular monitoring of plant trade, pet trade, and other markets, and the public is not sufficiently involved in early detection and rapid response.

Control and Management: Most invasive species management activities in Georgia are focused on individual populations and do not address invasive species in a strategic manner. In addition, control of pests may require herbicides or pesticides, host removal, trapping, animal depopulation, biological controls, etc., some of which are opposed by stakeholders. Expanding international trade and technological advances in transportation facilitate invasive species introductions. Also, the use of herbicides and other biocides is difficult on many federal lands, especially where listed Threatened or

Endangered species occur. There is a need to address restoration actions that are required after invasive species eradication in order to maintain the area as a sustainable system, as well as the ecological dynamics of semi-natural and manmade systems (i.e., impoundments).

Monitoring Populations and Habitats: Detecting the presence or absence of invasive species in an area usually relies on costly, time-consuming field surveys. In addition, little training is provided to agency and private personnel to identify invasive species and to provide avenues to report new sightings. Although any significant plant pest detection (insect, weed, pathogen) will result in USDA-APHIS-PPQ notification, Georgia generally lacks widely accepted protocols for monitoring and reporting invasive species information. Therefore, monitoring programs for existing invasive species populations as well as high priority natural habitats and conservation lands are needed. The state needs a central point for reporting information on invasive species and methods for maintaining that information in an easily accessible format, but the Cooperative Agricultural Pest Survey (CAPS) administered by the GADA, and APHIS-PPQ have a system in place to report systematic surveys and occurrence data. Finally, there is a need for follow-up reports of presence/absence of invasive species to ensure there is no viable, breeding population present.

Research: Coordination of research between agencies is needed as well as more research on cost/benefits and efficacy of existing control measures and information for systematically classifying priorities for invasive species. Research on life history characteristics, limiting factors, vectors, and pathways is needed for many invasive species. More research is needed on economic and ecological impacts on invasive species in Georgia, how to develop effective educational material and marketing tools to reach target audiences, and development of new technologies for detection, control, eradication, and maintaining sustainable systems.

Regulations and Enforcement: Vague and confusing regulations along with limited funding and staffing contribute to difficulties in enforcement. Existing state and federal jurisdictional authority is allowed for several state and federal agencies, but there is limited funding to adequately survey, quarantine and eradicate invasive species. In addition, economic gains in the smuggling and sale of exotic species often outweigh fines assessed by agencies, so smugglers have little financial incentive to comply with import regulations. There is a lack of understanding of each agency's roles and authorities relating to invasive species, and often a lack of jurisdiction or confusing jurisdiction. In some cases, the state also needs new regulations to prevent the commercial sale, possession, and importation of non-native species that have the potential to be invasive in Georgia, and the continued development of an Invasive Species Task Force would allow for species to be systematically ranked in a scientific manner.

Funding: There is limited funding for education, prevention, control, monitoring, eradication, and research efforts. There is also limited funding to implement laws and regulations relating to invasive species, as well as for ongoing projects such as long-term management. Funding is the key to meeting the objectives outlined in this document. All of the priorities and action items listed below are meaningless unless secure, consistent, and adequate funding can be found to provide the resources needed to address the invasive species issues faced by Georgia.

Goals, Objectives, and Actions

This section describes the various ongoing and proposed management actions identified by the Committee listed according to the objective they support. The Committee recognizes that successful accomplishment of these actions will require close coordination with other state, regional, and federal authorities, and with local governments.

Goal: Prevent and control the introduction of invasive species into Georgia and minimize the future spread and impacts of existing invasive species populations on native species, environmental quality, human health, and the economy.

Objective 1: Coordinate local, state, regional, federal and international activities and programs pertaining to invasive species in Georgia

Action 1: Establish the Georgia Invasive Species Task Force to include the GA DNR, GDA, GFC, USDA-APHIS, and UGA to coordinate state activities related to invasive species management. This task force will seek advice and solicit input from many sources, including but not limited to members of the state invasive species council and experts within various fields.

Action 2: Hire a permanent, full-time Invasive Species Coordinator for each state agency that has invasive species management responsibilities. These agency invasive species coordinators will report to and act with the Georgia Invasive Species Task Force to ensure that each agency's programs, outreach materials, etc. are contributing to the goal of this management plan.

Action 3: Establish a Memorandum of Understanding among agencies with overlapping invasive species responsibilities in Georgia to foster enhanced communication and coordination of activities

Action 4: Work with other states to address invasive species issues through the Gulf and South Atlantic Regional Panel on Aquatic Invasive Species, Southeastern Aquatic Resources Partnership, the Southeastern Exotic Pest Plant Council, Southern Group of State Foresters (and the assigned forest health task force), the Southern Nursery Association, the Southeastern Plant Board, and other regional, national, and international organizations.

Action 5: Establish the Georgia Invasive Species Council to provide support for invasive species management programs in the state, serve as a forum for discussion of invasive species issues and policies, and monitor progress toward achievement of invasive species management goals.

Objective 2: Control and manage the introduction and spread of invasive species in Georgia through education and outreach

Action 1: Compile information on existing publications, posters, exhibits, videos, presentations, outreach programs and other outreach materials related to invasive species

Action 2: Develop invasive species outreach materials to be distributed to the general public at various events

Action 3: Develop specific outreach materials explaining existing regulations to be distributed at appropriate retail outlets such as plant nurseries and pet stores, targeting water garden hobbyists, aquarists, and pet owners

Action 4: Develop specific outreach materials to educate tourists, boaters, anglers, marina operators, homeowners, and pet owners about the potential spread of invasive species through boating and other recreational activities

Action 5: Develop specific outreach materials and partnerships with the construction, aquaculture, biofuel, forestry, horticulture and other industries (include information on regulatory issues, invasive species concerns, management and control, prevention, etc.)

Action 6: Provide invasive species curriculum resources and training to teachers (i.e., Project WET, Project Wild Aquatic, Project Wild, Project Learning Tree, etc.)

Action 7: Coordinate an annual Georgia invasive species symposium

Action 8: Provide training workshops to agency staff and various volunteer groups to assist with early detection, identification, and control of invasive species

Action 9: Develop a comprehensive Georgia invasive species website managed collaboratively by member organizations in the Georgia Invasive Species Council

Action 10: Leverage resources to enable their best use for education and outreach purposes

Objective 3: Prevent the establishment of invasive species populations in Georgia through early detection and rapid response programs

Action 1: Implement and coordinate existing or new early detection/rapid response plans

Action 2: Identify and implement rapid assessment sampling techniques for various habitats, and specific pests in Georgia to detect new occurrences of invasive species

Action 3: Implement protocols and new technologies for inspections of ships (including ballast areas) and cargo at Georgia ports, airports and other transportation hubs

Action 4: As appropriate technologies are developed, create and implement protocols for treatment of contaminated cargo, packaging, hulls, and ballast water to eradicate invasive species

Objective 4: Control or eradicate established invasive species in Georgia through cooperative management activities designed to minimize impacts to non-target species

Action 1: Identify existing control programs for invasive species, and develop additional control programs as necessary

Action 2: Develop protocols for control of priority species

Action 3: Implement control programs for invasive species based on established protocols

Objective 5: Monitor the distribution and impacts of invasive species in Georgia to determine management priorities

Action 1: Identify existing invasive species monitoring efforts and data gaps

Action 2: Integrate existing GIS maps and data from state and federal sources and develop GIS-based distribution maps for Georgia

Action 3: Conduct surveys of habitats for invasive species occurrences

Action 4: Develop and maintain a public database of collected and identified invasive species specimens from Georgia

Action 5: Assess the impacts of invasive species on populations of rare species and other high priority native species

Objective 6: Identify and implement needed research on impacts and control of invasive species in Georgia

Action 1: Conduct research on economic and ecological impacts of invasive species in Georgia

Action 2: Evaluate the cost/benefit of control or eradication of priority invasive species

Action 3: Support research to determine limiting factors for growth and survival of priority invasive species and to predict impacts related to changes in these factors (e.g., global climate change)

Action 4: Support research to develop effective methods and technologies for detection, control, and eradication of priority invasive species and restoration of sustainable ecosystems

Action 5: Support research to develop outreach programs for effective invasive species prevention and control

Action 6: Support research on effectiveness of regulatory, education-based, and incentive-based programs in controlling invasive species and their relative values

Objective 7: Prevent the introduction and spread of invasive species in Georgia through legislative and regulatory efforts

Action 1: Maintain a comprehensive list of all current state and federal laws regulating invasive species (including penalties)

Action 2: Promulgate rules regulating importation of priority invasive species not currently established or known to occur in Georgia

Action 3: Promulgate rules, including education- and incentive-based, that limit the spread of priority invasive species already found in Georgia.

Action 4: Coordinate enforcement of existing regulations and proposals for new regulations pertaining to invasive species importation, possession, and commerce

Action 5: Work toward greater consistency of invasive species regulations and enforcement within the Southeast

Objective 8: Secure adequate long-term funding for invasive species programs in Georgia

Action 1: Utilize state appropriations, federal funds, and private funds to expand existing invasive species programs

Action 2: Develop budgets for new invasive species management programs and request additional state and federal funding to support these programs

Program Monitoring and Evaluation

Program monitoring and evaluation is vitally important. It will enable the State to determine the effectiveness of objectives and actions identified in this management plan at stopping the introduction and spread of invasive species. Timely oversight of program objectives will permit corrections as additional information becomes available. Overall program progress will involve three components: oversight, evaluation, and dissemination of information.

Oversight: The Georgia Invasive Species Council will be established and convened to oversee invasive species program management issues and progress. This council will be composed of representatives from all state agencies involved in invasive species management. Representatives of federal agencies and nongovernmental organizations with invasive species management authority or expertise will be invited to participate as stakeholders. The Council will be coordinated by members of the Georgia Invasive Species Task Force and will meet at least annually. The Council, as envisioned, will:

- Advise state agencies regarding the prevention and control of invasive species,
- Facilitate development of a coordinated network among state agencies to document, evaluate, and monitor effects from invasive species on the economy, the environment, and human health,
- Share information on a local, state, and national level and facilitate access to information on distribution and status of invasive species, and
- Prepare and release a biennial state invasive species report in even numbered years.

Evaluation: Progress toward meeting program objectives is one element of the evaluation to be undertaken by the Council. More importantly, the Council must place special emphasis on the acquisition and assignment of funding necessary to meet tasks identified in the Strategy. Evaluation should also include participation from interests affected by plan implementation.

Dissemination: The Council will prepare periodic reports highlighting progress toward meeting the Strategy's goals and objectives. These reports will be made available to the public, and local, state, and federal decision makers.

Glossary of Terms

Aquaculture: The production of fish or crayfish for consumption or for stocking.

Aquatic habitats: All bodies of flowing and standing water such as streams, rivers, reservoirs, lakes and ponds; estuarine, and forested wetlands; riparian areas along streams, rivers, lakes and reservoirs; karsts; coastal freshwater dune swales; coral reefs, oyster reefs, sand and algal flats.

Aquatic species: All organisms living at least partially in a water environment. Usage commonly refers to aquatic plants such as water hyacinth and salvinia, fish, and invertebrates, but also includes mammals such as nutria.

Aquarium industry: Collectively, any entities that breed, grow, import, hold, transport, and sell nonnative fish, invertebrates, and plants specifically for display in fresh and salt water aquaria.

Aquatic plant: A plant that naturally grows in water, saturated soils, or seasonally saturated soils, including algae, submerged, and floating leafed or emergent plants.

Aquatic species: All organisms living at least partially in a water environment. Usage commonly refers to aquatic plants such as water hyacinth and salvinia, fish, and invertebrates, but also includes mammals such as nutria.

At risk: A description of populations that are likely to become severely reduced or extinct due to imminent threats.

Ballast: Water or other matter placed in specific areas of the hull of a vessel for navigation stability. Species are often inadvertently transported in ballast water when it is released in another water body. Species can be transported inadvertently or purposefully in or on ballast material.

Biodiversity: The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

Ecosystem: A community of plants, animals and other organisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment.

Endemic: A species restricted in distribution to a particular geographic area or drainage.

Established: The condition of growing in a particular location.

Fouling: Entanglement, clogging, or obstruction by an undesired organism that may threaten the diversity or abundance of native species or the ecological stability and/or uses of infested waters.

Habitat: Area where a species has the necessary food, water, shelter, and space to live and reproduce.

Indigenous species: Organisms naturally occurring in a specific geographic area or ecosystem. Synonym includes native species.

Infestation: An invasive population that is living in and overrunning an ecosystem to an unwanted degree or harmful manner.

Intentional introduction: An introduction made deliberately by humans, involving the purposeful movement of a species outside of its natural range and dispersal potential. Such introductions may be authorized or unauthorized.

Introduced species: An organism that has been brought into an area where it does not normally occur. Introduced species often compete with and cause problems for native species. An introduced species is not necessarily an invasive species. Also called exotic, nonnative, or alien species.

Invasion: An infestation of an invasive species.

Invasive species: Nonnative organisms whose introductions cause or are likely to cause adverse environmental, economic, and/or human health impacts. For purposes of this document,, these are nonnative species that threaten the diversity or abundance of native species or the ecological stability of infested areas, or commercial, agricultural, aquacultural, or recreational activities dependent on such areas.

Marsh: A wetland with emergent vegetation, and located in zones progressing from terrestrial habitat to open water. May be dominated by either salt or freshwater.

Monitor: To watch, observe, or check for a special purpose. For purposes of this document, observing or checking activities based on scientific method to accumulate data about invasive species and their environs.

Native species: A species naturally present and reproducing within the state or that naturally expands from its historic range into the state.

Nonnative species: Any species or other viable biological material that enters an ecosystem outside of its historic range, including organisms transferred from one country to another. Species introduced or spread from one region of the U.S. to another outside their normal range are nonnative. Also called introduced, exotic, alien, foreign, nonindigenous species, immigrant, transplants.

Parasite: An organism living in or on another organism.

Pathogen: A specific agent causing disease. May be a bacteria, virus, or fungus.

Pathway: The means by which species are transported from one location to another.

Riparian: Pertaining to, situated or dwelling on the margin of a river or other water body.

Regulation: A rule or order having to do with details or procedures and having the force of law.

Species: A group of organisms that differ from all other groups of organisms and that are capable of breeding and producing fertile offspring. This is the smallest unit of classification for plants and animals.

Terrestrial species: Organisms living primarily on land.

Unintentional introduction: An accidental movement of a species into a new habitat outside of its native range, often as a result of a species using humans or animals as vectors for dispersal.

Vector: Transportation of a species on or in a media through a pathway.

Water body: Any area with water flowing or standing above ground to the extent that evidence of an ordinary high water mark is established in any normal year. It can be a stream, river, lake, spring, backwater, bayou, creek, ocean, bay, pond, or wetland.

Wetland: Land areas containing much soil moisture, usually poorly drained, and characterized by hydrophytic vegetation, and hydric soils. The land area may have permanent or periodic inundation by water or prolonged soil saturation generally resulting in anaerobic soil conditions.

Literature Cited

Barry, N. 2006. Georgia's beautiful wiregrass trail. Georgia Forestry Today. March-April.

Bell, Malcolm III. 1966. Some Notes and Reflections upon a Letter from Benjamin Franklin to Nobel Wimberly Jones October 7, 1772. Ashantilly Press: Darien, Georgia.

Benson, Amy J., Pam L. Fuller, and Colette C. Jacono. 2001. Summary Report of Nonindigenous Aquatic Species in the U.S. Fish and Wildlife Service Region 4. U.S. Department of the Interior, Geological Survey, Gainesville, Florida.

Britton, Kerry O., Donald A. Duerr II, and James H. Miller. 2004. Understanding and Controlling Nonnative Forest Pests in the South. In Southern Forest Science: Past, Present, and Future, edited by H. Michael Rauscher and Kurt Johnsen. USDA, FS, SRS: Asheville, N.C.

Burkhead, Noel, M. and Dane H. Huger. 2002. The Case of the Red Shiner: What Happens When a Good Fish Goes Bad? Florida Integrated Science Center, U.S. Geological Survey
<http://cars.er.usgs.gov/Southeastern_Aquatic_Fauna/Freshwater_Fishes/Shiner_Research/shtml>
Accessed 8 December, 2006.

Cameron, R. Scott, Chip Bates, and James Johnson. 2008. Distribution and Spread of Laurel Wilt Disease in Georgia: 2006-08 Survey and Field Observations. Georgia Forestry Commission
<http://www.gatrees.org/ForestManagement/documents/GeorgiaLaurelWiltReport_2006-08.pdf>
Accessed 6 January, 2009.

Canerday, T. Don. 1988. Fire Ants in Georgia, The University of Georgia College of Agricultural & Environmental Sciences, Cooperative Extension Service
<<http://pubs.caes.uga.edu/caespubs/pubcd/1332-w.html>> Accessed 14 January, 2009.

Christopher, Tom. 2008. Can weeds help solve the climate crisis? The New York Times
<<http://www.nytimes.com/2008/06/29/magazine>> Accessed 15 July.

Crosby, Alfred W. 2004. Ecological Imperialism: The Biological Expansion of Europe, 900-1900. Cambridge University Press: New York.

Crosier, Danielle M. and Daniel P. Molloy. 1996. Black Carp - *Mylopharyngodon piceus*. Environmental Laboratory, U.S. Army Corps of Engineers
<http://el.erdc.usace.army.mil/ansrp/mylopharyngodon_piceus.pdf> Accessed 11 April, 2008.

Daughdrill, B.E., and K.N. Zickert. 2001. Tree preservation ordinances: Sacrificing private timber rights on the diminutive altar of public benefit. Mercer Law Review. 52(winter):705.

Ellis, H.C. and D.L. Horton. 1999. Boll Weevil. Bugwood Network, University of Georgia
<<http://www.bugwood.org/factsheets/99-001.html>> Accessed 26 September 2008.

Evans, C.W., C.T. Barger, D.J. Moorhead, and G.K. Douce. 2005. Invasive Weeds in Georgia: You Can Help Stop Their Spread! Bugwood Network, University of Georgia. BW-2005-01
<<http://www.gainvasives.org/publs/flyerfinal.pdf>> Accessed 12 February, 2008.

Draft 1/16/09

Evans, Mike. 2008. Director of the Plant Protection Division of the Georgia Department of Agriculture. Personal communication.

Fuller, Pam. 2008. *Pylodictis olivaris*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL <<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=750>> Revision Date: 4/21/2006. Accessed 25 June.

Garrett, K.A., and C.M. Cox. 2008. Applied biodiversity science: Managing emerging diseases in agriculture and linked natural systems using ecological principles. in: Infectious Disease Ecology: The Effects of Ecosystems on Disease and of Disease on Ecosystems. Eds. R. Ostfeld, F. Keesing, and V. Eviner. Princeton University Press.

Georgia Department of Agriculture. 2008a. Georgia Department of Agriculture bans cogongrass <http://agr.georgia.gov/00/press/detail/O,2668,38902732_99640361_110853797,00.html> Accessed 21 July.

_____. 2008b. Plant Protection – Tropical Soda Apple (*Solanum viarum*) <<http://agr.georgia.gov/gta>> Accessed 21 July.

Georgia Department of Natural Resources, Wildlife Resources Division. 2009. Georgia Aquatic Nuisance Species Management Plan < http://georgiawildlife.dnr.state.ga.us/assets/documents/ANS_Plan_7-1-08.pdf > Accessed 14 January, 2009.

_____. 2007. Georgia Rare Species and Natural Community Information – Protected Species Lists <<http://georgiawildlife.dnr.state.ga.us/documentdetail.aspx?docid=89&pageid=2&category=conservation>> Accessed 22 September, 2008.

_____. 2005. A Comprehensive Wildlife Conservation Strategy for Georgia <<http://www1.gadnr.org/cwcs/Documents/strategy.html>> Accessed 11 December, 2006.

Georgia Forestry Commission. 2008. Cogongrass in Georgia <<http://www.gatrees.org/ForestManagement/Cogongrass.cfm>> Accessed 6 January, 2009.

_____. 2005. Sudden Oak Death <<http://www.gatrees.org/ForestManagement/documents/SuddenOakDeath0607.pdf>> Accessed 29 September, 2008.

_____. 2004. Forest Inventory and Analysis Factsheet: Georgia 2004. Georgia Forestry Commission <<http://www.gatrees.org/ForestManagement/documents/FIAFactsheetGA2004.3.pdf>> Accessed 6 January, 2009.

Georgia Invasive Species Task Force. 2007. Examples of Georgia's Invasive Species of Concern <<http://www.gainvasives.org/pubs/gaexamples.pdf>> Accessed 12 March.

Glick, Patty. 2007. The Gardener's Guide to Global Warming: Challenges and Solutions. National Wildlife Federation <http://www.nwf.org/gardenersguide/Gardeners_Guide.pdf> Accessed 22 June.

Draft 1/16/09

Haney, P.B., W.J. Lewis, and W.R. Lambert. 1996. Cotton Production and the Boll Weevil in Georgia: History, Cost of Control, and Benefits of Eradication. Research Bulletin Number 428. The Georgia Agricultural Experiment Stations, College of Agricultural and Environmental Sciences, University of Georgia: Athens, Georgia.

International Panel on Climate Change. 2007. Synthesis Report: Summary for Policymakers <http://www.ipcc.ch/pdf/assessment/ar4/syr/ar4_syr_spm.pdf> Accessed 31 January, 2008.

Invasive Species Advisory Committee. 2006. Invasive Species Definition Clarification and Guidance White Paper. National Invasive Species Council <<http://www.invasivespeciesinfo.gov/aquatics/main/shtml>> Accessed 23 January, 2007.

Invasive Species Specialists Group. 2008. Global Invasive Species Database <<http://www.issg.org/database/species>> Accessed 16 April.

Jacono, Colette C. and M.M. Richerson. 2006. *Hydrilla verticillata*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. <<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=237>> Revision Date: December 18, 2003. Accessed 8 December.

Johnson, James. 2007. The Hemlock Crisis in Georgia (and the eastern U.S.). Georgia Forestry Commission < <http://www.gainvasives.org/hwa/hwapublic.pdf> > Accessed 14 January, 2009.

Lewis, A. Jefferson. 2004. Historic Heritage and Heirloom Plants of Georgia and the American South: a Collection of Short Essays on Plants and Crops of Historic and Socioeconomic Interest and Importance. State Botanical Garden of Georgia: Athens, Georgia.

Mayfield, Albert E. III and Michael C. Thomas. 2006. Pest Alerts: Redbay Ambrosia beetle. Florida Department of Agriculture and Consumer Services, Division of Plant Industry <<http://www.doacs.state.fl.us/pi/enpp/ento/x.glabratus.html>> Accessed 25 June, 2007.

McGinley, Mark, and J. Emmett Duffy. 2008. Invasive species, in: Encyclopedia of Earth. Eds. Cutler J. Cleveland. [First published in the Encyclopedia of Earth May 22, 2008; Last revised May 23, 2008] Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment <http://www.eoearth.org/article/Invasive_species> Accessed 7 August.

Merkle, Scott A. 2006. American Chestnut. The New Georgia Encyclopedia <<http://www.georgiaencyclopedia.org>> Accessed 1 October, 2008.

Merkle, Scott A. and Claud L. Brown. 1991. The American chestnut: its past, present and future in Georgia. Tipularia 6(1):2-13.

Mississippi Boll Weevil Management Corporation. 2008. History of the Boll Weevil in the U.S. <http://www.bollweevil.ext.msstate.edu/webpage_history.htm> Accessed 26 September.

Morrison, Mike. 2008. Satilla's flatheads are on the way out. The Florida Times-Union <<http://www.jacksonville.com/tu-online/stories/030908/geo-255198107.shtml>> Accessed 10 March.

Draft 1/16/09

National Invasive Species Council and Aquatic Nuisance Species Task Force. 2005. Focus Group Conference Report and Pathways Ranking Guide <<http://www.invasivespeciesinfo.gov>> Accessed 21 August, 2008.

Nico, L.G., 2008. *Mylopharyngodon piceus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL <<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=573>> Revision Date: July 20, 2007. Accessed 11 April.

Oregon Department of Agriculture, Plant Division, Insect Pest Prevention and Management. 2007. Imported Fire Ant <http://www.oregon.gov/ODA/PLANT/IPPM/profile_rifa.shtml> Accessed 14 January, 2009.

Peabody, A. 2003. Lack of understanding could hurt agriculture. Gainesville Times <<http://www.gainesvilletimes.com>> Accessed December 1.

Pimentel, David, Rodolfo Zuniga, and Doug Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52:273-88.

Price, Terry S. 2008. Forest Health Guide for Georgia. Georgia Forestry Commission <<http://www.forestpests.org/gfcbook/>> Accessed October 3.

Reilly, Michael. 2007. Invasive vine is a prodigious polluter. *New Scientist*. 195(2616):13.

Rockwell, H. William. 2003. Summary of a Survey of the Literature on the Economic Impact of Aquatic Weeds. The Aquatic Ecosystem Restoration Foundation <<http://www.aquatics.org>> Accessed 4 November, 2008.

Russello, Michael A., Michael L. Avery, and Timothy F. Wright. 2008. Genetic evidence links invasive monk parakeet populations in the United States to the international pet trade. *Evolutionary Biology*. 8:217.

Somma, Louis A. 2006. *Osteopilus septentrionalis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL <<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=48>> Revision Date: April 26, 2006. Accessed 25 June, 2008.

Southeastern Exotic Pest Plants Council. 2008. Early Detection and Distribution Mapping System <<http://www.se-eppc.org/eddmmaps>> Accessed 26 September.

Stein, Bruce A. and Stephanie R. Flack. 1996. America's Least Wanted: Alien Species Invasions of U.S. Ecosystems. The Nature Conservancy <<http://www.tnc.org/science/library>> Accessed September 17, 2007.

Stein, Bruce A., Lynn S. Kutner, Jonathan S. Adams. 2000. Precious Heritage: The Status of Biodiversity in the United States. New York: Oxford University Press.

Draft 1/16/09

Thomas, M.E. 1995. Monitoring the effects of introduced flathead catfish on sport fishing populations in the Altamaha River, Georgia. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies. 47(1993):531-38.

Tirrell-Wysocki, David. 2007. Billions in forest damage caused by campers transporting insect-Infested firewood. Environmental News Network <<http://enn.com>> Accessed 25 June.

U.S. Congress, Office of Technology Assessment. 1993. Harmful Non-Indigenous Species in the United States, OTA-F-565 Washington, DC: U.S. Government Printing Office, September 1993.

U.S. Department of Agriculture, Animal and Plant Health and Inspection Service. 2008. Plant health – Asian longhorned beetle
<http://www.aphis.usda.gov/plant_health/plant_pest_info/asian_lhb/index.shtml > Accessed 6 January, 2009.

U.S. Department of Agriculture, Animal and Plant Health and Inspection Service, Plant Protection and Quarantine. 2007. Boll Weevil Eradication Factsheet
<http://www.aphis.usda.gov/publications/plant_health/content/printable_version/faq_boll_weevil_07.pdf> Accessed 24 September, 2008.

U.S. Department of Agriculture, National Resources Conservation Services. 2008. Plants Profile <<http://plants.usda.gov>> Accessed 25 June.

Wiley, F.E., S.B. Wilde, A.H. Birrenkott, S.K. Williams, T.M. Murphy, C.P. Hope, W.W. Bowerman, and J.R. Fischer. 2007. Investigation of the link between avian vacuolar myelinopathy and a novel species of cyanobacteria through laboratory feeding trials. Journal of Wildlife Diseases. 43(3): 337-44.

Ziska, Lewis H. and K. George. 2004. Rising carbon dioxide and invasive, noxious plants: Potential threats and consequences. World Resource Review 16:427-447.

Appendix A: Invasive Species of Concern in Georgia

Priority 1 Species

Priority 1 species are those that the organization currently spends a significant amount of time and/or money on for some aspect of management or that the organization definitely plans to spend time and money on in the next five years.

Common name	Scientific Name	Aquatic/ Terrestrial	Present/ Not Present
Plants			
Tree of heaven	<i>Ailanthus altissima</i>	T	P
Mimosa	<i>Albizia julibrissin</i>	T	P
Garlic mustard	<i>Alliaria petiolata</i>	T	P
Brazilian elodea	<i>Egeria densa</i>	A	P
Common water hyacinth	<i>Eichhornia crassipes</i>	A	P
Autumn olive	<i>Elaeagnus umbellata</i>	T	P
English ivy	<i>Hedera helix</i>	T	P
Hydrilla	<i>Hydrilla verticillata</i>	A	P
East Indian hygrophylia	<i>Hygrophila polysperma</i>	A	P
Cogongrass	<i>Imperata cylindrica</i>	T	P
Sericea lespedeza	<i>Lespedeza cuneata</i>	T	P
Chinese privet	<i>Ligustrum sinense</i>	A/T	P
Asian marshweed	<i>Limnophila sessiliflora</i>	T	P
Japanese honeysuckle	<i>Lonicera japonica</i>	T	P
Creeping water primrose	<i>Ludwigia peploides</i>	A	P
Japanese climbing fern	<i>Lygodium japonicum</i>	A	P
Blue-green algae	<i>Lyngbya spp.</i>	A	P
Japanese stilt grass, Nepalese Browntop	<i>Microstegium vimineum</i>	A	P
Asian spiderwort, marsh dewflower	<i>Murdannia keisak</i>	A	P
Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	A	P
Variable Leaf Milfoil	<i>Myriophyllum heterophyllum</i>	A	P
Spiny leaf naiad	<i>Najas marina</i>	A	NP
Small broomrape	<i>Orobanche minor</i>	T	P
Princesstree	<i>Paulownia tomentosa</i>	T	P
Sand pine	<i>Pinus clausa</i>	T	P
Water lettuce	<i>Pistia stratiotes</i>	A	P
Kudzu	<i>Pueraria montana</i>	T	P
Multiflora rose	<i>Rosa multiflora</i>	T	P
Common salvinia	<i>Salvinia minima</i>	A	P
Giant salvinia	<i>Salvinia molesta</i>	A	P
Chinese tallow	<i>Sapium sebiferum (=Triadica sebifera)</i>	A	P
Tropical soda apple	<i>Solanum viarum</i>	T	P
Japanese wisteria	<i>Wisteria floribunda</i>	T	P
Chinese wisteria	<i>Wisteria sinensis</i>	T	P
Giant cut grass (Southern wild rice)	<i>Zizaniopsis miliacea</i>	A	P
Fishes			
Goldfish	<i>Carassius auratus</i>	A	P
Grass carp	<i>Ctenopharyngodon idella</i>	A	P

Draft 1/16/09

Red shiner	<i>Cyprinella lutrensis</i>	A	P
Asian swamp (rice) eel	<i>Monopterus albus</i>	A	P
Blue tilapia	<i>Oreochromis aureus</i>	A	P
Nile tilapia	<i>Oreochromis niloticus</i>	A	P
Red lionfish	<i>Pterois volitans</i>	A	P
Flathead catfish	<i>Pylodictis olivaris</i>	A	P
Mammals			
Coyote	<i>Canis latrans</i>	T	P
Nine-banded armadillo	<i>Dasypus novemcinctus</i>	T	P
Feral swine	<i>Sus scrofa</i>	A/T	P
Mollusks			
Giant East African snail	<i>Achatina fulica</i>	A	NP
Asian clam	<i>Corbicula fluminea</i>	A	P
Zebra mussel	<i>Dreissena polymorpha</i>	A	NP
Charua mussel	<i>Mytella charruana</i>	A	P
Green mussel	<i>Perna viridis</i>	A	P
Channeled apple snail	<i>Pomacea insularum</i>	A	P
Crustaceans			
Titan Acorn Barnacle	<i>Megalbalanus coccoporna</i>	A	P
Green porcelain crab	<i>Petrolisthes armatus</i>	A	P
Insects			
Hemlock woolly adelgid	<i>Adelges tsugae</i>	T	P
Emerald ash borer	<i>Agrilus planipennis</i>	T	NP
Citrus longhorned beetle	<i>Anoplophora chinensis</i>	T	NP
Asian longhorned beetle	<i>Anoplophora glabripennis</i>	T	NP
Boll weevil	<i>Anthonomus grandis grandis</i>	T	NP
Swede midge	<i>Contarinia nasturtii</i>	A	NP
Siberian silk moth	<i>Dendrolimus superans sibericus</i>	T	NP
Light brown apple moth	<i>Epiphyas postvittana</i>	T	P
Brown marmorated stink bug	<i>Halyomorpha halys</i>	T	NP
Asian gypsy moth	<i>Lymantria dispar dispar</i>	T	P
Gypsy moth	<i>Lymantria dispar</i>	T	P
Rosy gypsy moth	<i>Lymantria mathura</i>	T	NP
Nun moth	<i>Lymantria monacha</i>	T	NP
Red imported fire ant	<i>Solenopsis invicta</i>	T	P
Common pine shoot beetle	<i>Tomicus piniperda</i>	T	NP
Khapra beetle	<i>Trogoderma granarium</i>	T	NP
Sirex woodwasp	<i>Sirex noctilio</i>	T	NP
Redbay ambrosia beetle	<i>Xyleborus glabratus</i>	T	P
Disease Organisms			
Baculovirus of Shrimp	<i>Baculovirus penaei</i>	A	P
A chytrid fungus	<i>Batrachochytridium dendrobatidis</i>	A/T	P
Great Asian Tapeworm	<i>Bothriocephalus opsarichthydis</i>	A	P
Yellow Head Virus	<i>Coronaviridae</i>	A	P
Avian vacuolar myelopathy (AVM)	<i>Cyanobacterium (unknown spp.)</i>	A	P
West Nile virus	<i>Flavivirus sp.</i>	A	P

Draft 1/16/09

Avian influenza virus	<i>Influenza A (H5N1)</i>	T	P
Large Mouth Bass Virus	<i>Iridoviridae</i>	A	P
Oyster mikrocytosis	<i>Mikrocytos mackini</i>	A	P
Whirling Disease	<i>Myxobolus cerebralis</i>	A	P
Infectious Haematopietic Necrosis	<i>Novirhabdovirus</i>	A	P
Clam and Cockle Perkinsus	<i>Perkinsus olseni</i>	A	P
Dermo disease	<i>Perkinsus marinus</i>	A	P
Sudden oak death	<i>Phytophthora ramorum</i>	T	NP
Taura Syndrome Virus	<i>Picornaviridae</i>	A	P
Plum pox virus	<i>PPV-D strain</i>	T	NP
Laurel wilt disease	<i>Raffaelea sp.</i>	T	P
Southern bacterial wilt	<i>Ralstonia solacearum race 3 biovar 2</i>	T	P
Epizootic Haematopietic Necrosis	<i>Ranavirus</i>	A	P
Bacterial Kidney Disease	<i>Renybacterium salmoninarum</i>	A	P
Spring Viremia of Carp	<i>Rhabdovirus</i>	A	P
Viral Hemorrhagic Septicemia	<i>Rhabdovirus</i>	A	P
Infectious Hypodermal Haematopietic Necrosis	<i>Shrimp parvovirus</i>	A	P
White Spot Disease	Whispovirus	A	P

Priority 2 Species

Priority 2 species are those that the organization deals with infrequently or attempts to control in selected high-priority areas (because they are thought to be lesser threats, or because they are widespread and difficult to control).

Common name	Scientific Name	Aquatic/ Terrestrial	Present/ Not Present
Plants			
Alligatorweed	<i>Alternanthera philoxeroides</i>	A	P
Giant reed	<i>Arundo donax</i>	A	P
Oriental bittersweet	<i>Celastrus orbiculatus</i>	T	P
Tropical spiderwort	<i>Commelina benghalensis</i>	A	P
Shrubby lespedeza	<i>Lespedeza bicolor</i>	T	P
Purple loosestrife	<i>Lythrum salicaria</i>	A	NP
Chinaberrytree	<i>Melia azedarach</i>	T	P
Parrotfeather	<i>Myriophyllum aquaticum</i>	A	P
Golden bamboo	<i>Phyllostachys aurea</i>	T	P
Common reed	<i>Phragmites australis</i>	A	P
Japanese knotweed	<i>Polygonum cuspidatum</i>	A	P
Rattlebox	<i>Sesbania punicea</i>	T	P
Beach vitex	<i>Vitex rotundifolia</i>	A/T	P
Fishes			
Blueback herring	<i>Alosa aestivalis</i>	A	P
Birds			
Monk parakeet	<i>Myiopsitta monachus</i>	T	P
Mollusks			
Amber snail	<i>Calcisuccinea dominicensis</i>	A	NP
Asian date mussel	<i>Musculista senhousia</i>	A	NP
Black-striped mussel	<i>Mytilopsis sallei</i>	A	NP
Mediterranean mussel	<i>Mytilus galloprovincialis</i>	A	NP
Brown mussel	<i>Perna perna</i>	A	NP
White garden snail	<i>Theba pisana</i>	T	NP
Crustaceans			
European green crab	<i>Carcinus maenas</i>	A	NP
Indo Pacific swimming crab	<i>Charybdis hellerii</i>	A	NP
Chinese mitten crab	<i>Eriocheir sinensis</i>	A	NP
Gray-speckled crayfish	<i>Orconectes (Buannulifictus) palmeri creolanus</i>	A	P
Rusty crayfish	<i>Orconectes rusticus</i>	A	NP
Rapa whelk	<i>Rapana venosa</i>	A	NP
Coelenterates			
Australian spotted jellyfish	<i>Phyllorhiza punctata</i>	A	P
Polychaetes			
Reef-building polychaete (Australian tubeworm)	<i>Ficopomatus enigmaticus</i>	A	P

Tubeworm	<i>Hydroides elegans</i>	A	NP
Insects			
Oak splendour beetle	<i>Agrilus biguttatus</i>	T	NP
Japanese cedar longhorn beetle	<i>Callidiellum rufipenne</i>	T	NP
Plum curculio	<i>Conotrachelus nenuphar</i>	T	P
Southern corn rootworm	<i>Diabrotica undecimpunctata howardi</i>	T	P
Western corn rootworm	<i>Diabrotica virgifera virgifera</i>	T	P
Mexican bean beetle	<i>Epilachna varivestis</i>	T	P
Alfalfa weevil	<i>Hypera postica</i>	T	P
Cereal leaf beetle	<i>Oulema melanopus</i>	T	P
Viburnum leaf beetle	<i>Pyrrhalta viburni</i>	T	NP
Ash whitefly	<i>Siphoninus phillyreae</i>	T	P
Disease Organisms			
Sorghum ergot	<i>Claviceps africana</i>	T	P
MSX	<i>Haplosporidium nelsoni</i>	A	P
Soybean rust	<i>Phakopsora pachyrhizi</i>	T	P
White rust of chrysanthemum	<i>Puccinia horiana</i>	T	ND
Karnal bunt/ryegrass bunt	<i>Tilletia spp.</i>	T	P

Priority 3 Species

Priority 3 species are those that are dealt with only in unusual circumstances, either because they represent minor threats or are essentially naturalized and impossible to control with current methods.

Common name	Scientific Name	Aquatic/ Terrestrial	Present/ Not Present
Plants			
Japanese chaff flower	<i>Achyranthes japonica</i>	T	NP
Small carpgrass	<i>Arthraxon hispidus</i>	A	P
Skunk vine	<i>Paederia foetida</i>	T	P
Fishes			
Pacus	<i>Colossoma macropomum</i>	A	P
Brook stickleback	<i>Culaea inconstans</i>	A	NP
Western mosquitofish	<i>Gambusia affinis</i>	A	P
Blue catfish	<i>Ictalurus furcatus</i>	A	P
Redbreast sunfish	<i>Lepomis auritus</i>	A	P
Green sunfish	<i>Lepomis cyanellus</i>	A	P
Spotted bass	<i>Micropterus punctulatus</i>	A	P
White perch	<i>Morone americana</i>	A	P
Yellow bass	<i>Morone mississippiensis</i>	A	P
Mammals			
Feral dog	<i>Canis familiaris</i>	T	P
Fallow deer	<i>Cervus dama</i>	T	P
Red deer	<i>Cervus elaphus</i>	T	P
Feral cat	<i>Felis catus</i>	T	P
Nutria	<i>Myocastor coypus</i>	A	P
Birds			
Pigeon (rock dove)	<i>Columba livia</i>	A	P
House sparrow	<i>Passer domesticus</i>	A	P
Eurasian collared dove	<i>Streptopilia decaocto</i>	A	P
European starling	<i>Sturnus vulgaris</i>	A	P
Reptiles			
Brown anole	<i>Anolis sagrei</i>	T	P
Brown tree snake	<i>Boiga irregularis</i>	T	NP
Indo-Pacific gecko	<i>Hemidactylus garnotii</i>	T	P
Cosmopolitan house gecko	<i>Hemidactylus mabouia</i>	T	P
Mediterranean gecko	<i>Hemidactylus turcicus</i>	T	P
Brahminy blind snake	<i>Rhamphtyphlops braminus</i>	T	P
Amphibians			
Cane toad	<i>Bufo marinus</i>	A	P
Cuban treefrog	<i>Osteopilus septentrionalis</i>	A	P
Greenhouse frog	<i>Eleutherodactylus planirostris</i>	A	P

Mollusks

Chinese mystery snail *Cipangopaludina chivesis* A NP

Crustaceans

An isopod *Synidotea laticauda* A P

Insects

Soybean aphid *Aphis glycines* T P

African honeybee *Apis mellifera scutellata* T NP

Cactus moth *Cactoblastis cactorum* T P

Pine cone cerambycid *Chlorophorus strobilicola* T NP

Pine caterpillar *Dendrolimus pini* T NP

Argentine ant *Linepithema humile* T P

Japanese beetle *Popillia japonica* T P

Red palm mite *Raoiella indica* T NP

Chilli thrip *Scirtothrips dorsalis Hood* T NP

Large elm beetle *Scolytus scolytus* T NP

Panicle rice mite *Steneotartsonemus spinki* T NP

Black spruce beetle *Tetropium castaneum* T NP

Brown spruce longhorn beetle *Tetropium fuscum* T NP

Giant wood wasp *Urocerus gigas* T NP

Disease Organisms

Chronic wasting disease Transmissible spongiform encephalopathy T NP

Invasive Species Watch List

Species are considered to be future threats if (1) they are not known to be present in the state (and there is not a formal program to prevent their occurrence) but they have been documented in other southeastern states and have been shown to have significant ecological, economic, or health impacts where they occur; or (2) the species is present in Georgia and is currently not considered a serious pest, but may become one based on its history in other states.

Common name	Scientific Name	Aquatic/		Region
		Terrestrial	Present/ Not Present	
Plants				
Coral ardisia	<i>Ardisia crenata</i>	T	NP	Coastal plain
Purple cabomba	<i>Cabomba pulcherrima</i>	A	P	May be in Lake Worth
Camphortree	<i>Cinnamomum camphora</i>	T	P	Coastal plain
Wild taro	<i>Colocasia esculenta</i>	A	P	Prevalent in state
Bermuda grass	<i>Cynodon dactylon</i>	T	P	Present statewide
Air yam	<i>Dioscorea bulbifera</i>	T	NP	
Chinese yam	<i>Dioscorea oppositifolia</i>	A	P	Present statewide
Silverberry, Thorny Olive	<i>Elaeagnus pungens</i>	T	P	Present statewide
Oxeye daisy	<i>Leucanthemum vulgare</i>	T	P	North of the fall line
Japanese privet	<i>Ligustrum japonicum</i>	T	P	Present statewide
Tall fescue	<i>Lolium arundinaceum</i>	T	P	
Amur honeysuckle	<i>Lonicera maackii</i>	T	P	North of the fall line
Uruguayan water primrose	<i>Ludwigia hexapetala</i>	A	P	Lake Worth, Bull Sluice
Oregon grape	<i>Mahonia aquifolium</i>	T	P	
Dwarf water clover	<i>Marsilea minuta</i>	A	P	
Chinese silvergrass	<i>Miscanthus sinensis</i>	T	P	Blue Ridge, Upper Piedmont
White mulberry	<i>Morus alba</i>	T	P	
Brittle (European) Naiad	<i>Najas minor</i>	A	P	Lakes Oliver, Sinclair, Worth
Nandina, Heavenly bamboo	<i>Nandina domestica</i>	T	P	Piedmont, Coastal plain
Watercress	<i>Nasturtium officinale</i>	A	P	Present statewide
Torpedo grass	<i>Panicum repens</i>	A	P	Lakes Jackson, Worth
Bahiagrass	<i>Paspalum notatum</i>	T	P	Piedmont, Coastal plain
Callery pear	<i>Pyrus calleryana</i>	T	P	
Itchgrass	<i>Rottboellia cochinchinensis</i>	T	P	
Bigpod sesbania	<i>Sesbania herbacea</i>	A	P	Coastal plain
Johnsongrass	<i>Sorghum halepense</i>	T	P	
Japanese spirea	<i>Spiraea japonica</i>	T	P	Blue Ridge
French tamarisk	<i>Tamarix gallica</i>	A	P	Coastal plain
Salt cedar	<i>Tamarix ramosissima</i>	T	P	Cumberland Island
Tungoil tree	<i>Vernicia fordii</i>	T	P	Cumberland Island
Bigleaf periwinkle	<i>Vinca major</i>	T	P	Present statewide
Common periwinkle	<i>Vinca minor</i>	T	P	Present statewide
Fishes				
Black carp	<i>Mylopharyngodon piceus</i>	A	NP	
Crustaceans				
An isopod	<i>Paradella diana</i>	A	P	

Appendix B: Summary of Federal Laws Relevant to Invasive Species

This appendix contains a brief description of a number of the major federal legal authorities that deal with invasive species.¹

Animal Quarantine laws (21 U.S.C. §§101 – 135b; 19 U.S.C. §1306)

The USDA's authority to regulate the importation and interstate movement of invasive animal species derives from several statutes collectively referred to as the animal quarantine laws. These laws authorize USDA to promulgate regulations and take measures to prevent the introduction and dissemination of communicable diseases and pests of livestock and poultry. The animal quarantine laws also authorize USDA to regulate the importation and interstate movement of all members of the animal kingdom, domestic and wild, except humans, for the purpose of regulating communicable diseases and pests of livestock and poultry. The fact that a disease or pest primarily affects animals other than livestock and poultry does not limit USDA's authority to regulate a species, as long as it carries a communicable disease or pest of livestock or poultry.

Under these laws, USDA is authorized to seize, quarantine, and dispose of animals, animal products, or other material that can harbor disease or pests of livestock or poultry that are moving or are being handled, or have moved or have been handled, in interstate or foreign commerce if they are infected with or exposed to a communicable disease of livestock or poultry, or if the animals are moved contrary to any of the animal quarantine laws. In addition, when a state is unable or unwilling to take the necessary action to prevent the dissemination of a communicable disease of livestock or poultry, the USDA has the authority to declare an extraordinary emergency and take the actions described in this paragraph within a state (i.e., whenever interstate movement is not involved).

The animal quarantine laws authorize USDA to cooperate with states in the control and eradication of diseases and pests of livestock and poultry. There is some specific research authority in the animal quarantine laws, but that authority is focused on certain animal diseases and pests such as foot-and-mouth disease and cattle grubs.

The animal quarantine laws do not cover situations involving diseases and pests that are not communicable diseases and pests of livestock or poultry. For example, they do not cover genetic disorders, exposure to radiation in nuclear accidents, or chemical residues. Further, they do not cover situations in which the method of transmission is not clearly communicable. Also, they do not cover progeny of illegally imported animals unless they have or have been exposed to a communicable disease of livestock or poultry or they have been moved in violation of regulations. In the early stages of an outbreak, it may be difficult to make such a finding.

¹ See the National Invasive Species Council, National Management Plan: Appendix 3 – Legal Authorities Related to Invasive Species. Retrieved 3 February 2007 from www.invasivespeciesinfo.gov/council/appendix3.shtml.

Thus, there is no authority for USDA to enter any premises to ascertain whether or not a communicable disease is present without probable cause to believe that it is present. Currently, USDA must rely on the voluntary permission of the owner or custodian of the animals to conduct tests or state authority to require that such tests be conducted to determine the presence or absence of infection or exposure.

Clean Water Act (33 U.S.C. §1251 *et seq.*)

This Act is the primary federal law that protects U.S. waters, including lakes, rivers, aquifers, and coastal areas (33 U.S.C. §1251(a)). It provides a comprehensive framework of standards, technical tools and financial assistance to address the many causes of pollution and poor water quality, including municipal and industrial wastewater discharges, polluted runoff from urban and rural areas, and habitat destruction. Among other things, the Act protects wetlands and other aquatic habitats through a permitting process that ensures development and other activities are conducted in an environmentally sound manner (33 U.S.C. §1322).

Coastal Zone Management Act (16 U.S.C. §1451 *et seq.*)

The Coastal Zone Management Act (CZMA) is another avenue by which invasive species can be controlled and managed. Under the CZMA, the federal and state governments work together to “preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation’s coastal zone for this and succeeding generations” (16 U.S.C. §1452(1)). Specifically, the federal government is to encourage and assist the states to achieve “wise use” of land and water resources in the coastal zone (*id.* §1454(2)). Invasive species issues can be incorporated into State Coastal Zone Management Plans through modification or amendment, subject to the approval of the Department of Commerce (DOC) (*id.* §1455(e)). Section 1555a(b) allows the DOC to make grants to eligible coastal states to assist them in preserving or restoring specific areas, redevelopment of deteriorating and underused urban waterfronts and ports, access to public beaches or development of a permit process to regulate aquaculture facilities in the coastal zone. In addition, the Act establishes the National Estuarine Research Reserve System (*id.* §1461(c)). Under this program, monitoring and other invasive species research could be sponsored.

Cooperative Forestry Assistance Act (41 U.S.C. §2104)

Under cooperative authorities, the Secretary of Agriculture may assist other federal, state, and private entities in controlling and managing invasive species on other federal lands and non-federal lands. The Secretary’s primary cooperative authority for invasive species is section 8 of the Cooperative Forestry Assistance Act of 1978 (16 U.S.C. §2104). Section 8(b) authorizes the Secretary of Agriculture to conduct activities and provide technical assistance relating to insect infestations and disease conditions affecting trees on National Forest System lands, on other federal lands (in cooperation with other federal departments) and on non-federal lands (in cooperation with state officials, other entities, or individuals). These activities include in part: conducting surveys to detect and appraise insect infestation and disease conditions, determining biological, chemical, and mechanical measures necessary to prevent, retard, control or suppress incipient, potential, threatening, or emergency insect infestations and disease conditions affecting trees and providing technical assistance to maintain healthy forests and manage the

use of pesticides (*id.* §2104(b)). Section 8(g) of the Act also authorizes the Secretary to provide financial assistance through the Forest Service to state entities and private forestry or other organizations to monitor forest health and protect forest lands. The Act gives the USDA authority to provide support for good forest management practices, including financial assistance to maintain health timber ecosystem to prevent incursion of invasive species on privately owned non-industrial forest lands.

Section 8 of the Act applies only to insect infestations and disease conditions affecting trees. The Act does not contain similar authority for insect infestations and disease conditions not affecting trees or for invasive plants. Section 4 of the Act provides support for good forest management practices on privately owned non-industrial forestlands.

Endangered Species Act (16 U.S.C. §1531 *et seq.*)

The Endangered Species Act (ESA) is jointly administered by the Secretaries of Interior and Commerce and contains provisions regulating import and export of listed species. However, other provisions of the ESA, relating as to how invasive species may negatively affect a listed species are probably more significant and can provide powerful management tools. Section 7 of the ESA requires any federal agency to ensure that any action authorized, funded, or carried out by the agency not jeopardize the continued existence of any endangered or threatened species or adversely modify any critical habitat of such species (16 U.S.C. §1536(a)(2)). Thus, each federal agency must consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service, depending on the species, for any action that may affect a listed species. If the action is not likely to adversely affect a listed species, the appropriate Service issues a Biological Opinion, which may authorize take that is incidental to the action or, if the federal action would otherwise jeopardize the continued existence of the species, offer alternatives to the federal action that will avoid such jeopardy (*id.* §1536(b)).

Any take of an endangered or threatened fish species unless otherwise authorized is unlawful under the statute (*id.* §1538). Thus, a federal agency will be held responsible for any unauthorized take directly or indirectly caused by the authorization, funding, or other federal action associated with invasive species.

The ESA treats threatened or endangered plants somewhat differently from federally listed animals. Section 9 prohibitions on take do not apply to plants, (*id.* §1538(a)(2)), but cautions can be provided in a Biological Opinion on prohibitions against removal or disturbance of plants. Thus, a federal agency will be held responsible for prohibited acts affecting both animal and plants that result from authorization, funding, or other federal action associated with invasive species. Section 7 consultation requirements apply, however, only to federal action.

Federal Insecticide, Fungicide, and Rodenticide Act (7 U.S.C. §136 *et seq.*)

The primary focus of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is to provide federal control of pesticide distribution, sale, and use. The EPA has authority under FIFRA not only to study the consequences of pesticide usage but also to require users (farmers, utility companies, and others) to register when purchasing pesticides. Through later amendments to the law, users also must take exams for certification as pesticide applicators. All pesticides used in the U.S. must be registered (licensed) by EPA. Registration assures that pesticides will be properly labeled and that if used in accordance with

specifications will not cause unreasonable harm to the environment. FIFRA is critical whenever pesticides are used to control or reduce the impact of invasive species. Examples include the use of a pesticide to control lamprey populations in the Great Lakes and the use of herbicides to control noxious weeds. FIFRA also gives EPA review authority for biological control agents when they are used to control invasive pests.

Federal Noxious Weed Act (7 U.S.C. §2801 *et seq.*)

The Federal Noxious Weed Act (FNWA) has been replaced by the Plant Protection Act, 7 U.S.C. §7701 *et seq.*, except for Section 2814. This section requires each federal agency to manage plant species that are classified as “undesirable, noxious, harmful, exotic, injurious, or poisonous” (7 U.S.C. §2814(e)(7)) on federal lands. They are to develop and coordinate a management program to control such plants on federal land and to enter into cooperative agreements with state agencies to implement their management plants. However, a federal agency is not required to carry out a management plan on federal lands unless similar programs are being implemented on state or private lands in the same area.

Federal Seed Act (7 U.S.C. §1551 *et seq.*)

The Federal Seed Act (FSA) mandates accurate labeling and purity standards for seeds in commerce, and prohibits the importation and movement of adulterated or misbranded seeds. The FSA works in conjunction with the Federal Noxious Weed Act to authorize USDA to regulate the importation and movement of field crop, pasture and forage, or vegetable seed that may contain noxious weed seeds. The FSA may offer protection against interstate transportation of invasive species because it requires labeling of seeds entering interstate commerce and requires standards for certain imported seeds.

The FSA allows interstate movement of agricultural seed containing noxious weed seeds if the shipment is accurately labeled as to the kinds of noxious weed seeds present and their rate of occurrence (7 U.S.C. §201). The rate of noxious weed seeds in an interstate shipment of agricultural seeds is not allowed to exceed the rate for shipment, movement, or sale in the state in which the seed is offered for transportation or transported, or in accordance with regulations issued by USDA. USDA has promulgated regulations setting tolerances for the nine noxious weeds specifically listed in the FSA in shipments of agricultural or vegetative seeds in interstate commerce.

The FSA also requires shipments of imported agricultural and vegetable seeds to be labeled correctly and to be tested for the presence of certain noxious weeds as a condition of entry into the U.S (*id.* §301). As is the case with the interstate movement of seeds, tolerances have been established for the seeds of nine specifically listed noxious weeds in imported seed.

Fish and Wildlife Coordination Act (16 U.S.C. §661 *et seq.*)

One of the purposes of the Fish and Wildlife Coordination Act (FWCA) is to give wildlife conservation equal consideration and coordination with other features of water resource development programs “through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation. . . (16 U.S.C. §661). The FWCA requires the Department of

Draft 1/16/09

Interior to provide assistance to, and cooperate with, federal, state, and public or private agencies and organizations to control, manage, and protect wildlife resources (*id.* §661(1)).

This Act authorizes the National Marine Fisheries Service to review development projects proposed or licensed by federal agencies and to make recommendations. It also makes funds available through grants and cooperative agreements that could encompass invasive species projects (*id.* §663).

Hawaii Tropical Forest Recovery Act (16 U.S.C. §4502a et seq.)

Section 3 of the Hawaii Tropical Forest Recovery Act (16 U.S.C. §4502(a)) authorizes the USDA's Forest Service to protect indigenous plants and animals from invasions, establish biological control agents for invasive species that threaten natural ecosystems, establish monitoring systems to identify baseline conditions and determine detrimental changes or improvements over time, and provide assistance to states with tropical forests (*id.* 4501a).

International Forestry Cooperation Act (16 U.S.C. §4501 et seq.)

Under Section 602(b) of the International Forestry Cooperation Act (16 U.S.C. §4501(b)), the Secretary may, in support of forestry and related natural resource activities outside the United States and its territories and possessions, provide assistance for the prevention and control of insects, diseases, and other damaging agents.

Under these authorities, the USDA's Forest Service delivers research and development products for vegetation management and protection; wildlife, fish, water and air sciences; resource valuation and use; and inventory and monitoring. The Forest Service Research & Development program addresses all aspects of that agency's invasive species program activities. The Forest Service's research authorities provide for the Service to conduct prevention, rapid response, control, and management activities related to invasive species and to restore areas affected by invasive species.

Lacey Act (18 U.S.C. §42 et seq.)

The Lacey Act, administered by the USFWS, prohibits importation into the U.S. or any U.S. territory or possession and shipment between the continental U.S., the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, and any possession of the U.S. of certain categories of animal species determined to be "injurious to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States" (18 U.S.C. §42(a)(1)). Wildlife and wildlife resources are defined broadly to include all wild animals and "all types of aquatic and land vegetation upon which such wildlife resources are dependent" (*id.*). The statute gives the USFWS the authority to export or destroy any injurious species at the expense of the importer, although permits may be issued to allow importation of otherwise injurious species for specific purposes (*id.* §42(a)(3)). Regulations listing species found to be injurious under the Lacey Act are in 50 C.F.R. Part 16.

Several restrictions within the Lacey Act, however, limit its ability to comprehensively address invasive species introductions. First, the Act is limited to animals. In fact, the statute does not apply to all animals, but only those specifically listed along with mammals, birds, fish, amphibians, reptiles,

mollusks, and crustaceans generally. In addition, the statute only applies to “wild” birds and mammals; presumably any species that has been domesticated could not be regulated. The statute also excludes restrictions on any species that is regulated under the Plant Pest Act, explicitly stating that Section 42 does not authorize “any action with respect to the importation of any plant pest as defined in the Federal Plant Pest Act, insofar as such importation is subject to regulation under that Act.” Thus any animal species whose importation is regulated under the Plant Pest Act cannot be regulated under the Lacey Act.

The “other” Lacey Act (16 U.S.C. §3371 *et seq.*)

A separate provision known as the “other” Lacey Act also has implications for regulating introductions of invasive species. This law, administered by the Secretaries of the Interior, Commerce, and Agriculture, generally makes it unlawful for any person to import, export, transport, sell, receive, acquire, or purchase (or attempt to commit any such act) in interstate or foreign commerce any fish, wildlife, or plant taken, possessed, transported, or sold in violation of any federal, tribal, state, or foreign law (16 U.S.C. §3372(a)(1)(2)(4)). Thus, while the statute does not substantively grant authority to regulate the importation, transportation, exportation, or possession of any species, violation of another federal, state, tribal, or foreign law governing these activities would become a violation of federal law and subject to particular civil and criminal penalties. The Secretaries of the Interior and Commerce have the authority to enforce laws involving fish and wildlife, while the Secretary of Agriculture has the authority to enforce laws involving plants.

This statute also has restrictions, however, that limits its effectiveness to address invasive species introductions. As with 18 U.S.C. §42, the definition of fish or wildlife limits its application to “wild” animals. In addition, while the definition of fish or wildlife is broad (“any wild animal, whether alive or dead, including without limitation any wild mammal, bird, reptile, amphibian, fish, mollusk . . . or other invertebrate” (*id.* §3371(a)), the definition of plant is limited to “any wild member of the plant kingdom . . . which is indigenous to any state and which is either (A) listed on an appendix to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, or (B) listed pursuant to any State law . . .” (*id.* §3371(f)). Thus plants covered by the act are limited to those indigenous to the United States and listed under CITES or a state endangered species law; all other plants are not covered.

Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 *et seq.*)

Essential fish habitat provisions of this Act (16 U.S.C. §1855) provide for review of federal and/or other actions that could affect essential fish habitat with authority to make recommendations necessary to conserve essential fish habitat. Specifically, the DOC, in consultation with participants in the fishery, must provide each Fishery Management Council with recommendations and information regarding each fishery under that council’s authority (*id.* §1855(b)(1)(B)). The purpose is to assist the Councils in identification of essential fish habitat (EFH), the adverse impacts on that habitat, and the actions that should be considered to ensure the conservation and enhancement of that habitat. Also, the DOC must review programs it administers and ensure that any relevant programs further the conservation and enhancement of EFH (*id.* §1855(b)(1)(C)). Finally, the DOC must coordinate with and provide information to other Federal agencies to further the conservation and enhancement of EFH (*id.* §1855(b)(1)(D)).

Multiple-Use Sustained-Yield Act (16 U.S.C. §528 et seq.)

USDA manages National Forests for multiple uses under the Multiple-Use Sustained-Yield Act (MUSY). The policy behind the MUSY is that the “the national forests are established and shall be administered for outdoor recreations, range, timber, watershed, and wildlife and fish purposes” (16 U.S.C. §528). The MUSY authorizes the USDA to develop and administer renewable surface resources of the national forests and to cooperate with interested state and local government agencies and others in the development and management of national forests (*id.* §529). Therefore, the MUSY may be a possible source of authority if invasive species threaten the vitality of national forests and their ability to produce a sustained yield of products and services under the principles of multiple use.

National Environmental Policy Act (42 U.S.C. §4221 et seq.)

Compliance with the National Environmental Policy Act (NEPA) can serve to identify actions that are likely to affect invasive species or be affected by them. The rationale behind the NEPA process - that agencies should be fully informed of the consequences of their actions before making a decision – is especially important when dealing with an issue like invasive species, where problems are often unanticipated side effects of otherwise desirable actions. Analysis and interagency, intergovernmental, and public review and comment that identify potential problems with invasive species for a particular proposed action may also yield ideas for alternative methods of approaching an issue or other forms of mitigation.

Agencies also need to comply with NEPA for actions that are proposed to respond quickly to invasive species management. In some cases, agencies may chose to prepare programmatic analyses on particular methodologies for addressing either the prevention or control of invasive species. In emergency situations that call for an immediate response by an agency that would normally require preparation of an environmental impact statement, the agency can work out alternative arrangements to their normal NEPA procedures with the Council of Environmental Quality.

National Forest Management Act (16 U.S.C. §1604)

Congress has required that the USDA develop and maintain forests plans for each administrative unit of the National Forest System (16 U.S.C. §1604(f)). However, site-specific management decisions must be consistent with the relevant forest plan for that site, or the plan itself must be amended to permit the activity (*id.* §1604(i)). Moreover, each plan must be consistent with the NEPA, the Multiple-Use and Sustained-Yield Act, and other federal environmental laws (*id.* §1604(e), (g)(1)). Since forest management is specific to each area, management may relate to invasive species as they become an issue in particular national forest areas.

National Invasive Species Act (16 U.S.C. §4701 et seq.)

The National Invasive Species Act (NISA) reauthorized and amended the Non-Indigenous Aquatic Nuisance Prevention and Control Act. The focus of NISA is on the spread of aquatic nuisance species through ballast water releases. NISA created a national Task Force co-chaired by the Director of the USFWS and the Undersecretary of Commerce for Oceans and Atmosphere (16 U.S.C. §4721(a)). This

Task Force was charged with developing and implementing a program to prevent the unintentional introduction and dispersal of aquatic nuisance species through ballast water management (*id.* §4722(a)).

NISA requires the development of voluntary national guidelines to prevent the introduction and spread of nonindigenous species into U.S. waters via ballast water of commercial vessels (*id.* §4711). The guidelines apply to vessels equipped with ballast water tanks and direct vessels that enter U.S. waters after operating beyond the Exclusive Economic Zone (EEZ) to undertake ballast exchange in the seas. The Secretary is also required to establish record keeping and reporting procedures and sampling techniques, based on the best available science, to monitor compliance (*id.* §4711(2)(F)(i), (G), and (I)). However, a vessel is not required to conduct ballast water exchange if the exchange would threaten the safety or stability of the vessel, its crew, or its passengers (*id.* §4711(c)(2)).

Furthermore, the Secretary and Task Force are required to conduct ecological and ballast discharge studies and surveys in waters highly susceptible to invasion or requiring further study (*id.* §4712(a)). The purpose of conducting these surveys is to examine invasions and the effectiveness of ballast management and its guidelines.

States, through their respective Governors, may submit their own comprehensive management plans to the Task Force for approval (*id.* §4724). These management plans identify areas or activities within each state or the surrounding region, except for those related to public facilities, for technical, enforcement, or financial assistance (or any combination thereof) to reduce or eliminate the risks associated with aquatic nuisance species.

NISA promotes research on species that fall under the definition “aquatic nuisance species” through competitive research grants, educational programs, and technical assistance to state and local governments and persons (*id.* §4722(f)). Such research may include the environmental and economic risks associated with the introduction of such species, the pathways by which such species are introduced and dispersed, possible methods for prevention, monitoring, and control, and assessment of the effectiveness of such methods.

National Marine Sanctuary Act (16 U.S.C. §1431 *et seq.*)

The National Marine Sanctuary Act (NMSA) established the National Marine Sanctuary System, the purpose of which is to “improve the conservation, understanding, management, and wise and sustainable use of marine resources, enhance public awareness, understanding, and appreciation of the marine environment, and maintain for future generations the habitat and ecological services of the natural assemblages of living resources that inhabit these areas” (16 U.S.C. §1431(a)(4)).

The Act requires the Department of Commerce to take actions to promote and coordinate the use of sanctuaries for research, monitoring, and education (*id.* §1440). In addition, the DOC may issue special use permits for specific activities, if necessary, to “establish conditions of access and use of any sanctuary resources or to promote public use and understanding of a sanctuary resource (*id.* §1441(a)). The DOC may enter into cooperative agreements, contracts, or other agreements with states, local governments, regional agencies, interstate agencies, or other persons in order to carry out the purposes and policies of the Act (*id.* §1442(a)).

Grant and contract funds are available for research, monitoring, and education for conservation and management activities (*id.* §1440(b)(1)). Such purposes could include control and management of any invasive species that is or may be in the future in a particular Sanctuary.

Under NMSA, it is unlawful for any person to “destroy, cause the loss, or injure any sanctuary resource managed under law or regulations for the sanctuary (*id.* §1436(l)). Therefore, regulations for particular Sanctuaries could prohibit the introduction of invasive species into the Sanctuaries. For example, the management plan for the Florida Keys National Marine Sanctuary prohibits introduction of exotic species into the Sanctuary.

Plant Protection Act (7 U.S.C. §7701 *et seq.*)

The Plant Protection Act (PPA) authorizes the USDA to prohibit or restrict the importation or interstate movement of any plant, plant product, biological control organism, noxious weed, article, or means of conveyance if the Secretary of Agriculture determines that the prohibition or restriction is necessary to prevent the introduction into the U.S., or the dissemination within the U.S., of a plant pest or noxious weed (7 U.S.C. §411(a)).

The movement of plants, plant products, biological control organisms, noxious weeds, articles, and means of conveyance are also regulated (*id.* §412). The USDA may prohibit or restrict the importation, entry, exportation, or movement of the aforementioned in interstate commerce if it determines that prohibition or restriction is necessary to prevent the introduction into the U.S. or the dissemination of a plant pest or noxious weed within the U.S. (*id.*). The USDA may also publish, by regulation, a list of noxious weeds that are prohibited or restricted in interstate commerce (*id.* §12(f)(1)).

The PPA specifically authorizes USDA to hold, seize, quarantine, treat, apply other remedial measures to destroy or otherwise dispose of any plant, plant pest, noxious weed, biological control organism, plant product, article or means of conveyance that is moving (or has moved) into or through the U.S. or interstate, if USDA considers it necessary in order to prevent the dissemination of a plant pest or noxious weed that is new to or not known to be widely prevalent or distributed within or throughout the U.S (*id.* §414(a)). This authority extends to progeny of prohibited items moved in violation of the PPA. The PPA also authorizes USDA to order an owner, or an agent of the owner, of a plant, plant pest, noxious weed, biological control organism, plant product, article or means of conveyance to treat, destroy, or otherwise dispose of those items (*id.*).

In addition, the PPA authorizes USDA to cooperate with other federal agencies or entities, states or political subdivisions of states, national governments, local governments of other nations, domestic or international organizations, domestic or international associations, and other persons to carry out the provisions of the PPA (*id.* §431).

Virus-Serum-Toxin Act (21 U.S.C. §151 *et seq.*)

This Act authorizes USDA to regulate veterinary biological products that are intended for use in the treatment (i.e., prevention, diagnosis, management, or cure) of animal diseases. These include, but are not limited to, vaccines, bacterins, sera, antisera, antitoxins, toxoids, allergens, diagnostic antigens

Draft 1/16/09

prepared from, derived from, or prepared with microorganisms, animal tissues, animal fluids, or other substances of natural or synthetic origin. The Act prohibits the shipment or delivery for shipment in intrastate commerce, as well as in interstate commerce, and the importation or exportation of any veterinary biological product that is worthless, contaminated, dangerous, or harmful (21 U.S.C. §151). It also prohibits the importation or exportation of any biological product not prepared in compliance with regulations prescribed by USDA at an establishment licensed by USDA (*id.* §152).

Appendix C: Summary of Georgia Laws Relevant to Invasive Species

Bird Dealers Licensing Act (O.C.G.A. §4-10-7.1): The Java Rice Bird (*Padda oryzivora*) and the Monk Parakeet (*Myiopsitta monachus*) are prohibited from entry into Georgia because they are capable of breeding in the wild and any established populations could present a threat to the state's agriculture. Importation of these birds, except by special permit from the State Veterinarian's Office is illegal (GA Rules 40-13-12.06(1)(2)). A special permit will be issued if the person applying for the permit establishes that adequate precautions will be taken to ensure that neither the bird for which the permit is issued nor any of the bird's offspring will be allowed to escape captivity. The Georgia Department of Agriculture may quarantine, seize, and destroy any bird brought into the state in violation of the law.

Coastal Marshlands Protection Act of 1970 (O.C.G.A. §12-5-280): This Act created the Coastal Marshlands Protection Committee which grants, denies, revokes, and amends all permits provided for by the Act and details the process to handle grievances of a party in relation to any rules, or regulations adopted by the Board of Natural Resources. The Act outlines the powers and duties of the DNR and the Board of Natural Resources as to coastal marshlands. Marshlands may not be filled, drained, dredged, or otherwise altered without a permit from the committee. The Act indicates the process for obtaining a permit and explains the points reviewed by the committee prior to issuing or denying a permit. It authorizes the inspection of marshlands by GA DNR officers and conservation rangers to verify compliance with the rules, regulations, and permits, and enforcement in the case of noncompliance.

Endangered Wildlife Act of 1973 (O.C.G.A. §27-3-130): This law provides for identification, inventory, and protection of animal species that are rare, unusual, or in danger of extinction. The Board of Natural Resources approves changes to the list of state protected species. The protection offered to these species is limited to those that are found on public lands of the State. It is a misdemeanor to violate the rules prohibiting capture, killing, or selling of protected species, and protection of protected species habitat on public lands. The rules and regulations are established and administered by GA DNR for implementation of this Act. Acquisition of unique habitats and natural areas for the protection of rare species is encouraged.

Entomology Act of 1937 (O.C.G.A. § 2-7-1): This Act makes it illegal to grow or sell live plants in Georgia without a license issued by the Georgia Department of Agriculture (Department) (GA Rules 40-4-9-.02). It is also unlawful to sell or distribute any live plants infected or infested with plant pests, or any plant listed on the Federal Noxious Weed list (GA Rules 40-4-9-.11), and a special permit is needed to import into Georgia any insect injurious to plants in any stage of development or of any specimen of any disease injurious to plants (O.C.G.A. §2-7-26). The Department may require all growers of plant or nursery stock intended for sale or distribution that has been declared by the Department as being liable or likely to disseminate or capable of disseminating plant pests to be registered (O.C.G.A. §2-7-21).

The Department has the power to inspect any plants or plant products that may be capable of carrying plant pests, defined as any organism which may be injurious to the agricultural, horticultural, or other interests of the state, including, but not limited to, insects, bacteria, fungi, viruses, or weeds (O.C.G.A.

§2-7-2(8.1); §2-7-10). Plants and plant products are trees, shrubs, vines, forage and cereal plants, and all other plants, cuttings, grafts, scions, buds, and other parts of plants; and fruit, vegetables, roots, bulbs, seeds wood, timber, and all other plant products. The term “trees” includes shade trees and all other trees except forest trees. Nursery stock of all trees, including forestry trees, is also included in this definition (O.C.G.A. §2-7-2(9)). The Department may order any live plants to be quarantined, returned to place of origin, or destroyed at cost to the owner if the plants are believed to have entered Georgia in violation of the terms of this Act (O.C.G.A. §2-7-13). The Department may also visit any section of the state in which a dangerous pest is supposed to exist and determine whether any infested trees or plants are worthy of remedial treatment or needs to be destroyed. If a plant pest is found, the Department may supervise or directly treat, cut, or otherwise destroy infested or infected plants or trees when deemed necessary to prevent, control or eradicate the dissemination of plant pests (O.C.G.A. §2-7-12). Any dangerous plant pest or infected or infested plant likely to spread may be declared to be a public nuisance, and after receiving written notice, the owner must control, eradicate, or prevent the dissemination of the plant pest and remove, cut, or destroy infested or infected plants and plant products (O.C.G.A. §2-7-15; §2-7-16).

The Department may declare a quarantine against any area or place in reference to dangerous plant pests and may prohibit the movement within the state or the introduction into the state from other states or foreign country of all plants and plant products from such quarantined places as are likely to carry dangerous plant pests, if it is determined by the Department to be necessary in order to protect the agricultural, horticultural, or other interests of the state. When the Department does declare a quarantine of a dangerous plant pest, it is illegal until the quarantine is removed for any person to introduce into this state or to move, sell, or otherwise dispose of within the state any plant, plant produce, or other things included in such quarantine (O.C.G.A. §2-7-20).

Forest Resources and Other Plant Life Code (O.C.G.A. §12-6-1): This legislation established the State Forestry Commission (Commission) and gave it authority to:

- Take all action appropriate to foster, improve, and encourage reforestation;
- Engage in research and other projects for the ascertainment and promulgation of better forestry practices;
- Offer aid, assistance, and technical advice to landowners relative to the preservation and culture of forests; and
- Conduct and direct fire prevention work and maintain equipment, personnel, and installations for fire detection, prevention, and combating (O.C.G.A. §12-6-5(a)(1)(2)(3)(5)).

Whenever the Commission determines that there exists an infestation of forest insect pests or an infection of forest tree diseases, injurious or potentially injurious to the timber or forest trees within the state, and the infestation or infection may be a menace to the timber or forest growth of the state, the Commission can declare the existence of a zone of infestation or infection and declare and fix zone boundaries. The Commission must give written notice to each forest landowner within the designated control zone advising the owner of the nature of the infestation or infection and the recommended control measures and offering the owner technical advice on methods of carrying out controls. The Commission also has the authority to declare and define areas of quarantine and to enforce these areas (O.C.G.A. §12-6-16).

The Commission may also enter any land which it believes contain infested or infected trees in order to determine the existence of such infestation or infection, and the extent and cause of any infection or infestation. If an infestation or infection is found to exist by the Commission, it must notify the landowner and recommend a course of action to prevent the spread of the infestation or disease. If the landowner, within a reasonable period of time following such notification, fails to take action to prevent the spread of the infestation or disease, then the Commission may: fell and remove infested or diseased trees; fell and chemically treat infested or diseased trees; chemically treat standing infested or diseased trees; or take any other appropriate control methods (O.C.G.A. §12-6-22).

Game and Fish Code (O.C.G.A. §27-1-1): This legislation provides the ownership of, jurisdiction over, and control of all wildlife to be vested in the State of Georgia. The Wildlife Resources Division of GA DNR is the principal state agency vested with statutory authority for the protection, management and conservation of terrestrial wildlife and fresh water wildlife resources, including fish, game, nongame, and endangered species. All licensing of recreational and commercial fish and wildlife activities, excluding the harvest of shellfish, is performed by the Wildlife Resources Division. The Coastal Resources Division of GA DNR issues shellfish permits, regulates marine fisheries activities including the opening and closing of the commercial shrimp harvesting season, areas of shrimp harvest, regulates marine species size and creel limits, and enforces the National Shellfish Sanitation Program. The Commissioner of the DNR has directed that there will be cooperation and coordination between of GA DNR's Divisions in the administration of their respective responsibilities.

- Definitions:
 - Domestic Species: Those animals that have traditionally lived in a state of dependence on and under the dominion and control of mankind and have been kept as tame pets or livestock. These may be possessed without permits (O.C.G.A. §27-1-2(23)).
 - Domestic Fish Species: Those fish which are lawfully obtained farmed fish which are held in confinement in private ponds, but only if they are fish species which are either indigenous to Georgia or are fish species which have been recognized before 1992 as having an established population in Georgia's public waters. White perch (*Morone americana*) cannot be considered a domestic fish (O.C.G.A. §27-1-2(23)).
 - Feral hog: Feral hog (*Sus scrofa*) means any hog which is normally considered domestic but which is living in a wild state and cannot be claimed in private ownership (O.C.G.A. §27-1-2(28)).
 - Game fish: Game fish include the following:
 - Bass
 - Largemouth (*Micropterus salmoides*)
 - Smallmouth (*Micropterus dolomieu*)
 - White (*Morone chrysops*)
 - Striped (*Morone saxatilis*)
 - Spotted (*Micropterus punctulatus*)
 - Redeye (Coosa) (*Micropterus coosae*)
 - Striped-white bass hybrid (*Morone saxatilis* X *Morone chrysops*)

- Shoal bass (Flint River smallmouth) (*Micropterus cataractae*)
- Suwannee (*Micropterus notius*)
- Trout
 - Rainbow (*Oncorhynchus mykiss*)
 - Brown (*Salmo trutta levenensis*)
 - Brook (*Salvelinus fontinalis*)
- Crappie
 - White (*Pomoxis annularis*)
 - Black (*Pomoxis nigromaculatus*)
- Shad
 - American (*Alosa sapidissima*)
 - Hickory (*Pomolobus mediocris*)
- Sunfish or bream
 - Flier (*Centrarchus macropterus*)
 - Spotted sunfish (*Lepomis auritus*)
 - Rock bass (*Ambloplites rupestris*)
 - Shadow bass (*Ambloplites ariommus*)
 - Redbreast sunfish (*Lepomis auritus*)
 - Redear sunfish (*Lepomis microlophus*)
 - Bluegill (*Lepomis macrochirus*)
 - Warmouth (*Lepomis gulosus*)
- Perch
 - Walleye (*Sander vitreus*)
 - Sauger (*Sander canadense*)
- Pickerel
 - Chain (*Esox niger*)
 - Grass (*Esox americanus vermiculatus*)
 - Redfin (*Esox americanus americanus*)
- Catfish
 - Channel (*Ictalurus punctatus*)
 - Flathead (*Pylodictis olivaris*) (O.C.G.A. §27-1-2(36)).
- Wild animal: Wild animal means any animal not indigenous to Georgia and not normally a domesticated species. This group would include practically all exotic animals. Tilapia (*Oreochromis* spp.) and non-sterile grass carp (*Ctenopharyngodon idella*) are examples of fish that are included in this definition (O.C.G.A. §27-1-2(75)).
 - Wildlife: Wildlife refers to those species of animals (mammals, birds, fish, amphibians, reptiles, crustaceans, and mollusks) indigenous to Georgia (O.C.G.A. §27-1-2(77)).
- Aquaculture Registration (O.C.G.A. §27-4-255): Aquaculturists producing and selling or re-selling domestic fish may register with the GA DNR. A Commercial Fish Hatchery License, Wholesale Fish Dealers License, or Retail Fish Dealers License is not needed to sell domestic fish if the seller

has registered as an aquaculturist. Persons in possession of domestic fish from registered aquaculturists must have a bill of sale or lading which provides the date of the sale, identifies the seller and which details two of the following three criteria for each species of fish: number, weight, or average length. Grocery stores do not have to register to sell domestic fish. Aquaculture Registration certificates expire on April 1 following two years of registration. Information provided by the aquaculturist for registration must be updated if there are changes during the registration period. Registration certificates should be displayed in a prominent location at the place of business, and a copy should be in possession of the owner or his agents when conducting business off the premises. Examples of fish species that may NOT be raised or sold with an Aquaculture Registration and which require additional licenses include tilapia (*Oreochromis* spp.) and grass carp (*Ctenopharyngodon idella*), although these are not the only species. All grass carp dealers must be licensed through GA DNR (Wild Animal License). Examples of species of fish that ARE included on the Aquaculture Registration application:

- Channel catfish (*Ictalurus punctatus*)
 - Largemouth bass (*Micropterus salmoides*)
 - Rainbow, Brown, and Brook trout (*Oncorhynchus mykiss*), (*Salmo trutta leuvenensis*), (*Salmo trutta leuvenensis*)
 - Crappie (*Pomoxis* spp.)
 - Bluegill (*Lepomis macrochirus*)
 - Redear sunfish (*Lepomis microlophus*)
 - Hybrid sunfish (*Lepomis hybrids*)
 - Hybrid bass
 - Golden shiner (*Notemigonus crysoleucas*)
 - Fathead minnow (*Pimephales promelas*)
 - Goldfish (*Carassius auratus*)
 - Koi (*Cyprinus carpio* (ornamental))
 - Common carp (*Cyprinus carpio*)
 - Freshwater drum (*Aplodinotus grunniens*)
 - Smallmouth buffalo (*Ictiobus bubalus*)
 - Red drum (*Sciaenops ocellatus*)
 - Gizzard shad (*Dorosoma cepedianum*)
 - Threadfin shad (*Dorosoma petenense*)
 - Paddlefish (*Polyodon spathula*)
 - Yellow perch (*Perca flavescens*)
 - Mosquitofish (*Gambusia affinis*)
-
- Fish Dealers Licenses (O.C.G.A. §27-4-76): A Wholesale or Retail Fish Dealers License is needed to sell live fish or fish eggs. Exceptions include persons with a Commercial Fish Hatchery License, persons selling fish for use in aquaria, and registered aquaculturists selling only domestic fish. A Wholesale License is needed for persons selling fish to others for the purpose of resale, and for those persons importing live fish or eggs into the state. A Retail License is needed in other

instances. Nonresident persons may sell and import live fish and eggs into the state without purchasing a license if they sell to a GA DNR licensed wholesale fish dealer. Fish sold from licensed dealers must be accompanied by a bill of sale or lading which provides the date of the transaction, identifies the seller and which details two of the following three criteria for each species of fish: number, weight, or average length.

- Wild Animal License to sell regulated fish : This license is required to possess, import, transport, transfer, sell or purchase any wild animal including exotic fish species. No license is needed for exotic fish if they are held in containers fish from which no water is discharged, except during periodic cleaning, and which discharged water is passed through a filtering system capable of removing all fish and fish eggs and is disposed of only in a septic tank permitted by the county or in a waste water treatment system permitted by the EPD (O.C.G.A. §27-5-5(b)(6)). Exotic fish are all fish species not native to Georgia. However, rainbow trout, brown trout, common carp, goldfish, and fathead minnow are examples of non-native fish that are not considered exotic fish for regulatory purposes. Exceptions: A wild animal license is always needed to possess:

- Banded tetra (*Astyanax fasciatus*)
- Piranhas (all species including the Genera *Serrasalmus*, *Serrasalmo*, *Pygocentrus*, *Tadyyella*, *Rooseveltiella*, and *Pygopristsis*)
- Grass carp (*Ctenopharyngodon idella*)
- Silver carp (*Hypophthal-michthys molitrix*)
- Bighead carp (*Aristichthys nobilis*)
- Air-breathing catfishes (all species of the Family Clariidae)
- Parasitic catfishes (all species of the Genera *Vandellia* (candiru) and *Urinophilus*)
- Giant walking catfishes (all species of the Genus *Heteropneustes*)
- Snakeheads (all species of the Genera *Ophicephalus* and *Channa*)
- Fresh water stingray (all species of the Family Potamotrygonidae).

Licenses are individually conditioned to ensure that the requirements of the Game and Fish Code are met. Grass carp exception: no permit is required for persons buying triploid grass carp from wild animal dealers licensed by DNR to sell grass carp; if the buyer retains the bill of sale as proof, and the grass carp are stocked into a private pond.

Exotic Animals: Animals listed as exotic species are regulated under Georgia Law. GA DNR should be consulted before any exotic animals which are not normally domesticated are acquired. Hybrids or crosses between any combination of domestic animals, wildlife, or regulated wild animals and all subsequent generations are regulated in Georgia and may not be held with a license. Examples of exotic species which may also be invasive include:

- Monk parakeet; *Myiopsitta monachus*
- Sparrows: all species of genus *Passer* except English sparrow
- Blackbirds, grackles, etc.; all species of genera *Molothrus*, *Quiscalus*, *Agelaius*
- Starlings; all species except European starling
- Crocodiles; all species

- Alligators; all species
- Cobras, vipers, etc.; all species
- Gila monsters and beaded lizards; all species
- Giant and marine toads; all species
- Banded tetra; *Astyanax fasciatus*
- Piranha; all species
- Grass, Silver, and Bighead carp; *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, (*Aristichthys nobilis*)
- Air-breathing catfishes; all species
- Parasitic catfishes; all species
- Giant walking catfishes; all species
- Snakeheads; all species of genera *Ophicephalus* and *Channa*
- Fresh-water stingray; all species (O.C.G.A. §27-5-5(b))
- Liberation-of-wildlife and liberation-of-domestic fish permits: It is unlawful for any person to liberate any wildlife (except pen-raised quail) within the state or to liberate domestic fish except into private ponds except under permit from the GA DNR (O.C.G.A. §27-2-14).

Georgia Boll Weevil Eradication Act of 1985 (O.C.G.A. §2-7-150): This Act declares the boll weevil, *Anthonomus grandis*, to be a serious pest and a menace to the cotton-growing industry (O.C.G.A. §2-7-151). In order to provide for the eradication of this insect, the Act authorizes the Department of Agriculture (Department) to inspect any land, plants, plant products, or other articles, things, or substances that may be capable of disseminating or carrying the boll weevil (O.C.G.A. §2-7-154(2)). The Department may also require every person growing cotton in Georgia to furnish information relating to the size and location of all commercial and noncommercial cotton fields or patches being grown in the state (O.C.G.A. §2-7-154(3)). After a public hearing, the Department may determine that a quarantine of the state or a portion of the state is necessary to prevent or reduce the spread of the boll weevil (O.C.G.A. §2-7-154(4)). Finally, the Department may, after a public hearing, adopt rules:

- Governing the movement of regulated articles (i.e., cotton plants, seed cotton, hosts, gin trash, equipment, etc.) into, out of, or within the state;
- Establishing eradication zones within the state where eradication efforts will be undertaken;
- Restricting or prohibiting the planting of cotton in eradication zones when it is determined that the planting would jeopardize the success of eradication efforts to present a hazard to the public health or safety;
- Requiring that all growers of commercial cotton in the designated eradication zones participate in the eradication program, including cost sharing through assessment;
- Establishing a penalty fee for those growers in eradication zones who fail to comply with the rules established by the Department;
- Imposing restrictions on pasturing of livestock, entry by humans, and location of honeybee colonies in any eradication zone which has been or is to be treated with pesticides for eradication of the boll weevil;

- Enter upon any premise, property, or field within an eradication zone and treat with pesticides or destroy any volunteer or noncommercial cotton when he determines that such action is necessary to the success of the eradication efforts; and
- Require the destruction of commercial cotton in an eradication zone when it is not being grown in compliance with this Act (O.C.G.A. §2-7-154(5)).

Georgia Environmental Policy Act (O.C.G.A. §12-16-1): The Georgia Environmental Policy Act (GEPA) requires that all state agencies and activities prepare an Environmental Impact Report (EIR) as part of the decision-making process for all activities that may have an impact on the environment. Alternatives to the proposed project or activity must be considered as part of the report. The Act states that any proposed governmental action which may “significantly adversely affect the quality of the environment” including the state’s air, water, land, plants, and animals, requires an Environmental Effects Report. As outlined in the Act, an EIR describes the environmental impact and any adverse environmental effects of the action, alternative actions, mitigation, measures proposed to avoid or minimize impact, and other effects of the action. The government agency responsible for the action authors the report and provides it to the director of the Environmental Protection Division (EPD) in the GA DNR. A notice that the report has been prepared is to be published in the legal organ of each county in which the action is to take place, which may lead to a public hearing regarding the action. The Act requires the EPD director to issue guidelines to assist government agencies in the preparation of environmental effects reports.

Georgia Seed Law (O.C.G.A. §2-11-1): This Act makes it illegal to sell, offer for sale, expose for sale, or transport for sale any agricultural, vegetable, flower, tree, or shrub seed within Georgia that consists of or contains prohibited noxious weed seeds, or restricted noxious weed seeds per pound in excess of the prescribed number or the number declared on the seed container label or associated with the seed (O.C.G.A. §2-11-23(a)(4)(5)). Prohibited noxious weed seeds are weed seeds that are highly destructive and difficult to control by good cultural practices and the use of herbicides (O.C.G.A. §2-11-21(17)(A)). Restricted noxious weed seeds are those weed seeds that are very objectionable in fields, lawns, and gardens but can be controlled by good cultural practice (O.C.G.A. §2-11-21(17)(B)).

It is unlawful to sell, offer for sale, or expose for sale, any agricultural or vegetable seed for planting purposes in Georgia if the noxious weed seeds per pound of pure seed is in excess of the following limitations (GA Rules 40-12-4-.01):

(a) Prohibited Noxious Weed Seeds.

<u>Name</u>	<u>Limitations</u>
Balloonvine (<i>Cardiospermum halicacabum</i>)	Prohibited
Bindweed, Field (<i>Convolvulus arvensis</i>)	Prohibited
Bindweed, Hedge (<i>Calystegia sepium</i>)	Prohibited
Cocklebur (<i>Xanthium</i> spp.)	Prohibited
Crotalaria (<i>Crotalaria</i> spp.)	Prohibited
Morning glory, Giant or Moonflower (<i>Ipomoea turbinata</i>)	Prohibited

Draft 1/16/09

Nutsedge, Purple (<i>Cyperus rotundus</i>)	Prohibited
Nutsedge, Yellow (<i>Cyperus esculentus</i>)	Prohibited
Tropical Soda Apple (<i>Solanum viarum</i>)	Prohibited
Tussock, Serrated (<i>Nassella trichotoma</i>)	Prohibited

(b) Restricted Noxious Weed Seeds.

<u>Name</u>	<u>Limitations</u>
Bermudagrass (<i>Cynodon dactylon</i>)	300 per pound
Blueweed (<i>Helianthus ciliaris</i>)	200 per pound
Cheat or Chess (<i>Bromus commutatus</i> and/or <i>Bromus secalinus</i>)	300 per pound
Corncockle (<i>Agrostemma githago</i>)	100 per pound
Darnel (<i>Lolium temulentum</i>)	200 per pound
Dock (<i>Rumex</i> spp.)	100 per pound
Dodder (<i>Cuscuta</i> spp.)	100 per pound
Foxtail, Giant (<i>Setaria faberi</i>)	100 per pound
Horsenettle (<i>Solanum carolinense</i>)	200 per pound
Johnsongrass (<i>Sorghum halepense</i>)	100 per pound
Knapweed, Russian (<i>Acroptilon repens</i>)	100 per pound
Mustard, Wild and Turnips (<i>Brassica</i> spp.)	27 per pound
Except for Winter Rape, <i>Brassica napus</i> var.	
Biennis, and Rape, <i>B. rapa</i> var. <i>rapa</i>	
Nightshade, Silverleaf or Purple (<i>Solanum elaeagnifolium</i>)	200 per pound
Onion, Wild or Wild Garlic (<i>Alliums</i> pp.)	27 per pound
Panicum, Texas or Texas Millet (<i>Panicum texanum</i>)	27 per pound
Plantain, Bracted (<i>Plantago aristata</i>)	200 per pound
Plantain, Buckhorn (<i>Plantago lanceolata</i>)	200 per pound
Quackgrass (<i>Elytrigia repens</i>)	100 per pound
Radish, Wild (<i>Raphanus raphanistrum</i>)	27 per pound
Rice, Red (<i>Oryza rufipogon</i>)	300 per pound
Sandbur, Field (<i>Cenchrus incertus</i>)	27 per pound
Sorghum alnum (<i>Sorghum X alnum</i>)	100 per pound
Sorrel, Red or Sheep (<i>Rumex acetosella</i>)	200 per pound
Thistle, Blessed (<i>Cnicus benedictus</i>)	9 per pound
Thistle, Canada (<i>Cirsium arvense</i>)	100 per pound
(c) Sum total of Noxious Weed Seeds	300 per pound

Nongame Wildlife Conservation Programs Act of 1985 (O.C.G.A. §12-3-600): This asserts that the policy of the State of Georgia is to enable and encourage citizens voluntarily to support nongame wildlife conservation programs and wildlife habitat acquisition programs and recognizes the need for a separate source of funds from game management sources. The Act establishes nongame wildlife conservation

and acquisition programs, and educational and promotional activities in support of these programs. It allows for a funding source from contributions through an income tax return contribution mechanism and through fund raising or other promotional techniques. The Nongame Wildlife Conservation and Wildlife Habitat Acquisition Fund is established with this Act. Balances in the fund are deposited in an interest-bearing account identifying the fund and are to be used by these programs.

Tropical Soda Apple Rules (GA Rules 40-4-22): The Georgia Department of Agriculture has declared tropical soda apple to be a public nuisance to the agricultural and horticultural interests of the State (GA Rules 40-4-22-.01). Any location in Georgia containing tropical soda apple plants, fruits, or seeds is subject to regulation (GA Rules 40-4-22-.03). All plants with fruit must be removed and buried or incinerated (GA Rules 40-4-22-.04(1)(a)). All plants without fruit must either be: mowed once a month to a stubble height of no more than three inches, or treated with an herbicide at the highest recommended label rate and at the shortest treatment intervals (GA Rules 40-4-22-.04(b)). Livestock may not be moved from a regulated property unless held in a tropical soda apple free holding area for at least seven days after their last exposure to the plant's fruit (GA Rules 40-4-22-.04(4)). Manure may not be moved from a regulated property unless it is composted for at least six months and the property owner monitors the compost pile monthly (GA Rules 40-4-22-.04(5)). Soil may not be moved from a regulated property unless it is steam sterilized (GA Rules 40-4-22-.04(6)), and hay may not be removed from a regulated property at all (GA Rules 40-4-22-.04(8)).

Wildflower Preservation Act of 1973 (O.C.G.A. §12-6-170): This legislation provides for the designation of officially protected plants and authorizes rules for the collection, transport, sale, and listing of these plants. Under this Act, the GA DNR has the authority to list as protected any plants meeting the requirements approved by the Board of Natural Resources. Protected plants must not be collected on public lands unless authorized by the GA DNR. The sale of protected plants is prohibited unless grown on private land and sold by the landowner or with the permission of the landowner. Protected plants must not be transported unless permission has been granted by the landowner as evidenced by the presence of an affixed tag from the department and a written document detailing such permission. This Act also authorizes the enforcement of these policies through prosecution of any violations of the Act.

Appendix D: Survey Results of Invasive Species Management Activities in Georgia

As part of the process of drawing up an ANS Management Plan for Georgia, Committee members were asked to describe the type of ANS management responsibilities their various agencies and organizations undertake. The results are summarized in the table below.

Agency	Operations	Research	Public Outreach	Information Management	Agency Resource Expenditures
US Army Corps of Engineers	P, D, CM, R	Yes	Yes	No	N/A*
USDA-APHIS	D, RR, CM,	No	Yes	Yes	N/A
USDA-FS	P, D, RR, CM, R	Yes	Yes	Yes	\$500,000/yr
USDA-NRCS	P, CM, R	No	No	No	300 FTE**
DOI-FWS	P, D, R	No	Yes	No	1/8 FTE
DOI-FWS Region 4	P, R	Yes	No	No	N/A
DOI-NPS	P, D, RR, CM, R	No	Yes	Yes	N/A
GDA	P, D, RR, CM	No	No	No	N/A
GDA-PPD	P, D, RR, CM	No	Yes	Yes	6.25-6.7 FTE
GADHR-DPH	D	No	Yes	Yes	2 FTE
GA DNR-CRD	P, CM	Yes	Yes	Yes	\$130,000/yr
GA DNR-EPD	P, CM, R	No	Yes	No	N/A
GA DNR-PRHSD	P, D, RR, CM, R	No	Yes	Yes	2 FTE
GA DNR-WRD	P, D, RR, CM, R	Yes	Yes	Yes	8 FTE
GDOT	P, D, RR, R	Yes	No	Yes	10 FTE
GA Forestry Commission	P, D, RR, CM, R	Yes	Yes	No	31 FTE
UGA-CAES	P, D, RR, CM,	Yes	Yes	Yes	0.1 FTE
UGA-Horticulture	P, CM	Yes	Yes	Yes	N/A
UGA-MAREX	P, D, R	Yes	Yes	Yes	< 1% of annual budget

Agency	Operations	Research	Public Outreach	Information Management	Agency Resource Expenditures
UGA-Odum School of Ecology	R	Yes	Yes	No	N/A
UGA-Warnell School of Forestry & Natural Resources	P, D, RR, CM, R	Yes	Yes	Yes	N/A
GA Aquarium	None	No	Yes	No	N/A
GA Forestry Association	P, CM	No	Yes	No	N/A
GA Green Industry Association	P, D	Yes	Yes	Yes	N/A
GA Native Plant Society	P, RR, R	Yes	Yes	No	N/A
GA Ports Authority	P, D	No	No	No	N/A
GA Power Company	P, D, CM	No	Yes	Yes	1.5 FTE
GA Wildlife Federation	D, CM, R	No	Yes	No	N/A
The Nature Conservancy	P, D, RR, CM, R	Yes	Yes	Yes	1 FTE
Trees Atlanta	CM, R	No	Yes	No	N/A

Operations include: P = Prevention, D = Detection, RR = Rapid Response, CM = Control and Management, R = Restoration

*Not available

** Full time equivalent

Appendix E: Federal Noxious Weed List²

Scientific Name	Common Name
<i>Aeginetia L.</i>	
<i>Ageratina adenophora</i>	Crofton weed
<i>Alectra Thunb.</i>	
<i>Alternanthera sessilis</i>	Sessile joyweed
<i>Asphodelus fistulosus L.</i>	Onionweed
<i>Avena sterilis</i>	Animated oat
<i>Azolla pinnata</i>	Mosquito fern
<i>Carthamus oxyacanthus</i>	Wild safflower
<i>Caulerpa taxifolia</i>	
<i>Commelina benghalensis</i>	Benghal dayflower
<i>Crupina vulgaris</i>	Common crupina
<i>Cuscuta</i>	Dodder
<i>Digitaria velutina</i>	Velvet fingergrass
<i>Drymaria arenarioides</i>	Alfombrilla
<i>Eichhornia azurea</i>	Anchored waterhyacinth
<i>Emex australis</i>	Three-cornered jack
<i>Emex spinosa</i>	Devil's thorn
<i>Galega officinalis</i>	Goatsrue
<i>Heracleum mantegazzianum</i>	Giant hogweed
<i>Homeria</i>	Cape tulip
<i>Hydrilla verticillata</i>	Hydrilla
<i>Hygrophila polysperma</i>	Miramar weed
<i>Imperata brasiliensis</i>	Brazilian satintail
<i>Imperata cylindrica</i>	Cogongrass
<i>Ipomoea aquatica</i>	Chinese waterspinach
<i>Ischaemum rugosum</i>	Murain-grass
<i>Lagarosiphon major</i>	Oxygen weed
<i>Leptochloa chinensis</i>	Asian sprangletop
<i>Limnophila sessiliflora</i>	Ambulia
<i>Lycium ferocissimum</i>	African boxthorn
<i>Melaleuca quinquenervia</i>	Melaleuca
<i>Mikania cordata</i>	Mile-a-minute weed
<i>Mikania micrantha</i>	Mile-a-minute weed
<i>Mimosa peltata</i>	Catclaw mimosa
<i>Monochoria hastata</i>	Monochoria
<i>Monochoria vaginalis</i>	Pickerel weed
<i>Nassella trichotoma</i>	Serrated tussock
<i>Opuntia aurantiaca</i>	Jointed prickly pear
<i>Orobanche L.</i>	Broomrape
<i>Oryza longistaminata</i>	Red rice
<i>Oryza punctata</i>	Red rice

² Plant Protection and Quarantine. 2006. *Federal noxious weed list* (<http://www.phis.usda.gov/ppq/weeds/weedlist2006.pdf>, 24 May 2006). USDA Animal and Plant Health Inspection Service.

Scientific Name	Common Name
<i>Oryza rufipogon</i>	Red rice
<i>Ottelia alismoides</i>	Duck-lettuce
<i>Paspalum scrobiculatum</i>	Kodo-millet
<i>Pennisetum clandestinum</i>	kikuyugrass
<i>Pennisetum macrourum</i>	African feathergrass
<i>Pennisetum pedicellatum</i>	Kyasuma-grass
<i>Pennisetum polystachion</i>	Mission grass
<i>Prosopis spp.</i>	Mesquite
<i>Rottboellia cochinchinensis</i>	Itchgrass
<i>Rubus fruticosus</i>	Wild blackberry complex
<i>Rubus moluccanus</i>	Wild blackberry
<i>Sagittaria sagittifolia</i>	Arrowhead
<i>Salsola vermiculata</i>	Wormleaf salsola
<i>Salvinia auriculata</i>	Giant salvinia
<i>Salvinia biboba</i>	Giant salvinia
<i>Salvinia herzogii</i>	Giant salvinia
<i>Salvinia molesta</i>	Giant salvinia
<i>Setaria pallidifusca</i>	Cattail grass
<i>Solanum tampicense</i>	Wetland nightshade
<i>Solanum torvum</i>	Turkeyberry
<i>Solanum viarum</i>	Tropical soda apple
<i>Sparganium erectum</i>	Exotic bur-reed
<i>Spermacoce alata</i>	Borrenria
<i>Striga Lour.</i>	Witchweed
<i>Tridax procumbens</i>	Coat buttons
<i>Urachloa panicoides</i>	Liverseed grass

Appendix F: Invasive Species Pathway Outline

This outline, adapted from the Invasive Species Pathways Report³, lists and groups the pathways of introduction for invasive species. The pathways identified fall into three categories: transportation, living industry, and miscellaneous. For the “Organisms Transported” entry in the outline, the organisms have been listed with the following letter codes to avoid repetition. Some organisms may have been missed and some of the organism categories may be lumped together.

Key to Organisms Transported

ai = aquatic invertebrates (and larval stages)	in = insects and similar invertebrates
adp = animal disease pathogens and parasites	inv = other invertebrates (not insects)
ap = aquatic plants	mbv = microbes, bacteria and viruses
av = aquatic plants	pdp = plant disease pathogens
di = dinoflagellates	ph = phytoplankton
dp = disease pathogens	ps = plants and seeds
gm = gypsy moth	si = snails and other invertebrates
hfo = hull fouling organisms	tv = terrestrial invertebrates (insects and other arthropods)
	v = vertebrates

(T) Transportation: All pathways related to the transportation of people and goods and the vehicles themselves. This category includes military travel. Subcategories include: modes of transportation, items used in the shipping process, travel/tourism/relocation, and airmail/Internet/overnight shipping companies.

T1 Modes of Transportation

- T1.1 Air: includes all methods of moving through the air
Examples: planes, helicopters, etc. (e.g., stowaways in wheel wells, cargo holds, and anywhere else)
Organisms transported: v (snakes and others), in, inv, ps, pdp
- T1.2 Water/Aquatic: includes all methods of moving through the water
Examples: recreational boats and other craft, semi-submersible dry-docks, can be large or small; includes industrial, tourism, recreational, law enforcement, and Coast Guard crafts
- T1.2.1 Ship ballast water and sediments and other things that hold water: sea chests, engines, etc.
Organisms transported: ai, ap, mbv, di, ph
- T1.2.2 Hull/Surface Fouling (i.e., recreational boats and vessels)
Organisms transported: hfo, other aquatic organisms when talking about slow moving platforms
- T1.2.3 Stowaways in holds, cabins, etc.
Organisms transported: v, inv, ps, pdp

³ Pathway Task Team, National Invasive Species Council, 2003.

- T1.2.4 Superstructures/Structures above water line
Organisms transported: inv (gypsy moths)
- T1.2.5 Transportation/Relocation of dredge spoil material
Organisms transported: ai, av, ap, adp, pdp
- T1.3 Land Terrestrial: includes all methods of moving across the ground
Organisms transported: ps, gm, si, in, v, adp, pdp
 - T1.3.1 Cars, buses, trucks, ATVs, trailers for recreational boats
 - T1.3.2 Trains, subways, metros, monorails
 - T1.3.3 Construction/Firefighting vehicles and equipment
 - T1.3.4 Hikers, hunters, anglers, horses, pets
- T2 Items used in the Shipping Process
 - T2.1 Containers: both exterior and interior
 - T2.2 Packing Materials
 - T2.2.1 Wood packing materials: wood pallets, wood crates
Organisms transported: ps, in, pdp, si
 - T2.2.2 Seaweed
Organisms transported: ai, av, adp, pdp
 - T2.2.3 Other Plant Materials
Organisms transported: ps, psp, in, si, v, adp
 - T2.2.4 Sand/Earth – sometimes used in archaeological shipments
Organisms transported: in, inv, ps
- T3 Mail/Internet/Overnight shipping
Organisms transported: ps, pdp, in, si, ai, av
- T4 Travel Tourism/Relocation
Organisms transported: ps, insect, sim inverts, dp
 - T4.1 Travelers: includes humans as vectors for disease
 - T4.2 Baggage/Gear: carry on and checked items
 - T4.3 Pets/Plants and Animals Transported for Entertainment: includes pets that are transported when one moves or travels, and animals transported for horse shows, sporting events, circuses, rodeos, plant or garden shows, etc.
 - T4.4 Travel Consumables: includes food in RVs, etc.
 - T4.5 Service Industries

(L) Living Industry: All pathways associated with living plants and animals or their by-products. Subcategories within this broad category include food pathways (market ready, for immediate consumption), nonfood animal pathways (transporting animals for other reasons), and the plant trade (aquatic and terrestrial).

- L1 Plant Pathways
 - L1.1 Plant Trade: aquatic and terrestrial
Examples: importation of plants and sites of deliberate introductions (botanical gardens, nurseries, landscaping facilities, research facilities, public and private plantings, and aquariums/water gardening facilities when talking about aquatics, etc.)
Organisms transported: ps, pdp, in, si, v, ai, av, adp
 - L1.1.1 Plant parts

- L1.1.1.1 Above-ground plant parts (cuttings, budwood)
 - L1.1.1.2 Below-ground plant parts (bulbs, culms, roots, tubers, etc.)
 - L1.3.1.3 Seeds and the seed trade
 - L1.3.1.4 Aquatic propagules
 - L1.1.2 Whole plants
 - L1.1.3 Plant organism "in trade," intentionally released (authorized and unauthorized) or escaped
 - L1.1.4 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L1.1.4.1 On or with plant or plant part (includes parasites and pathogens)
 - L1.1.4.2 In water, growing medium, or packing material
- L2 Food Pathways
- L2.1 Live Seafood: market ready – imported into and/or throughout the U.S. for immediate consumption
Organisms transported: ai, ap, av, di, ph, adp, pdp, la
 - L2.1.1 Food organism "in trade," intentionally released (authorized and unauthorized) or escaped
 - L2.1.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L2.1.2.1 On or in live seafood (includes parasites and pathogens)
 - L2.1.2.2 In water, food, packing material, substrate
 - L2.2 Other Live Food Animals: imported alive into and/or throughout the U.S.
Examples: livestock, game birds
Organisms transported: adp, in, mbv, tv, v
 - L2.2.1 Food organism "in trade," intentionally released (authorized and unauthorized) or escaped
 - L2.2.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L2.1.2.1 On or in live animals (includes parasites and pathogens)
 - L2.1.2.2 In water, food, growing medium, nesting or bedding
 - L2.3 Plants and Plant Parts as Food: imported into an/or throughout the U.S.
Examples: fruits, vegetables, nuts, roots, seeds, edible flowers, etc.
Organisms transported: ps, pdp, in, inv, v (frogs on plants, etc.)
 - L2.2.1 Food organism "in trade," intentionally released (authorized and unauthorized) or escaped
 - L2.2.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L2.1.2.1 On or in live animals (includes parasites and pathogens)
 - L2.1.2.2 In water, food, growing medium, nesting or bedding
- L3 Non-Food Animal Pathways
- L3.1 Bait Industry
Examples: anything used as bait for fishing, etc.
Organisms transported: ai, ap, av, di, ph, adp, pdp, la
 - L3.1.1 Bait organisms "in trade," intentionally released (authorized and unauthorized) or escaped

- L3.1.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L3.1.2.1 On or with bait (includes parasites and pathogens)
 - L3.1.2.2 In water, food, growing medium, nesting or bedding
- L3.2 Pet/Aquarium trade: includes the organisms and their facilities
Examples: dogs, cats, birds, reptiles, exotic mammals, fish, other aquarium stock, invertebrates (tarantulas, scorpions, etc.)
Organisms transported: almost anything is possible
 - L3.2.1 Pet organism "in trade," intentionally released (authorized or unauthorized) or escaped
 - L3.3.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L3.3.2.1 On or in pet organism (includes parasites and pathogens)
 - L3.3.2.2 In water, food, growing medium, nesting or bedding, aquarium substrates
- L3.3 Aquaculture: includes the sites where organisms are raised, the raising of the organisms, and their movement, unless classified as live seafood; if an organism usually classified as live seafood is being transported for reproduction purpose or other reasons, it falls under aquaculture
Examples: fish, shellfish, shrimp and other invertebrates
Organisms transported: when including larval stages of animals, almost any aquatic plant or animal is possible, with the exception of marine mammals
 - L3.3.1 Aquacultured organism "in trade," intentionally released (authorized or unauthorized) or escaped
 - L3.3.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L3.3.2.1 On or in cultured organism (includes parasites and pathogens)
 - L3.3.2.2 In water, food, growing medium, nesting or bedding
- L3.4 Non-Pet Animals
Examples: importation of animals for non-food livestock (hunt clubs, breeding, racing, work animals), research, harvesting fur/wool/hair, entertainment and their sites of deliberate introduction (zoos, public aquaria, ranches, rodeos, lab facilities, etc.)
Organisms transported: adp, in, mbv, tv, v
 - L3.4.1 Non-pet organism "in trade," intentionally released (authorized or unauthorized) or escaped
 - L3.4.2 Hitchhikers: includes plants, animals, invertebrates, parasites, diseases, and pathogens
 - L3.4.2.1 On or with non-pet organism (includes parasites and pathogens)
 - L3.4.2.2 In water, food, growing medium, nesting or bedding

(M) Miscellaneous: Pathways that did not fit under the other two categories. Subcategories include other aquatic pathways, ecosystem disturbance, other nonliving animal- and plant-related pathways and natural spread of established populations of invasive species.

M1 Other Animal and Plant Related Pathways

M1.1 Minimally Processed Animal Products

Examples: hides, trophies, feathers

Organisms transported: adp, in, inv

- M1.2 Minimally Processed Plant Products
Examples: logs, firewood, chips, mulch, straw, baskets, sod, potting soils, etc.
Organisms transported: in, inv, ps, pdp, si, v
- M1.3 Meat Processing Waste
Organisms transported: adp
- M2 Other Aquatic Pathways
Organisms transported: ai, av, ap, adp, pdp
 - M2.1 Interconnected Waterways
 - M2.1.1 Freshwater canals
 - M2.1.2 Marine/estuarine canals
 - M2.1.3 Domestic waste streams
 - M2.2 Interbasin Transfers
- M3 Natural Spread of Established Populations
Examples: natural migration, movement and spread of established populations, ocean currents, wind patterns, unusual weather events, spread by migratory waterfowl, etc.
Organisms transported: this category contains all invasive species
- M4 Ecosystem Disturbance
 - M4.1 Long-Term Disturbances that Facilitate Introduction
Examples: highway, railroad, and utility rights-of-way; land clearing, logging, development, damming, stream channelization
Organisms transported: ps, pdp, in, inv, v
 - M4.2 Short Term Disturbances that Facilitate Introduction
Examples: habitat restoration, enhancement, creation; forestry; post fire treatments (BAER – Burned Area Emergency Response)
Organisms transported: ps, pdp, in, inv, v

Draft 1/16/09

Appendix G: Public Comments

Appendix H: Members of the Georgia Invasive Species Advisory Committee

Chuck Barger

University of Georgia
Warnell School of Forestry and Natural Resources
P.O. Box 748
Tifton, GA 31793

Carter Black

Georgia Department of Agriculture
19 Martin Luther King Jr. Dr.
Room 106
Atlanta, GA 30334

Jim Candler

Georgia Power Company
5131 Maner Rd.
Smyrna, GA 30080

Keith Douce

University of Georgia
College of Agricultural and Environmental Sciences
P.O. Box 748
Tifton, GA 31793

Mike Evans

Georgia Department of Agriculture
Plant Protection Division
19 MLK Jr. Dr. SW, Room 243
Atlanta, GA 30334

Tom Greene

The Nature Conservancy
1330 W. Peachtree St., Suite 410
Atlanta, GA 30309

Bill Kauffman

USDA APHIS-PPQ
1498 Klondike Rd., Suite 200
Conyers, GA 30094

Rick Barnes

Georgia Green Industry Association
1270-A Turner Rd.
Lilburn, GA 30047

Gary Burtle

University of Georgia
CAES Aquaculture Unit
P.O. Box 748
Tifton, GA 31793

Ron Carroll

University of Georgia
The Eugene Odum School of Ecology
Athens, GA 30602

Brent Dykes

Georgia Soil & Water Conservation Commission
State Headquarters
4310 Lexington Rd.
Athens, GA 30603

Connie Gray

Georgia Exotic Pest Plant Council
3681 Waterford Place
Clarkston, GA 30021

James Johnson

Georgia Forestry Commission
1055 Whitehall Rd.
Athens, GA 30605

Rosmarie Kelly

Georgia Department of Human Resources
Division of Public Health
2 Peachtree St. SW, Suite 14-204
Atlanta, GA 30303-3186

Draft 1/16/09

Jim Long

National Park Service
Regional Office
1978 Island Ford Pkwy
Atlanta, GA 30350

Greg McFall

Gray's Reef National Marine Sanctuary
10 Ocean Science Circle
Savannah, GA 31411

David Moorhead

University of Georgia
Warnell School of Forestry and Natural Resources
P.O. Box 748
Tifton, GA 31793

Elaine Nash

Georgia Native Plant Society
3390 Hwy. 20, SE
Conyers, GA 30013

James Sykes

U.S. Army Corps of Engineers
4144 Russell Dam Dr.
Elberton, GA 30635

John Taylor

USDA Forest Service
Forest Health Protection, Southern Region
1720 Peachtree Rd. NW, Suite 862 S
Atlanta, GA 30309

Sandy Tucker

U.S. Fish & Wildlife Service
Ecological Services Field Office
105 Westpark Dr., Suite D
Athens, GA 30606

Gary Wade

University of Georgia
Department of Horticulture
221 Hoke Smith Annex
Athens, GA 30602

Tim Lowrimore

Georgia Forestry Association
P.O. Box 1217
Forsyth, GA 31029

Hope Moorer

Georgia Ports Authority
Corporate Headquarters
P.O. Box 2406
Savannah, GA 31402

Kim Morris-Zarneke

Georgia Aquarium
Education Department
225 Baker St.
Atlanta, GA 30313

Alan Power

UGA Marine Extension Service
Shellfish Research Laboratory
20 Ocean Science Circle
Savannah, GA 31411

Terry Tatum

Georgia Wildlife Federation
11600 Hazelbrand Rd.
Covington, GA 30014

Jay Troxel

U.S. Fish & Wildlife Service
Region 4 Office
1875 Century Boulevard, Suite 250
Atlanta, GA 30345

Dhaval Vyas

Georgia Department of Transportation
Office of Environment/Location
3993 Aviation Circle
Atlanta, GA 30336

Keith Wooster

Natural Resources Conservation Service
355 East Hancock Ave.
Athens, GA 30601