

Invasive Species

# Statewide Invasive Species

## Strategic Plan for Florida 2002



INVASIVE SPECIES WORKING GROUP

# Invasive Species Working Group

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# Executive Summary

Most of Florida has a climate similar to that of the Neotropics with an absence of yearly hard freezes and exhibits a disturbed and diverse patchwork of agricultural, environmental, and urban habitats. The southern third of Florida is a peninsula and a habitat island, bounded on three sides by water and fourth by frost, and it is typified, as oceanic islands, by an impoverished native flora and fauna that makes it particularly prone to nonindigenous species invasions. Florida also has many lakes, streams, and rivers that can facilitate the easy spread of invasive species throughout the state. During the past 400 years, Florida has been invaded with periodic influxes of mostly tropical and subtropical nonindigenous plants and animals. These influxes of introductions increased during the twentieth century with the rise of the ornamental plant and pet industries and through the unintentional contaminants of imported commodities. Today, the Port of Miami receives 85% of the live nonindigenous plant shipments that arrive each year in the United States.

Fortunately, few of the thousands of species that have been introduced into Florida have become invasive. And not all nonindigenous species are harmful to agriculture and the environment and they are essential to many Florida industries and provide positive economic benefits. But even a few invasive species can have a large negative economic impact in Florida. Two Mediterranean fruit fly infestations in Florida cost federal and state taxpayers nearly \$50 million to eradicate. Equine prioplasmosis, a parasitic disease transmitted by ticks, along with Heartwater and other lesser-known animal and plant maladies, have already cost the taxpayers more than \$400 million to address. In south Florida alone, state and federal agricultural agencies are conducting a multi-year (more than \$300 million already spent) effort to stop reintroduced Asian citrus canker from spreading to central Florida by cutting thousands of citrus trees on private property. In the natural environment, more than \$240 million has been spent in Florida by state, federal, and local agencies since 1980 to control invasive nonindigenous aquatic, wetland, and upland plants on publicly owned waterways and conservation lands.

In fiscal year 1999-2000, a total of \$90.8 million was spent by nine Florida state agencies. The Florida Department of Agriculture and Consumer Services spent the most (\$45.9 million) for prevention, monitoring, eradication, control, and restoration efforts.

Florida is at high risk for the introduction of new invasive nonindigenous species because of the state's strategic southeastern-most location and is expected to act as one of the nation's sentinels against these invasive species. Yet, federal and state systems in place to intercept, eradicate, or contain these invaders have not kept pace with the influx of non-native agricultural pests (including diseases) along with environmental invaders arriving each year in Florida. The costs associated with harmful invasive species are expected to grow with increasing world trade and the introduction of new invasive species.

Any effective statewide strategy for preventing and managing invasive species must first consider that these invading species are not limited by legislative and professional boundaries, geography, or even individual programs. A growing number of scientists, resource managers, and agricultural officials recognize that a statewide invasive species strategic plan could provide a framework for coordinating state agency prevention and management efforts in Florida while facilitating cooperation with local and federal agencies. In order to develop and implement a Statewide Invasive Species Strategic Plan for Florida, the Invasive Species Working Group (ISWG) was formed in 2001. The ISWG is comprised of thirteen representatives from nine state agencies and one university. The ISWG also recognizes that the successful implementation of this plan necessitates the involvement of individuals, organizations, and businesses involved with direct though sometimes conflicting interests in nonindigenous species.

The Statewide Invasive Species Strategic Plan for Florida recommends a total of eighteen general action items that improve statewide coordination and cooperation, prevention of new biological invasions, surveillance, rapid response, control and management, and public education about invasive species. In addition, individual state agencies and one university nonindigenous species efforts are described within this plan

along with specific findings for each of their existing programs. The strategic plan also recognizes the need to help private landowners in preventing, controlling, and managing invasive species. The following are critical actions planned along with their recommended completion dates:

### **January 2003**

The Invasive Species Working Group (ISWG) will develop a Memorandum of Understanding (MOU) for presentation to state agencies involved in invasive species prevention, eradication, research, and control by January 2003.

The ISWG will provide recommendations to agencies to implement a coordinated public awareness campaign about the impact of invasive nonindigenous species on Florida's agriculture and environment and disseminate information on statutes and rules pertaining to these species by January 2003.

### **July 2003**

By July 2003, each state agency that is a party to the MOU and a member of the ISWG will conduct an evaluation of its current statutes and rules relevant to invasive nonindigenous species.

Starting in July 2003, the ISWG will review and evaluate the status of invasive species reporting.

Each member of the ISWG will work with its own agency information technology staff to provide links among existing invasive species websites and databases by July 2003.

State agencies will encourage federal agencies to cooperate in the development and implementation of Pest Risk Management Committee partnerships at all significant ports of entry in Florida by July 2003.

The ISWG will identify known invasive species problems in Florida and recommend management actions to federal, state, and local governments, private landowners and others by July 2003.

State agencies will identify information, staff, research, and budget needs to improve invasive species management in Florida by July 2003.

### **January 2004**

ISWG will evaluate current surveillance programs and make recommendations to improve prevention and detection efforts by January 2004.

Beginning in January 2004, the ISWG will recommend rapid response procedures appropriate for new discoveries of invasive nonindigenous species. Coordination with federal and local agencies and non-governmental organizations will be implemented where appropriate.

State agencies will develop or revise invasive species management plans to achieve cost-effective management efforts of invasive species by January 2004.

The ISWG will evaluate potential incentive programs or assistance for private landowners and make recommendations to the Florida Legislature to establish incentive programs or assistance to private landowners for the control of invasive nonindigenous species on private lands by January 2004.

### **July 2004**

ISWG will review and make recommendations regarding an inter-agency information support network and database for invasive species by July 2004.

The ISWG will review established procedures for fair and feasible multiple levels of risk assessments for evaluating first time introduced nonindigenous species by July 2004.

The ISWG will review agency invasive species procedures and make recommendations, where appropriate, to coordinate species management plans across agencies by July 2004.

## Glossary of Acronyms

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<b>APHIS</b>	Animal and Plant Health Inspection Service (USDA)
<b>CFA</b>	Cooperative Forestry Assistance program
<b>AQUA</b>	Division of Aquaculture (FDACS)
<b>DAI</b>	Division of Animal Industry (FDACS)
<b>DOF</b>	Division of Forestry (FDACS)
<b>DPI</b>	Division of Plant Industry (FDACS)
<b>EADAU</b>	Emerging Animal Disease Assessment Unit (FDACS-DAI)
<b>EPA</b>	United States Environmental Protection Agency
<b>EPPC</b>	Florida Exotic Pest Plant Council
<b>FBI</b>	Federal Bureau of Investigation
<b>FAS</b>	Department of Fisheries and Aquatic Sciences (Univ. of Florida)
<b>FDACS</b>	Florida Department of Agriculture and Consumer Services
<b>FDEP</b>	Florida Department of Environmental Protection
<b>FDOT</b>	Florida Department of Transportation
<b>FWC</b>	Florida Fish and Wildlife Conservation Commission
<b>GFC</b>	Game and Freshwater Fish Commission, now the FWC
<b>IFAS</b>	Institute of Food and Agricultural Sciences (Univ. of Florida)
<b>IPPC</b>	International Plant Protection Convention
<b>ISWG</b>	Invasive Species Working Group
<b>NFWFMD</b>	Northwest Florida Water Management District
<b>SFWMD</b>	South Florida Water Management District
<b>SJRWMD</b>	St. Johns River Water Management District
<b>SRWMD</b>	Suwannee River Water Management District
<b>SWFWMD</b>	Southwest Florida Water Management District
<b>USDA</b>	United States Department of Agriculture
<b>WMD</b>	Water Management Districts

# Glossary of Terms

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**Control and Management**– means eradicating, containing, suppressing spread, reducing population size, or reducing the effects of invasive species and preventing new invasions in Florida.

**Introduction** – means the intentional or unintentional escape, release, dissemination, or placement of a species into a Florida ecosystem as a result of human activity.

**Invasive species** – means a nonindigenous species that has the ability to establish self-sustaining, expanding, free-living populations, and may cause economic and/or environmental harm as measured by risk assessment(s) accepted by the Invasive Species Working Group (ISWG).

**Native species** – means a species within its natural range or natural zone of dispersal, i.e., within the range it could or would occupy without direct or indirect introduction and/or care by humans. It excludes species descended from domesticated ancestors.

**Nonindigenous species (synonyms: exotic or non-native species)** - means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, which is not native to Florida.

**Pathways** - natural and human connections that allow movement of species or their reproductive propagules from place to place.

**Risk assessment** – a science based process to evaluate the economic and/or environmental risk(s) of nonindigenous species.

**Stakeholders** – means any and all interested parties.

# Introduction

The movement of plants, animals, and microbes beyond their natural range is much like a “game of biological roulette” (U.S. Congress, 1993). Once in a new environment, an organism may simply die or it may become established and reproduce with little noticeable effects on its surroundings (Simberloff, 1997). But sometimes, a new species becomes invasive, and it spreads unimpeded and causes great environmental and/or economic harm.

Florida is particularly prone to nonindigenous species invasions (Simberloff, 1997). Most of Florida has a climate similar to that of the Neotropics with an absence of yearly hard freezes and exhibits a disturbed and diverse patchwork of agricultural, environmental, and urban habitats. The southern third of Florida is a peninsula and a habitat island, bounded on three sides by water and the fourth by frost, and it is typified, as are oceanic islands, by an impoverished native flora and fauna. Florida also has many lakes, streams, and rivers that can facilitate the easy spread of invasive species. These characteristics make Florida an epicenter for biological invasions (Simberloff, 1997), a process that dates back to early commerce between the City of St. Augustine and South America (Schmitz et al., 1993). During the past 400 years, Florida has been invaded with periodic influxes of mostly tropical and subtropical nonindigenous plants and animals. These influxes of introductions increased during the twentieth century with the rise of the ornamental plant and pet industries and through unintentional contaminants of imported commodities. Today, the Port of Miami receives 85% of the live nonindigenous plant shipments that arrive each year in the United States (U.S. Congress, 1993).

Fortunately, few of the thousands of species that have been introduced into Florida have become invasive. For example, approximately 25,000 nonindigenous plant species have been introduced into the United States with 1,180 of these species becoming established in Florida and thriving outside of human cultivation (Wunderlin, 1997). Sixty-nine of these are considered by the Florida Exotic Pest Plant Council to be altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with native species; another fifty-six have increased in abundance or frequency but are not yet known to be harmful (Florida Exotic Pest Plant Council, 2001). But even a few invasive species can have a large economic impact in Florida. More than \$240 million has been spent in Florida by state, federal, and local agencies since 1980 to control invasive nonindigenous aquatic, wetland, and upland plants on publicly owned waterways and conservation lands (Bureau of Invasive Plant Management, 2001).

In Florida, there has been no comprehensive statewide measurement of the direct and indirect economic costs associated with the majority of harmful invasive species. However, there are indications that invasive species have a significant economic impact. A recent report prepared by Florida scientists and agricultural officials estimates that the annual impact of invasive nonindigenous plants, animal pests, and diseases are costing sales losses of \$179 million in agricultural production (Pest Exclusion Advisory Committee, 2001). According to information compiled by the Florida Governor’s Office for the U.S. General Accounting Office Survey of States Regarding Expenditures for Invasive Species Activities for fiscal year 1999-2000, a total of \$90.8 million was spent by nine Florida state agencies. The Florida Department of Agriculture and Consumer Services spent the most (\$45.9 million) for prevention, monitoring, eradication, control and restoration efforts.





*Asian Citrus canker is a bacterial disease of citrus that causes premature leaf and fruit drop. It is highly contagious and can be rapidly spread by rain, lawnmowers, animals and birds, moving infected plants, and people. Citrus canker is one of the most destructive bacterial diseases impacting citrus. There is no known chemical compound that will destroy the bacteria within the plant tissue.*

landowners need help in preventing, controlling, and managing them. These costs associated with harmful invasive species are expected to grow with increasing world trade and the introduction of new invasive species (Schmitz and Simberloff, 1997).

## Florida is at high risk for new invasions

Florida is at high risk for the introduction of new invasive nonindigenous species because of the state's strategic southeastern-most location.

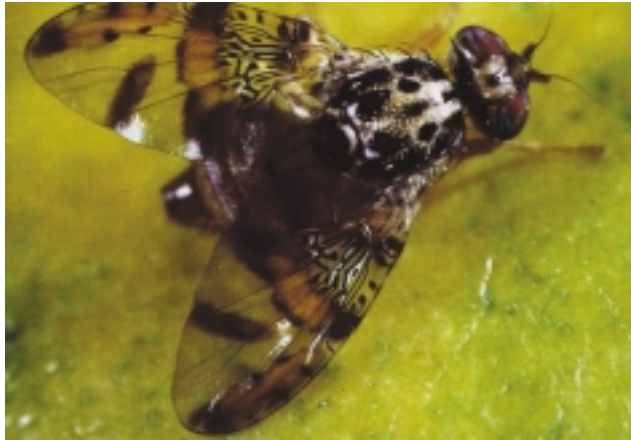
Florida, as with other states with ports and complex transportation systems, is expected to act as one of the nation's sentinels against these invasive species (Pest Exclusion Advisory Committee, 2001). Yet, federal and state systems in place to intercept, eradicate, or contain these invaders have not kept pace with the influx of non-native agricultural pests (including diseases) along with environmental invaders arriving each year in Florida. The frequency at which nonindigenous organisms entered Florida via the plant and animal material brought in by tourists, smugglers, and cargo substantially grew during the 1990s (Pest Exclusion Advisory Committee, 2001). The number of tourists entering Florida in the last ten years grew 20 percent, approaching nearly 50 million people yearly. Perishable cargo nearly tripled to more than 6 million tons. Mail deliveries and smuggling operations that avoid official inspections also grew exponentially. However, the resources needed to regulate these activities are nearly unchanged (Pest Exclusion Advisory Committee, 2001).

As a consequence, two Mediterranean fruit fly infestations in Florida cost federal and state taxpayers nearly \$50 million to eradicate (Pest Exclusion Advisory Committee, 2001). The tick-borne Heartwater disease, an outbreak of which could kill 50-90 percent of Florida's cattle, other ruminant livestock, and the state's native deer population, is as close as the Caribbean islands (Pest Exclusion Advisory Committee, 2001).

In south Florida alone, state and federal agricultural agencies are conducting a multi-year (more than \$300-million dollars have already been spent) effort to stop reintroduced citrus canker from spreading to central Florida by cutting thousands of citrus trees on private property (Schmitz and Simberloff, 2001). Many of Florida's private lands are impacted by invasive nonindigenous species and interfere with the use of these lands. They also act as sources of invasive nonindigenous species that invade public conservation lands and Florida's agricultural areas. These private



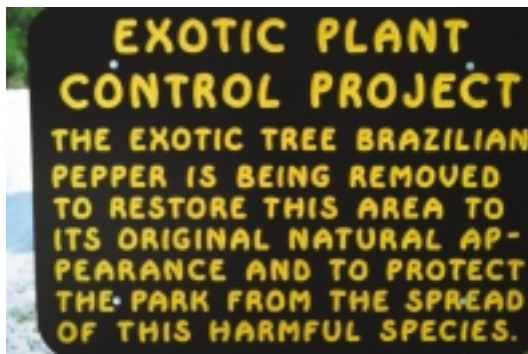
*In order to eradicate citrus canker, infected and exposed trees must be cut down and disposed of. As of July, 2002, more than 600,000 residential citrus trees and 1.6 million grove citrus trees have been destroyed to remove the threat of citrus canker from Florida.*



*The Mediterranean fruit fly is one of the world's most destructive fruit pests. Its larvae develop and feed on most deciduous, subtropical, and tropical fruits and some vegetables. In this age of jet transportation, medflies can be easily transported from a distant part of the world into Florida.*

before they became noteworthy. For example, Brazilian pepper (*Schinus terebinthifolius*), introduced during the nineteenth century, started becoming noticeable on the south Florida landscape only in the early 1960s. Although long time lags between introduction and observed rapid population expansion might be related to other factors, such as unnoticed growth, some sites act as staging areas from which nonindigenous species shower the surrounding landscape with seeds, and populations may eventually produce genetic variants adapted to local conditions (Ewel, 1986).

Nine state agencies have responsibilities for invasive nonindigenous species including their prevention, detection, control, and monitoring as well as restoration of invaded habitats and agricultural areas (Table 1). Three state agencies (FDEP, FDACS, and FWC) have regulatory authority over invasive



*Today, there are extensive projects in south and central Florida to remove Brazilian pepper from federal, state, and local public lands.*

Equine piroplasmiasis, a parasitic disease also transmitted by ticks, along with Heartwater and other lesser-known animal and plant maladies, have already cost the taxpayers more than \$400 million to address (Pest Exclusion Advisory Committee, 2001).

In addition to new introductions that may become invasive, species that have already been introduced but are not especially invasive may also become problematic in the future (Schmitz et al. 1997). Many of Florida's most widespread nonindigenous plant species were introduced long



*To find and eradicate medflies before they become established, Florida Department of Agriculture and Consumer Personnel monitor special insect traps located throughout central and south Florida for medflies.*

nonindigenous species. Historically, policies held by some of these agencies occasionally conflicted. Presently, there are no comprehensive mechanisms to coordinate prevention and management activities among the responsible agencies.

Agency	Operations	Research/ Development	Outreach Efforts	Information Management
FDEP <sup>1</sup>	I,P,D,C,M,R	Yes	Yes	Yes
FWC <sup>2</sup>	I,P,D,C,M,R	Yes	Yes	Yes
FDACS <sup>3</sup>	I,P,D,C,M,R	Yes	Yes	Yes
FDOT <sup>4</sup>	D,C,M,R	Yes	Yes	No
NFWFMD <sup>5</sup>	D,C,M	Yes	Yes	Yes
SWFWMD <sup>6</sup>	D,C,M,R	Yes	Yes	Yes
SFWMD <sup>7</sup>	D,C,M,R	Yes	Yes	Yes
SJRWMD <sup>8</sup>	P,D,C,M,R	Yes	Yes	Yes
SRWMD <sup>9</sup>	D,C,M	Yes	Yes	Yes

**Table 1. State agencies with jurisdictional responsibilities for invasive species in Florida. Operations indicate: I-importation regulatory program, P-prevention, D-detection, C-control, M-monitoring, and R-restoration efforts.**

<sup>1</sup> Florida Department of Environmental Protection

<sup>2</sup> Florida Fish and Wildlife Conservation Commission

<sup>3</sup> Florida Department of Agriculture and Consumer Services

<sup>4</sup> Florida Department of Transportation

<sup>5</sup> Northwest Florida Water Management District

<sup>6</sup> Southwest Florida Water Management District

<sup>7</sup> South Florida Water Management District

<sup>8</sup> St. Johns River Water Management District

<sup>9</sup> Suwannee River Water Management District

## Not all nonindigenous species are invasive or harmful in Florida

It should be noted that not all nonindigenous species are harmful to agriculture and the environment, and they are essential to many Florida industries. Many nonindigenous species provide economic, recreational, and social benefits. Florida's citizens, as well as agriculture and other industries, benefit from nonindigenous species that are produced and appreciated as pets, food, raw materials for soft and hard goods, and hunting and



Florida's aquarium industry has been culturing a wide variety of valuable and ecologically benign species since the 1920s.  
(photos by Harry Grier)

fishing resources, or used to mitigate environmental damage. Very few of Florida's agronomic crops (vegetables, horticulture, fruit, livestock, tropical fish, and others) valued in excess of \$55 billion per year are native species.

Simberloff et al. (1997) reported that the ecological effects of Florida's nonindigenous species found in the natural environment vary enormously. Of all the taxa introduced into the state, nonindigenous plants are currently having the greatest environmental impact (Simberloff et al., 1997). For other introduced taxa, the documented effects are few. For example, in other parts of the United States, nonindigenous fishes have often played a key role in the endangerment or extinction of native fish species. In





*Feral pigs are more destructive to natural habitats than any other nonindigenous Florida mammal. However, they also provide an important part of the diet of the endangered Florida panther.*

Florida, Shaffland (1996) reported that fishes introduced into Florida have had few, if any, negative effects on native fish fauna and an important sport fishery has been established using the nonindigenous butterfly peacock bass. And recent data from eight quantitative fish surveys conducted in South Florida (Trexler, 2000) provide little evidence of ecological effects of introduced fish species in the central or northern Everglades wet-prairie communities. On the other hand, because south Florida lacks native specialized fish species, the kind that are most susceptible for endangerment or

extinction, Trexler et al. (2000) warn this ability for native fish species to cope with more than 50 introductions of nonindigenous fish species and the profound environmental alterations that characterize this region is no guarantee they will not be affected by further introductions of nonindigenous fish species.

Another example is the nonindigenous feral pig. Feral pigs, through their rooting, have a more destructive impact on natural habitats than any other nonindigenous Florida mammal (Layne, 1997). However, they, along with the armadillo, now comprise an important part of the diet of the endangered Florida panther. Maehr et al. (1990) report that feral pigs and armadillos make up from 63.3% of the biomass consumed to as little as 33% in more southern areas, but deer are the most significant food because of their cosmopolitan distribution. Dalrymple and Bass (1996) rate feral pig and armadillo consumption even lower: 29% biomass combined versus 36% for deer. Maehr suspects that deer populations are sufficient to support existing Florida panthers without the addition of nonindigenous feral pigs (Maehr, personal communication, 2001). And, there are those who have even suggested that the feral pig is an impediment to panther range expansion because it harbors pseudorabies, a disease that once proved fatal to a panther in the heart of its range in southern Hendry County (Glass et al., 1994).

Clear agricultural and environmental benefits of nonindigenous species are those that are used for biological control of invasive species. Frank and McCoy (1993) report the release of 151 insect species in Florida since 1890 for use against insects and weeds. About 28% of these agents became established. Thirty-four were released against insect pests of agriculture and horticulture, the other eight against aquatic weeds (Frank and McCoy, 1993). Some have been very successful in controlling unwanted invaders. For example, Alligatorweed, once a severe problem in Florida, is now suppressed by a nonindigenous flea beetle (Center et al., 1997).



*Damage by the alligator flea beetle to the South American alligator weed in Florida.*

A major challenge for government agencies in Florida will be to accurately assess all the costs and benefits associated with each nonindigenous species, and to find ways to minimize the costs while maintaining the benefits.

# Statewide Invasive Species Strategic Plan for Florida

## How a statewide invasive species strategic plan can help

The need for coordinated multi-agency planning and programs for preventing and controlling invasive nonindigenous species has been raised by several studies, such as the Office of Technology Assessment's report "Harmful Nonindigenous Species in the United States" (U.S. Congress, 1993), the Florida Department of Environmental Protection's report "An Assessment of Nonindigenous Species on Florida's Public Lands" (Schmitz and Brown, 1994), the National Invasive Species Council's "National Invasive Species Management Plan" (National Invasive Species Council, 2001)," the Florida Pest Exclusion Advisory Committee Report (Pest Exclusion Advisory Committee, 2001), and the South Florida Ecosystem Restoration Task Force and Working Group's report "An Assessment of Invasive Plants in Florida" (Doren and Ferriter, 2001). Any effective statewide strategy for preventing and managing invasive species must first consider that these invading species are not limited to legislative and professional boundaries, geography, or even individual programs. A growing number of scientists, resource managers, and agricultural officials recognize that a statewide invasive species strategic plan could provide a framework for coordinating state agency prevention and management efforts in Florida while facilitating cooperation with local and federal agencies. The successful implementation of this plan necessitates the involvement of individuals, organizations, and businesses involved with direct though sometimes conflicting interests in nonindigenous species.

Efforts to prevent new invasions and manage most invasions in Florida have proven to be inadequate despite some individual program successes. The exclusion and management of invasive nonindigenous species in Florida is a complex, multi-disciplinary problem that threatens Florida's agricultural resources and public conservation lands. A new paradigm must be developed in government that will encompass the multi-jurisdictional aspects of biological invasions in Florida and

reach out to obtain the cooperation of all stakeholders including private industry, private landowners, non-governmental organizations, and the public to lessen this threat.

The scope of this plan will encompass all harmful invasive species in Florida with the exception of those organisms that only cause human disease. The purpose of the plan is to provide a blueprint for state agency action to prevent the introduction of harmful invasive species, provide for their control, and minimize their economic, environmental, and other impacts. Many of the general action items in the plan were recommended by the reports listed above and can be completed or at least initiated with current available resources. The plan also recognizes that without significant and sustained resources for existing and new programs, the plan cannot be fully implemented in Florida. In addition, resources are needed for developing a multi-jurisdictional information-sharing network that will provide prevention, management, and public education about biological invasions in Florida to scientists, resource managers, policy-makers, students, and the public.

## The Invasive Species Working Group

The Florida Department of Environmental Protection undertook the responsibility of organizing and facilitating a July 10, 2001 meeting, at the request of the Governor (to be included with the final print copy in Appendix 1), to determine the most effective way of developing a comprehensive statewide plan that unifies and coordinates the responsibilities of government agencies to prevent and manage harmful biological invasions in Florida. The representatives from the state and federal agencies that attended the July 10 meeting recognized the need for a working group representing state agencies with responsibilities for invasive nonindigenous species to carry out the Governor's request of

developing a statewide invasive species strategic plan. In subsequent meetings, the Invasive Species Working Group (ISWG) was formed.

The ISWG is comprised of representatives from the following state agencies, state agency divisions, and university: Florida Department of Environmental Protection; Florida Department of Agriculture and Consumer Service's Divisions of Plant Industry, Animal Industry, Forestry, and Aquaculture; Florida Fish and Wildlife Conservation Commission; Florida Department of Transportation; Northwest Florida Water Management District; Southwest Florida Water Management District; South Florida Water Management District; St. Johns River Water Management District; Suwannee River Water Management District; and the University of Florida's Institute of Food and Agricultural Science.

## Statewide Coordination and Intergovernmental Cooperation

Coordination and cooperation among agencies are essential elements to the success of any invasive species prevention or management program. Because these elements are essential, a lack thereof creates many opportunities for the consensus on which such coordination and cooperation must be based to either break down at almost any stage in the process, or not even develop in the first place. Generally, coordination and cooperation fail over "turf" issues, environmental concerns about control activities, differing philosophies about an invading organism, funding issues, or limited information about the economic, agricultural, or environmental impacts of an invader. Developing a fair, balanced, and objective statewide invasive species plan in the face of frequently competing interests will be challenging, but this is the key to successful prevention and management operations in Florida.

## General Action Items

1. The Invasive Species Working Group (ISWG) will develop a Memorandum of Understanding (MOU) for presentation to state agencies involved in invasive species prevention, eradication, research, and control by January 2003. The purpose of the MOU is (a) to help integrate and coordinate

Florida-wide agency invasive species prevention, eradication, research, and control actions and help integrate them with national and international invasive species management efforts; and (b) to develop and outline procedures that will help resolve jurisdictional and other intrastate agency issues regarding invasive species programs.

2. By July 2003, each state agency that is a party to the MOU and a member of the ISWG will conduct an evaluation of its current statutes and rules relevant to invasive nonindigenous species. The purpose of this evaluation is to concur on potential legislation revisions to cover potential gaps or reduce duplication.
3. Starting in July 2003, the ISWG will review and evaluate the status of invasive species reporting. ISWG will work to develop a standardized reporting format, including a summary of fiscal year expenditures and agencies' suggested legislative budget requests for prevention, eradication, research, and control of invasive species.
4. Each member of the ISWG will work with its own agency information technology staff to provide links among existing invasive species websites and databases by July 2003. ISWG will review and make recommendations regarding an inter-agency information support network and database for invasive species by July 2004.
5. The final draft of the Statewide Invasive Species Management Plan will be sent to those federal agencies that have jurisdictional authority for preventing, regulating, eradicating, controlling, and researching invasive species in Florida for their responses to the state plan and will be attached in an appendix to this plan. After the Governor of Florida and the Florida Legislature accept the plan, representatives from those federal agencies will be invited to be non-voting members of the ISWG.

## Prevention of New Biological Invasions

Prevention activities can preclude the introduction and establishment of harmful invasive species and identify pathways that are serving as a means of introduction of new invasive species into Florida.

### General Action Items

1. The ISWG will review established procedures for fair and feasible multiple levels of risk assessments for evaluating first time introduced nonindigenous species by July 2004. The ISWG will identify gaps and make recommendations or assist in the establishment of new risk assessment procedures if they are warranted.
2. State agencies will encourage federal agencies to cooperate in the development and implementation of Pest Risk Management Committee partnerships at all significant ports of entry in Florida by July 2003. It is essential that local plant and animal quarantine officials who work in these facilities play a major role in these committees. Representatives from relevant agencies should be actively involved in the process.
3. State agencies will cooperate to conduct thorough pathway investigations in conjunction with relevant federal agencies and stakeholders when appropriate.

## Surveillance

Surveillance serves several purposes: it characterizes invasion patterns, detects new ones, suggests areas of new research, evaluates prevention and control programs, and projects future agricultural and resource management needs. Statewide surveillance requires adequate infrastructure, trained personnel within state agencies, and a network of scientific experts that are able to identify new invaders.

### General Action Item

1. ISWG will evaluate current surveillance programs and make recommendations to improve prevention and detection efforts by January 2004.

## Rapid Response

Rapidly responding to new invasions is crucial because some introduced invasive species can be eradicated if the invasion is recognized early enough and the eradication campaign is sufficiently well-designed, comprehensive, and adequately funded.

### General Action Item

1. Beginning in January 2004, the ISWG will recommend rapid response procedures appropriate for new discoveries of invasive nonindigenous species. Coordination with federal and local agencies and non-governmental organizations will be implemented where appropriate.

## Control and Management

When invasive species are permanently established or populations are too widespread for eradication and containment efforts, the only effective actions lessening their impacts are through control and management measures. Control and management efforts may include: population suppression through biological and chemical controls or other management activities, attempting to limit population dispersal, and maintaining an invasive species population at its lowest possible population density through aggressive control activities. Because the majority of biological invasions in Florida span jurisdictional boundary lines, control activities in Florida are often carried out by cooperating with federal and local government agencies. Sharing technical information, coordinating management priorities, and agency capacities across all affected agencies are crucial in developing cost-effective statewide control and management efforts.

### General Action Items

1. The ISWG will identify known invasive species problems in Florida and recommend management actions to federal, state, and local governments, private landowners and others by July 2003.
2. State agencies will identify information, staff, research, and budget needs to improve invasive species management in

Florida by July 2003. The ISWG will provide review and make recommendations to the agencies.

3. State agencies will develop or revise invasive species management plans to achieve cost-effective management efforts of invasive species by January 2004.
4. The ISWG will review agency invasive species procedures and make recommendations, where appropriate, to coordinate species management plans across agencies by July 2004.
5. The ISWG will evaluate potential incentive programs or assistance for private landowners and make recommendations to the Florida Legislature to establish incentive programs or assistance to private landowners for the control of invasive nonindigenous species on private lands by January 2004.
6. The ISWG will facilitate the dissemination of existing BMP (best management practices) for minimizing the human spread of invasive species.

## Public Education about Biological Invasions

Educating visitors, commercial importers, residents, and agricultural producers about the impacts of invasive nonindigenous species and the importance of keeping new invasive species out of Florida is a key component of a successful statewide invasive species prevention and management program.

### General Action Items

1. The ISWG will provide recommendations to agencies to implement a coordinated public awareness campaign about the impact of invasive nonindigenous species on Florida's agriculture and environment and disseminate information on statutes and rules pertaining to these species by January 2003. Existing interagency educational councils will be consulted for recommendations and coordination.
2. State agencies will make current publications available to interested parties by: (a) using existing resources on the web to provide information to the public on invasive species issues (see Statewide Coordination and Intergovernmental

Cooperation Section), and (b) creating a web-based list of invasive species publications currently available from agencies.

## Existing State Programs and Findings

### Florida Department of Environmental Protection (FDEP) Bureau of Invasive Plant Management

Florida has approximately 1.5 million acres of publicly accessible freshwater lakes and rivers. These public waterways provide wildlife habitat and more than \$1.5 billion in annual revenues to Florida from freshwater fishing and wildlife observation. In 1971, the Florida Legislature designated the Department of Environmental Protection (FDEP) as the lead agency for coordinating and funding aquatic plant management activities of government agencies and commercial companies on public waterbodies. This centralized approach has proven effective in that it established a statewide aquatic plant management and resource protection plan, ensured statewide priority distribution of available funds, reduced administration, coordinated management operations, avoided duplication, and ensured consistency in policy, goals, and control methods.

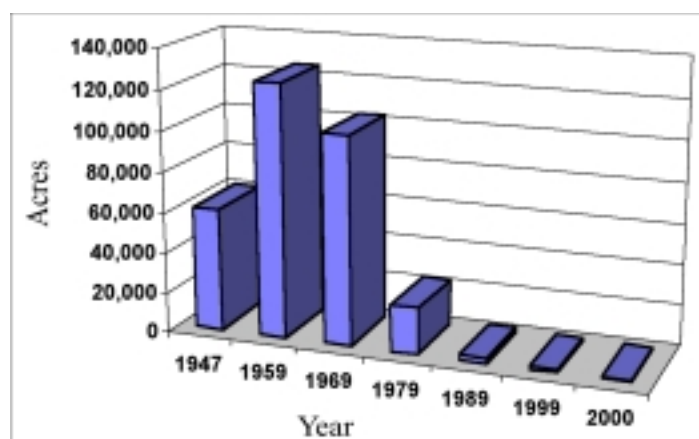


Figure 1. Acres of water hyacinth in Florida's public waterways from 1947 to 2000.

For example, when there was no statewide aquatic plant management plan, funding was inconsistent and invasive nonindigenous plant populations were out of control as recently as the early 1970s. Since this centralized approach has been implemented, water hyacinth has been reduced statewide from 120,000 acres in the late 1950s and early 1960s to less than 1,000 acres in 2000 (Figure 1).



Each year, staff from the Department of Environmental Protection survey 459 public waterbodies to determine the extent of invasive nonindigenous aquatic plant populations in Florida. This information is used to alert managers for rapid control measures to contain and eradicate new populations, to help develop management priorities to distribute state funds, and to evaluate



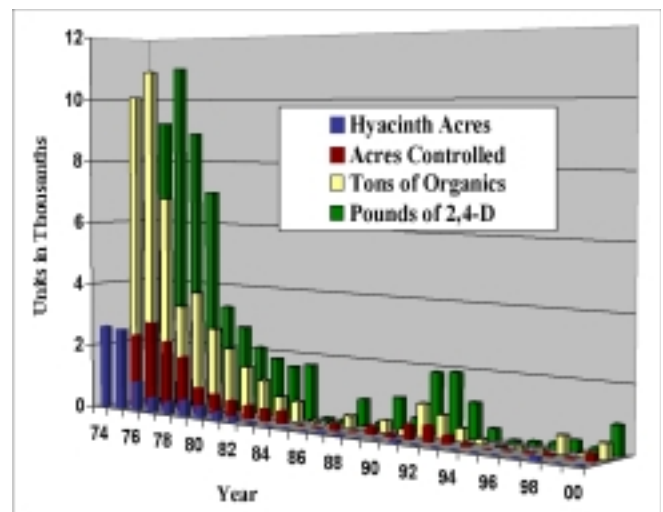
*Surfaced-out hydrilla in Wakulla Springs State Park, in North Florida. Hydrilla forms dense canopies in which 70 percent of the vegetative biomass is in the top 2 feet of the water. This type of growth reduces underwater light penetration, alters the amount of oxygen found in the water, and reduces water circulation. Beneath this canopy, extremely low levels of dissolved oxygen and significant changes in water chemistry are common.*

aquatic plant management programs for their overall effectiveness. In 2000, nonindigenous plant infestations were found in 408 (89%) of Florida's 459 public waterbodies. Eleven highly invasive nonindigenous species have been identified growing in Florida's waterways. Many of these infestations, especially canopy producers like water hyacinth and hydrilla, interfere with recreational use, cause severe oxygen depletion, stunt fish populations, cause fish kills, restrict water flow, increase flooding, restrict navigation, accelerate sedimentation, and reduce biodiversity in lakes and rivers.

Since 1974, Florida's overall aquatic plant management objectives have revolved around implementing the concept of "maintenance control," which was pioneered by the U.S. Army Corps of Engineers upon the completion of a massive water hyacinth control project in Florida during 1973. Maintenance control is defined as "a method for the control of nonindigenous plants in which control techniques are utilized in a coordinated manner on a continuous basis in order to maintain the plant population at the lowest feasible level." Previous to 1974, species like water hyacinth were allowed to reach problem levels before control measures were implemented. That strategy resulted in the death of large amounts of vegetation, which led to detrital loading. The only way to prevent such environmental disturbances and lower the amount of herbicides used associated with control operations was to prevent the targeted plant population from reaching a large size. For example, water hyacinth covered 2,300 acres of the Suwannee River in the early 1970s. Thousands of tons of sediments were produced by the

natural shedding of root and shoot material and from controlled plants. Hundreds of acres required control using thousands of pounds of herbicide. Crisis management was replaced by maintenance control efforts in the late 1970s. Since achieving maintenance control in 1985, the amount of control necessary has been substantially reduced thus lowering environmental and economic impacts. Native plants

have returned to the shores and marshes of the Suwannee River, restoring fish and wildlife habitat (Figure 2)



**Figure 2. Suwannee River water hyacinth population size, acres controlled, tons of organic material deposited within the river, and pounds of herbicides applied from 1974 to 2000.**

Aquatic plant management in Florida is a multidisciplinary effort in that chemistry, hydrology, biology, meteorology, and the multi-jurisdictional aspects all need to be considered before treatment operations begin. Individual aquatic plant management programs for all of Florida's public waterbodies are developed and/or revised each year. State biologists and government contractors prepare requests that are reviewed by local, state, and federal agency personnel that have jurisdictional authorities over affected waterbodies. These reviewers then meet annually to establish individual operational management plans and budgets. Past history has taught us that in order to successfully remove unwanted vegeta-

tion, managers must apply the appropriate control methods with the goal of preserving, restoring, or enhancing natural processes, and they must be flexible in assessing and revising management needs.

In 1996, the state formed a Task Force on Invasive Upland Plants that was comprised of federal, state, and local land management officials, along with private interest groups. A report was generated recommending four primary goals: raise awareness about the harm invasive nonindigenous plant species cause on public lands, develop and fund a program to remove these species, make the management of these species part of overall land management efforts in Florida, and develop strong partnerships among all agencies, universities, and private landowners for a coordinated approach for the management of these species. Legislation was passed in 1997 that authorized the state to expand its aquatic plant management program to include upland invasive nonindigenous plant species and bring these populations under maintenance control.

Perhaps the greatest difference between the statewide aquatic plant management program and the newer upland plant management program is the number of official jurisdictions involved within each program. In Florida, there are few on-site managers assigned to a specific waterbody because they are mostly interconnected waterways that are largely sovereign or owned by the state. Only a few state, federal, and local agencies have programs with jurisdictional responsibilities for managing invasive aquatic plants. Florida's aquatic plant control program funds the removal of invasive plants with six state agencies, four federal agencies, eleven counties, and one city. In contrast, there are diverse, distinct government agency land management responsibilities for public conservation lands and most have on-site managers to carry out these tasks. In addition, Florida's public conservation lands are increasing in their size and diversity because of an aggressive land buying effort during the past ten years to save critical wildlife habitat from development.

Another contrasting factor is the number of plant species that are managed within each program. In the aquatic environment, there are 11 invasive aquatic plant species where state funds are spent to remove them. In the upland environment, state funds target more than 125 invasive plant species making it more difficult and time

consuming to achieve management success. Many control methods are species-specific, and improper species identification or a lack of a suitable control method can lead to failure.

Because of these differences, the upland plant management program had to establish a mechanism to encompass this diversity of land ownership into a coherent strategy to map invasive plant population densities, prioritize funding needs, develop long-term management goals, and educate the public about why these species should be removed. To identify the extent of the problem and to form partnerships at the local level, eleven Regional Invasive Plant Working Groups were established covering the entire state (Figure 3).

Each working group has representatives from federal, state, county, city, and non-governmental organizations, and private landowners. These working groups have the responsibility to map the distribution of invasive upland nonindigenous plant species within their regions, set regional control priorities, develop long-term cause to public conservation lands.

The state relies on these working groups to appropriately direct funding toward their region's highest priorities. Because Florida's invasive plant populations vary in their distribution throughout Florida, with the southern portion of the state containing the largest population densities, each working group has flexibility to develop their own project ranking criteria for their region. Program liaisons have been designated for each working group to facilitate project proposal review and coordination with state program staff. Establishment of these regional working groups provides a foundation for maintaining partner-



**Figure 3.** Map showing the locations of FDEP's eleven Regional Invasive Plant Working Groups.

ships to integrate, coordinate, and fund efforts to remove invasive nonindigenous plant species from public lands, and on a voluntary basis, on private lands that may impact public lands. In order for invasive nonindigenous species removal projects to be eligible for state funds, there are several minimum requirements. Federal, state, and local government lands receiving state funds for invasive plant removal must be designated as public conservation land. In an effort to target the greatest number of the largest invasive plant populations for initial removal, the program requires that land management agencies continue maintenance control in perpetuity after the bulk of the plants are initially controlled from a project site. This insures that available state funding will not be tied to maintenance control costs on a limited number of public conservation lands. In addition, projects will be looked on more favorably for funding if cooperative cost share or matching funds are available; control technologies have been established for the targeted invasive plant species; the project will benefit specific threatened or endangered species; and the site has a high restoration potential. In 2000, the species with the most acres controlled were the Australian melaleuca tree and Brazilian pepper shrub under the FDEP upland plant management program (Table 2).



*A dense monospecific stand of Brazilian pepper in south Florida. Introduced into Florida during the 19th Century, Brazilian pepper, an evergreen shrub like tree, has invaded many habitats in central and south Florida. Local dispersal of its seeds (red berries) is primary by raccoons and opossums; long distant dispersal is facilitated by birds such as migratory American robins. This plant is the most widespread of all of Florida's invasive plant populations.*

**Table 2. Invasive plant acres controlled<sup>1</sup> for the top ten most invasive upland plant species found in Florida's conservation lands in 2000 along with their percent of total acres controlled for all upland plant species.**

Plant	Acres Controlled	% Total Acres
Melaleuca <sup>2</sup>	5827.68	34.28%
Brazilian pepper	3897.77	22.40%
Lygodium spp	2167.73	12.75%
Australian pine	1730.46	10.18%
Chinese tallow	1260.45	7.41%
Ardesia	824.59	4.85%
Wisteria	514.96	3.03%
Chinaberry	488.04	2.87%
Cogon grass	399.94	2.35%
Air potato	338.67	1.99%

<sup>1</sup>by estimated acres controlled and % of total project acres for all species

<sup>2</sup>does not include melaleuca acres controlled by SFWMD

Because over 410,000 of approximately 2 million acres of National Park Service lands in Florida are infested with invasive nonindigenous plant species, and act as seed sources for state public conservation lands, the state upland plant removal program began offering funding assistance to federal land managers. In 2000, the State of Florida developed a partnership with U.S. National Park Service in providing \$292,000 in matching funds for 12 invasive plant control projects. These matching funds provided cost-effective invasive plant control and benefited the park's services efforts to protect and reestablish native plant communities on federal lands. This state-federal matching fund program is expected to continue for the next several years.

FDEP's prevention efforts revolve around permitting

aquatic plant retail outlets and banning 26 nonindigenous plant species for most retail use and possession without a FDEP issued permit. However, present regulations for deterring the possession of prohibited plant species are lax and cumbersome to use. There are two prohibited state plant lists (FDEP's prohibited aquatic plant species and the Florida Department of Agriculture and Consumer Service's (FDACS) noxious weed list) with different criteria and listing processes. These two

separate weed lists have failed to provide for quick and effective listings of harmful species.

### Findings

- \* Civil instead of criminal penalties for violation of FDEP's rules governing the possession of prohibited aquatic plant species need to be implemented. These changes were initiated in the 2001 legislative session but a penalty schedule is still needed. FDEP should be able to levy a substantial fine for possession of prohibited plants. Additional changes to existing statutes and rules are needed to make it easier to confiscate prohibited plants held in violation of the rules and that authority needs to be del-

egated to the field staff level. These changes need to be implemented by July 2003.

- \* Legislation is needed to make it easier to place invasive plants that invade non-agricultural areas on a statewide prohibited plant list. Presently, FDEP must obtain FDACS and Florida Fish and Wildlife Conservation Commission (FWC) approval for placing a plant species on FDEP's list. Presently, the authority of regulating invasive plants is divided between FDACS and FDEP with no clear enforcement authority assigned to either agency.
- \* A cooperative agreement is needed between FDACS and FDEP to allow each agency to enforce each other's rules and statutes when it relates to prevention of harmful invasive plant species. FWC could also be added to this agreement.
- \* A prohibited plant species-working group should be established using staff from involved agencies that would meet to discuss new introductions or threats, and develop action plans for new infestations. Bureau staff is insufficient to adequately conduct inspections and research new potential invasive plant species. A designated research center and appropriate budget contributed to/shared by appropriate agencies to evaluate nonindigenous plant species potential invasiveness in Florida is needed.
- \* FDEP needs to develop better reporting, tracking, and rapid response of new plant invasions. All FDEP contracts with aquatic and upland plant removal contractors should be modified to allow for a rapid eradication program to be implemented and contractor services to be quickly utilized.

## Florida Department of Agriculture and Consumer Service (FDACS)

### Division of Plant Industry

The Division of Plant Industry has the state responsibility for detecting, intercepting, identifying, and controlling organisms, which directly or indirectly threaten Florida's agricultural, horticultural, and native plant resources. There are specific statutes and rules that provide for the regulation of plant pests, arthropods, noxious

weeds, genetically engineered plants or plant pest organisms, and biological control agents.

Historically, agriculture has been viewed as the primary beneficiary of the plant regulatory system. However, the economic benefits of protecting plant resources accrue broadly. Nationally, according to a General Accounting Office 1997 report, introduced invasive plant pests result in an estimated \$41 billion annually in production and in prevention and control expenses. On average, the State of Florida experiences the establishment of 12 new plant pest species each year. A ten-year high of 39 plant pests was established in FY 1996-97 (Figure 4).

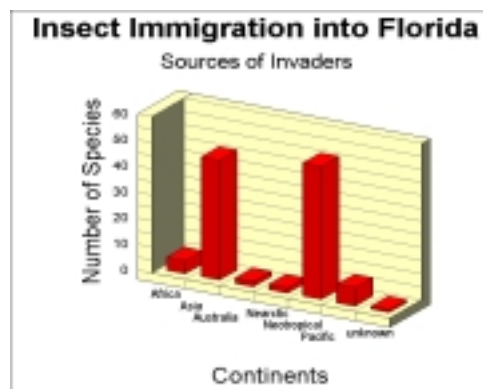
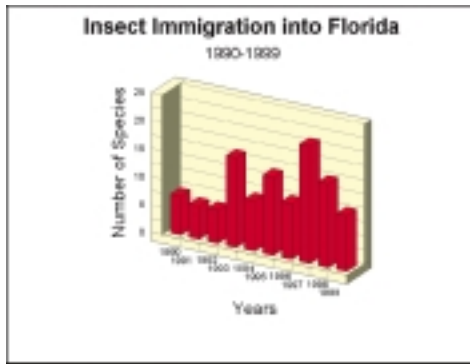


Figure 4. Graph showing insect species immigration into Florida from 1990 to 1999

A recent FDACS report, “The Exotic Invasion of Florida (2000),” states that nearly every month a new nonindigenous arthropod is detected in the state. Some turn out to be serious agricultural pests, such as Mediterranean and Oriental fruit flies, brown citrus aphid, citrus leaf miner, Asian citrus psyllid, and small hive beetle. Others, such as the bromeliad weevil and the cactus moth, attack native plants in natural areas. Many become established and their environmental impacts are unknown. In some cases, these pests or potential pests are effectively eradicated. Yet in many cases it is not biologically or economically feasible to eradicate them.

During the 1970s and 1980s, most of the nonindigenous insects introduced into Florida were from the Neotropical region—the tropical and subtropical areas in Central and South America and the Caribbean. But in the last 10 years the number of insects from Asia has increased until they now almost equal the number from the Neotropics. Trade with Asia, particularly with China, has substantially increased (Figure 5).





**Figure 5. Sources of insect immigration into Florida.**

Many manufactured goods are being produced in China and imported into the U.S. This has created yet another pathway for pest introduction. Wooden crates used for packing serve as sources of nonindigenous weevil and beetle introduction. Holiday crafts made with rice straw and other natural products have been found infested with pests. These “non-traditional” sources of plant and animal pest introduction have placed an additional burden on Florida’s safeguarding system.

Commercial smuggling, ever changing trade routes, and manufactured or processed products are just a few examples of the changing pathways for pest introduction into Florida. Likely there are more as-yet-undiscovered pathways that need to be addressed, particularly in regards to the interdiction of commercial smuggling.

The U.S. Department of Agriculture’s Animal and Plant Health Inspection Service (USDA-APHIS) and the Florida Department of Agriculture and Consumer Services (FDACS) are the primary federal and state agencies charged with protecting Florida’s animal and plant resources. Federal laws contain a number of separate acts that govern importation of plants, animals, and plant and animal products from other countries and interstate movement in accordance with federal plant or animal quarantine restrictions. The movement of these products into Florida from other states and their intrastate movement is governed by specific chapters in Florida Statutes and rules.

In addition to federal and state laws, various United Nations treaties govern international trade of agricultural



*The giant African snail is a serious agricultural pest. According to Simberloff (1997), in 1966, African snails were smuggled into Miami and were subsequently released into a subdivision. In 1969, the resulting infestation was brought to the attention of the Florida Department of Agriculture and Consumer Services. Within ten days, the Commissioner of Agriculture announced the snail was established and appealed for public cooperation in reporting and eliminating it. A total of 133 private properties were initially quarantined, but three subsequently discovered infestations led to the quarantine of 438 properties (about 42 blocks). Worse, within days a second infestation was discovered north in Hollywood (Broward County). An eradication campaign was mounted that used hand picking plus a granulated chemical compound. There were frequent, meticulous square-foot-by-square-foot surveys, and by 1971, only 46 snails were found during a six month period (compared to 17,000 in the previous 16 months). By April 1975, no live snails had been found for almost two years and the eradication campaign, which cost more than \$1 million was judged successful.*

products. One example is the International Plant Protection Convention (IPPC) that seeks to standardize entry requirements for plants and plant products using biological justification as a basis. The IPPC has developed guidelines for conducting scientifically based pest risk analysis, and USDA uses these analyses when making decisions regarding the importation of plant or plant products. Entry requirements vary depending on the commodity and the country of origin. In most cases, phytosanitary or animal health

certificates are required. The U.S. entry process permits the entry of plants and plant products without phytosanitary certification

preclearance programs in 29 countries for several types of fruit and flowering bulbs whereby the products are inspected by the

USDA prior to being exported to the U.S. USDA

does not have an established preclearance program for animals, but will travel to a country to inspect animals prior to shipment on a case-by-case basis. USDA monitors compliance with import requirements at U.S. ports of entry by verifying that the correct documents have accompanied the shipment and inspecting the shipment for pests or diseases. The USDA notifies FDACS of incoming shipments by mailing copies of the notice of imports. This enables FDACS to conduct a secondary, in-depth inspection at the



*The nonindigenous pink hibiscus mealybug attacks more than 125 plant species by feeding on the sap of a plant and releasing toxic substances that cause injury and death to the plant. It is spread by wind, by ants, or it can be stuck on clothing or hair.*

destination provided the shipment has not been dispersed to other locations.

Likewise, FDACS permits the entry of plants and animals from other states provided a certificate of inspection accompanies them. Plant products, such as fruits and vegetables, may need a certificate of inspection depending on the state of origin and the pest concerns. In the case of plants and plant products, a certificate of inspection does not necessarily mean the individual shipment was inspected; it may only mean the nursery or farm is under a routine inspection program for pests and diseases.

Anyone shipping agricultural products into Florida by truck is required to stop at the FDACS Agricultural Inspection Stations located on all roads crossing the Suwannee and St. Mary's Rivers. These stations verify certification status, reject non-enterable shipments, and notify the respective divisions of the shipment in case follow-up inspections are needed. In cases where there is a pest-concern, the truck may be returned to its origin or required to enter under seal, which can only be removed at its destination by an authorized FDACS representative.

## Findings

- \* A critical need exists for a comprehensive invasive plant pest detection system in the United States. An effective state and federal partnership is needed to establish pest detection priorities and clearly define action plans for coordination of pest detection activities at the state, regional, and national levels.
- \* Base funding is not adequate to respond to the increasing number of pest introductions occurring throughout the state.
- \* There is presently no standardized formula in place to identify the funding responsibilities or partnerships between agencies with respect to invasive species activities and their resulting financial obligations.
- \* Presently, there is no mechanism in place for identifying and determining the roll of stakeholders or primary beneficiaries.
- \* Presently, the authority of regulating invasive plants is divided between FDACS and FDEP with no clear enforce-

ment authority assigned to either agency.

- \* A coordinated plan should be developed and implemented to integrate Florida's efforts with the various databases on invasive species not known to occur in the U.S. with those of other organizations, both nationally and internationally.
- \* A proactive public out-reach plan should be developed and coordinated between all agencies involved with biological invasions in Florida.

## Division of Aquaculture

The culture of aquatic species in Florida has a long history, dating from the 1880s, that includes the production and sale of nonnative fish, molluscs, crustacean, reptilian and plant species. During 1999, the Florida Legislature created the Division of Aquaculture (AQUA) as a one-stop shop for all environmental regulations related to commercial aquaculture. Aquafarmers must obtain a Certificate of Registration from the Division to legally sell their products. As a component of the Certification process, Division representatives inspect facilities to insure compliance with Best Management Practices. The Best Management Practices were developed through agency, industry, local government and aquaculture extension agent contributions with an objective of providing a variety of options to meet Florida's environmental protection goals. Aquaculturists in compliance with the Best Management Practices must affix to their packaging, bill of sales, invoices or other business related paperwork a unique Aquaculture Certificate of Registration Number and carry on their person an identification card. Current compliance rate with the aquaculture Best Management Practices exceeds 95 percent.

One of Florida's environmental protection goals is to prevent the introduction, establishment and spread of aquatic invasive species. To obtain permission to culture non-native species, aquaculturists in Florida must design and operate their holding, transport, and culture systems in a manner to prevent escape of all life stages: egg, seed, fry, larvae, seedling or adult. Written authorization is required by the Florida Fish and Wildlife Conservation Commission (FWC) to import non-native verte-

brate and invertebrate aquatic species. Restricted nonindigenous species are listed under a FWC rule and the Division of Aquaculture enforces the provisions of this rule for aquacultural facilities. Prohibited vertebrate and invertebrate aquatic species, as identified by FWC rule, are not eligible for culture and may not be possessed by Florida aquaculturists.

## Findings

- \* A mechanism needs to be established for rapid communication between the Division of Aquaculture, FDEP, and FWC when invasive species are found on a farm.
- \* The Division needs to prepare an integrated agency rapid response plan and Best Management Practices to address invasive species found on farms.
- \* Memorandums of Understanding need to be signed between the FDACS and FDEP and FWC delineating



Water hyacinth (see arrow) was an integral component of a water filtration and nutrient removal system at a farm that recirculated 30 million gallons daily to produce 1.5 million pounds of hybrid striped bass per year

Photo courtesy: HydroMenta, Inc.

lines of jurisdiction for purposes of inspection for invasive species.

- \* Funding needs to be obtained for surveying Florida for aquatic invasive species.
- \* The Division strongly supports reasonable and common sense approaches to regulating nonnative species in a farm environment that focuses on public education, prevention (science-based screening systems and risk assessments) and incentives for private landowners to remove or control invasive species.

## Division of Forestry

The Florida Department of Agriculture and Consumer Services, Division of Forestry (DOF) has responsibility for three main program areas in the state of Florida: management of the state forest system, protection of resources from wildfire, and landowner assistance through the Cooperative Forestry Assistance program. All programs are cross-funded. Examples of this include wildfire response crews perform prescribed burning on State Forests or other public land. When it comes to catastrophic incidences, all resources work together to accomplish results. The DOF manages over 900,000 acres of State Forest public land. It is the lead management agency for 31 state forests ranging in size from the 183,670-acre Blackwater River State Forest to tracts of less than 50 acres. More than 184,000 acres are managed under special agreement with other state agencies, several counties, and water management districts.

The DOF practices multiple-use land management on lands in the state forest system, as defined in Section 253.034(2)(a), Florida Statutes. The mission of the Division is “to protect and manage Florida’s forest resources through a stewardship ethic to assure these resources will be available for future generations.” One of the Division’s strategies to fulfill this mission is “to manage public lands to retain their unique character, and to provide multiple public benefits.” Ecosystem management is the overall framework within which multiple use management occurs. Ecosystem management is an ecological approach to management that focuses on protecting native biodiversity, as well as ecosystem processes such as fire, hydrology, and species interactions. Public benefits include recreation, environmental education, protection of rare or sensitive natural resources (including endangered plants and animals as well as rare plant communities), watershed protection, and generation of revenue for both state and local governments through forestry and recreation. All of these aspects of state forest management are improved or enhanced by the control or management of nonindigenous, invasive species. Management of nonindigenous, invasive species is included in all state forest five-year management plans, and considered in review of all proposed management activities.

The practice of the DOF is to locate, identify, and control

invasive, nonindigenous plants and animals on State Forests. A majority of nonindigenous species issues in State Forests are invasive plant species. When nonindigenous plants on the Florida Exotic Pest Plant Council's (FLEPPC) list of most invasive plant species are discovered, a monitoring and control plan is developed and implemented based upon the severity of the infestation, its location, native species impacted, and availability of staff and funding. Across all state forests, approximately 46,000 acres are infested with FLEPPC Category I and II plant species. This includes approximately 43,000 acres infested in Picayune Strand State Forest.

Primary plant species of concern include: cogon grass, skunk vine, air potato, Japanese climbing fern, Old World climbing fern, melaleuca, Brazilian pepper, Chinese tallow, mimosa, and privet species; however, all FLEPPC Category I and II species are considered targets for control. Several of the state forests have nonindigenous feral hog populations established either on state forest property, or on adjacent lands, with encroachment into the forest. The Division works with the FWC to expand the hunting season in feral hogs on several of the state forests in an effort to reduce population sizes and reduce the natural resource damage done by these animals.

The Division's general strategy for addressing these complex and resource-demanding land management activities is to seek opportunities for utilization of contractual services. With regards to management of nonindigenous, invasive species, contractual services provide resources for accomplishment of large-scale, labor-intensive projects. From 1995 to 2001, the Division spent more than \$500,000.00 of in-house funds on invasive plant control efforts in both contracts and in-house work. Additionally, greater than \$350,000.00 of state and federal grant funding was spent on invasive plant control work, primarily in the form of contractual services. However, oversight of contracts, survey of properties for identification of treatment needs, follow-up treatments on sites, and treatment of areas too small to reasonably contract, or for which contractual funds are not available, necessitate a minimum staffing level which varies from forest to forest dependant upon site-specific issues. In 2001, four state forests spent greater than 5% of a full time

employee's time on invasive plant management. While current staffing levels meet the invasive plant management needs of some forests, certain key others have needs which exceed current levels. The Division has recognized the need for assistance with internal invasive plant management program development. In 2000, the Division re-classified a position in the Forest Health Section within the Forest Management Bureau to assist state forest managers with developing and implementing invasive plant management programs in the state forests.

Increasingly, as lands are acquired through the various public land acquisition programs in the state, they enter into public management with established nonindigenous invasive species populations. Management of these populations on newly acquired lands is dependent upon survey and identification of the populations, successful application for grant funding, or adequate internal budget and staff, and available current control technologies for specific species.

The presence of invasive non-indigenous species on state forest lands makes management more difficult by diverting staff and other resources to control efforts, disrupting ecosystems functions, and by displacing native species. For example, nonindigenous plants can drastically change fire ecology where they invade.

Some factors interfere with present nonindigenous species management efforts. This includes a lack of staff to manage those aspects associated with nonindigenous species, and a lack of public education about the harm these invasions cause. As a result, adjacent non-control of invasive plant populations can act as seed sources for new invasions to state forests. When surveyed in 2001, State Forest managers identified other natural resource responsibilities as the single greatest impediment to accomplishing invasive plant management goals and priorities. As is true in all state land management agencies, personnel are being required to "do more with less." The diversity of responsibilities given to the limited staff of many state forests, especially when coupled with the Division's responsibilities for wildfire protection and emergency response in the state, often leave invasive species management with a lower priority. Some aspects of this can not be completely



remedied with contractual services, and require a specifically dedicated approach to staffing and/or funding levels for key state forests.

The Division maintains an established relationship with Florida's forest industry and private, non-industrial forest landowners, primarily through the Cooperative Forestry Assistance (CFA) program. Through a network of county foresters, this program provides technical assistance in forest management through development of Forest Management plans, which includes in some cases Forest Stewardship plans. Additionally, the CFA program assists landowners with application for federal cost share programs. Each of the federal grant programs has some provision for funding of invasive plant management/control measures in specific situations. This relationship with private forest landowners provides an avenue for the dissemination of information on management, control, and prevention of nonindigenous, invasive pest problems.

The Division has provided or currently is providing technical expertise and field support that addresses prevention and survey of nonindigenous forest/tree pests and diseases including: Asian longhorned beetle, exotic ambrosia beetles, dogwood anthracnose, oak wilt, and many others. Additionally, the experience and training of Division personnel in emergency response through the Incident Command System, the Division assists, at the direction of the FDACS, with rapid response control and eradication programs for nonindigenous agricultural pest species such as Mediterranean fruit fly and Asiatic citrus canker.

The Division has a key role in Florida's future regarding nonindigenous species management. As managers of state forests and other state lands, and with established relationships with industrial and non-industrial private forest landowners and managers, the Division is situated to provide important outreach, support, and information about the management of nonindigenous plant species.

## Findings

- \* Complete comprehensive surveys of State Forests to accurately identify nonindigenous invasive plant and animal problems.

- \* Complete assessment of current invasive species situation and threats, including possibly review of adjacent landowners, considering regional nonindigenous species issues, and subsequent development of written invasive species plans for each forest or as a component of the five year resource management plan.
- \* Ensure communication with state and federal research entities regarding assessment of introduced or proposed nonindigenous "fast-growing" fiber and landscape species with regards to potential invasiveness. When appropriate, ensure that Division planting recommendations do not include species with high likelihood of invasiveness.
- \* Review silvicultural activities with regards to potential for vectoring invasive species in state forests (eg. timber harvest, site preparation, tree planting, etc.)
- \* Ensure that training and interagency cooperation needs are identified and fulfilled.

## Division of Animal Industry

The Mission of the Florida Department of Agriculture and Consumer Service's Division of Animal Industry is to prevent, control, and eradicate certain infectious or communicable diseases of livestock and other domestic animals. The Division receives its primary direction from Chapter 585, Florida Statutes, to focus on goals and objectives to protect the animals and citizens of Florida from exposure to disease, thus providing value for Florida's quality of life. The Division's activities directly affect the general economic infrastructure of the State of Florida.

In protecting Florida's animal populations from these dangerous diseases, the Division also protects the human population against diseases that cross species lines. Continually challenged by new and emerging issues/diseases that require the continuance of current activities and the development of new activities or methods involving the testing, vaccination, surveillance and monitoring of

animals, the Division moves forward to prevent, control and eradicate animal diseases through:

- \* Detecting diseases by inspection of livestock on farms/ranches, through programs and sentinel sites.
- \* Testing livestock using animal-related diagnostic laboratory procedures.
- \* Promoting and mandating healthy, sanitary, and humane care and confinement of livestock; vaccination of livestock, and identification of the origin and health status of imported animals.
- \* Regulating, administering and enforcing laws alongside identifying the origin and health status of imported animals via permits and health certificates.
- \* Teaching producers, private practitioners, and the public about regulatory requirements, successes, and consequences of failure to prevent, control and eradicate animal diseases through news releases, brochures, and the internet.
- \* Developing and practicing emergency response plans in the event of foreign animal diseases and other natural or man-made disasters affecting animals and animal food production.

The Division has been successful in the control and eradication of many animal diseases, including food-borne zoonotic diseases in livestock. Division successes through the years include eradication of many diseases such as bovine tuberculosis, hog cholera, equine piroplasmiasis, various poultry diseases; and pests such as screwworm and the cattle fever tick.

Continuation and enhancement of activities to reach the objective, despite the Division's slowing successes created by the continual decline in Federal support and funding, and the drain on dwindling Division resources from State personnel and budget reductions, are increasingly critical. The goals of providing a safe, affordable, quality assured, and abundant food supply, a healthy

animal population in general, and protecting the public can only be met by addressing head-on the threats of infrastructural decline, emerging diseases, and bioterrorism.

The Division of Animal Industry, designated as the lead agency for Emergency Support Function (ESF) 17, Animal Issues, in the State's Comprehensive Emergency Management Plan (CEMP), is responsible for coordinating the response of state agencies in assisting local and volunteer organizations to provide for animals affected by a disaster and to work with counties to secure the availability of animal shelters, along with food, water and medical supplies for animals displaced during natural disasters or other emergency situations. The Division utilizes the emergency management system for responding to a foreign animal disease outbreak in cooperation with USDA and is incorporating in its plan the inclusion of bioterrorism response issues.

Through news releases, brochures, and the Internet (<http://doacs.state.fl.us/ai/aiindex.htm>), the Division continues to put an emphasis on public information, awareness, and education. The Division realizes a well educated and informed public is a healthy and safe public, and one better able to address the hardships that would be caused by many of the potential diseases to Florida.

The Bureau of Animal Disease Control is responsible for administering this state's animal disease control and eradication programs. The Bureau, in cooperation with USDA, has moved beyond traditional perceptions of animal disease control and eradication programs by addressing public health issues and major economic impacts with the development of new programs. The recent outbreaks of Foot-and-Mouth Disease (FMD) outside the United States, and West Nile Virus (WNV) in the United States, only emphasize the necessity of having a strong active animal disease-monitoring program in place with an open line of communication with public officials. No longer perceiving disease control and eradication programs as bureaucratic obstacles, the public is demanding that more be done to protect the nation's animal-origin food supply. These needs, as perceived by the producer, the consumer, and associated animal industries, will influence the overall acceptability and effectiveness of future

disease control and eradication programs. Many of the Bureau's current program activities take these factors into consideration.

The Bureau's program activities also take into consideration the changing face of animal industries in Florida and throughout the United States. Numerous species previously considered exotic or wildlife have straddled or altogether crossed the line between wildlife and agriculture. Government and industry both are faced with daunting learning curves in veterinary medicine and disease risk analysis for unfamiliar species, with few or no precedents. The Division recognizes the need to include these emerging animal industries with traditional livestock industries so they can coordinate and respond to a greater range of issues.

The monitoring of the movement of livestock into Florida through the requirement of a veterinarian-issued Official Certificate of Veterinary Inspection, OCVI, (health certificate) is the Division's first line of defense against the transmission of animal diseases. All livestock transported into Florida are subject to certificate verification by Agricultural Law Enforcement officers.

The Division, through its Emerging Animal Disease Assessment Unit (EADAU), continues to work with the Florida animal industries, and state, federal and local government entities initiating and assisting with cooperative programs such as foot-and-mouth disease (FMD) intervention, West Nile virus (WNV) epidemiology, and feral/wild (F/W) swine seroprevalence investigations and studies. Using infrared thermography, the EADAU studied the efficacy and speed of aerial infrared for locating F/W swine in their natural environment during disease outbreaks of major importance such as foreign animal diseases. Citing repeated incidents of brucellosis-infection of dairy cattle that co-mingle with infected F/W swine, the EADAU began a study involving the oral brucellosis vaccination of the F/W swine. This vaccination process was designed to prevent or reduce the incidence of brucellosis in the cattle and swine. Working with the USDA and researchers at Louisiana State University, Virginia Polytechnic Institute, and the University of Florida, the EADAU has assisted in the development of new, multiple disease, oral vaccines for use in

combating specific diseases in wildlife and especially F/W swine. With existing available funds and working extensively with industry and the USDA, the EADAU is critically involved in the achievement of a practical Florida Swine Brucellosis and Pseudorabies Program.

The EADAU also works with owners of captive cervid herds on disease management programs. With the USDA's transition over the next few years to incorporate captive cervid herds into each state's disease status for bovine brucellosis and tuberculosis, management solutions must be found for disease testing and eradication in cervid herds. This is underscored by Michigan's ongoing battle against bovine tuberculosis which maintained itself silently for years in the deer population before spreading to domestic cattle and other animal populations.

Providing critical services at reasonable fees to our state's widely diverse animal industry, the Bureau of Diagnostic Laboratories (BDL), certified by the American Association of Veterinary Laboratory Diagnosticians (AAVLD) as an all species, full-service laboratory system, is composed of veterinarians and technicians with highly specialized training in various diagnostic disciplines both diligent and vigilant in their system of animal disease diagnosis. They are a first defense against potential hazards to the rest of the nation, providing state-of-the-art diagnostic laboratory services to the various animal industries and populations of the State of Florida. With a professional staff of veterinarians and technicians with specialized training in the various disciplines of diagnostic veterinary medicine (toxicology, pathology, bacteriology, virology), the BDL provides the knowledge and experience necessary to perform highly technical analyses, studies, monitoring and surveillance of animal diseases, and testing for other diseases of public health significance, such as Lyme's disease and Rocky Mountain Spotted Fever.

## Findings

- \* There is a lack of sufficient resources both in dollars and personnel to provide adequate protection to the agricultural industry and the citizens of Florida from dangerous invasive organisms.
- \* Currently, the Division is unable to perform necessary high level biosecurity diagnostics due to

the lack of a biosecurity level 3 building in the Kissimmee Diagnostic Laboratory. The Kissimmee Laboratory is approximately one-third the size (in square feet) of comparable state laboratories (built in other states) in the last 10 years.

- \* Funding is needed to purchase, develop and maintain a web-based information input-retrieval structure. This would provide for advanced surveillance and monitoring data integration to allow tracking and mapping to predict and analyze animal disease/bio-terrorism events from data collected by various entities and agencies in a system compatible across-the-board with USDA, FDACS, FBI, etc.
- \* Funding is needed to purchase mobile above-ground air curtain incinerators. These incinerators would be dispatched within 24 hours to begin the proper disposal of diseased, exposed, or other carcasses of public health concern. This quick response capability would greatly reduce the potential spread of dangerous contamination and would therefore reduce the economic impact of any such event.
- \* A public outreach program needs to be developed to increase public awareness of dangerous and infectious animal diseases, along with the proper mechanisms and systems available to reduce the public's risk of exposure and the risk of exposure to the State of Florida.

## Florida Fish and Wildlife Conservation Commission (FWC)

The Florida Fish and Wildlife Conservation Commission (FWC) was created July 1, 1999, merging the Florida Game and Fresh Water Fish Commission (Freshwater Fisheries, Wildlife, Environmental Services, Law Enforcement, Informational Services)

with elements from the Florida Department of Environmental Protection (Marine Fisheries, Florida Marine Research Institute, Florida Marine Patrol) and the Marine Fisheries Commission (rule making and stock assessment). FWC has the constitutional responsibility for managing and regulating wildlife, freshwater life and marine life.

In 2000, fish- and wildlife-related recreation resulted in an economic impact in Florida of \$7.8 billion, supporting 138,210 jobs based in part on \$336 million in sales of hunting and fishing products. Importation, exhibition, sale and breeding of non-native species generate \$300 million annually. There are 8,000 entities authorized to possess fish and wildlife for private and commercial purposes, including 300 zoological attractions and 300 exotic fish farms, e.g., the tropical fish industry.

Nonindigenous wildlife has long been a part of Florida ecosystems, particularly in the subtropical portion of the peninsula where, by some estimates, 26% of the fauna is not native. Individual pet owners have been the source of many exotics. Florida's long coastline, deepwater ports and international airports are also potential points of entry for vertebrates and invertebrates. Invertebrates are the principal concern in marine ecosystems, with ballast water an ongoing source of exotic organisms.

### Programs

The Division of Freshwater Fisheries first conducted research on a non-native species in 1961. In response to growing interest in nonindigenous aquatic fauna, the Non-Native Fish Research Project was established in 1966. This project remains active today at its location on Boca Raton. Project budget for 2001-02 was \$204,000.

In 1973, a special law enforcement unit was established, staffed by trained officers with degrees in zoology, to enforce regulations dealing with imported fish and wildlife. There are 13 Wildlife Inspectors that inspect facilities statewide. In 2000, wildlife inspectors inspected 5,352 facilities and seized 111 illegal specimens. The budget for the Wildlife Inspections Section for 2000-01 was \$?????.

In addition to non-native fish investigations, FWC's Aquatic Plant Management Section is responsible for permitting

herbivorous fish, primarily grass carp, for weed control. Only sterile triploid grass carp are permitted in Florida, to prevent reproduction of escaped fish and subsequent impacts on desirable native vegetation. The Aquatic Plant Section manages nuisance vegetation, including hydrilla, in waters with important sportfisheries, and coordinates with DEP's Bureau of Invasive Species Management and local cooperators to conduct control operations. The Section's annual budget is \$880,000.

Currently, FWC has no dedicated programs for dealing with nonindigenous wildlife and marine species, although non-native species are dealt with in the course of other management and research activities. Both the divisions of Wildlife and Marine Fisheries have staff expertise but no funding to develop programs. The Florida Marine Research Institute's (FMRI) Fisheries Independent Monitoring Program has accumulated information on occurrence of non-native species, but due to funding constraints, there has been no analysis or interpretation in this context. The Division of Marine Fisheries, in conjunction with FMRI, is evaluating selected marine organisms for FWC restricted species status (68A-23.008, F.A.C.).

## Status of Exotic Freshwater Fish

There are 32 reproducing species of freshwater nonindigenous fishes, more than anywhere else in the world. Eleven localized populations of nonindigenous species have been eliminated by FWC or by natural causes. An additional 43 freshwater nonindigenous fish species have been collected without evidence of reproduction. Traditionally, private indi-

viduals and fish farms have been the source of introductions, most of which are species commonly displayed in aquaria. Recently, an increasing number of introduced fish appear to have originated from a growing live food fish trade, e.g., brown hoplo (*Hoplosternum littorale*), bullseye snakehead (*Channa marulius*), and Asian swamp eel (*Monopterus albus*), that are popular food items from South America and southeast Asia. Consistent with other studies, few exotic freshwater fish species in Florida are invasive, and the presence of non-native species is not inherently harmful



*This albino fox, discovered in the Ocala National Forest, is one example of the unauthorized release of non-native pets.*

to native species. In south Florida canals, home to many exotic freshwater fish, native fish populations continue to maintain healthy populations.



*Detonating cord is used to sample fish populations in south Florida canals. Results are used to assess ecological relationships among native and introduced freshwater fish species.*

## Non-Native Fish and Wildlife Strategies

Three key elements have emerged to deal with non-native fish and wildlife in Florida: prevention, assessment, and management of established populations. Prevention involves regulations and enforcement, along with public awareness through news releases, brochures, public service announcements, and school educational programs. Multi-jurisdictional coordination with local, state, and federal agencies, along with stakeholders

from private industry and non-governmental organizations, is important in reviewing potential regulations prior to implementation. Eradication, although desirable, is rarely possible for nonindigenous fish introduced in open waterways and is even more difficult for marine life and wildlife.

Notwithstanding FWC's commitment to preventing unauthorized releases of non-native species, Florida's numerous points of entry and cultural diversity continue to facilitate the introduction of



nonindigenous wildlife, as evidenced by the establishment of several species of freshwater fish since 1994, e.g., jaguar guapote (*Cichlasoma managuense*), swamp eel, bullseye snakehead, brown hoplo. Upon discovery of an exotic species, the potential to eradicate the population is assessed immediately. Although FWC staff has been involved in the elimination of seven isolated populations of introduced freshwater exotic fishes, in most cases eradication is impractical, if not impossible, in Florida waterways (Shafland 1986). In such cases FWC conducts an assessment of a newly established fish species' distribution (and potential for spread), life history and environmental limiting factors (e.g., temperature and salinity tolerance), and associations with other species.

Following the assessment phase, management strategies for the newly introduced species are developed, with commercial utilization (e.g., blue tilapia) and sport fishing (e.g., oscar, Mayan cichlid *Cichlasoma urophthalmus*) explored to encourage removal. In one case, FWC has introduced a piscivorous exotic fish, the butterfly peacock (*Cichla ocellaris*), into southeast Florida canals to help control abundant of spotted tilapia (*Tilapia mariae*) and other non-native fish. Butterfly peacock is the only legally introduced established nonindigenous fish. This introduction, which followed extensive risk assessment, has proven successful in reducing spotted tilapia in extreme southeast Florida, while providing substantial sportfishing opportunities.

## Findings.

Critical concerns regarding exotic fish and wildlife are introduction pathways, habitat alteration and loss, research and monitoring, information and education.

There is a lack of adequate resources for basic research and monitoring of wildlife and marine invasive species. Permanently funded

programs to study and manage the ecological and socioeconomic consequences of invasive species are desirable. Greater funding is needed to present effective public information regarding the consequences of illegal introductions and emphasizing prevention of new introductions.

FWC's prohibited invasive species list (Chapter 68A-23.008, F.A.C.) may need additions and/or revisions.

Invasive species management should consider differences between categories of species (e.g., plants vs animals), as well as philosophical differences among stakeholders.

## Water Management Districts

Florida's Water Management Districts (WMDs) manage invasive plants and feral hogs on approximately 2 million acres of conservation lands, and in some 240,000 surface acres of public lakes and rivers, WMD waters, and flood control canals.

Funding for these operations come from trust funds administered by FDEP, Ad Valorem tax revenues, mitigation and special revenue funds, and county funding. The WMDs own an additional 400,000 acres of conservation lands that are managed by other entities. In fiscal year 2000, the WMDs spent \$7.5 million managing weeds in sovereign waters, \$5.0 million in flood control canals, \$276,000 in WMD-owned waters, and \$5.7 million on conservation lands. Operations are implemented through contractual services and in-house crews.

The water management districts have been cooperating



*Extensive investigations into the food habits of butterfly peacock confirmed this species preyed heavily on spotted tilapia. The butterfly peacock is the only authorized introduced freshwater fish established in Florida.*



*Wildlife Inspectors' duties include inspecting captive wildlife facilities to ensure humane treatment and to minimize the chances for escape of non-native species.*

for many years to identify and combat the threats associated with invasive exotic plants and wild hogs. The WMDs fund and conduct ecology and management related research projects on the most problematic plant species. Studies include research into biological control agents, screening trials for herbicides and site-specific evaluations of non-target damage to native plant communities after control operations have been conducted.



*The Australian melaleuca trees thrive in South Florida's wetland communities and can form dense monospecific stands that are little utilized by native wildlife communities.*

The WMDs carry out regional assessments and survey and mapping inventories for invasive pest-plants on managed properties. The WMDs produce and fund many educational materials on the invasive plant issues, and participate in public outreach opportunities. In 1995, the WMDs formed a working group to facilitate greater communications and improve cooperation between the WMDs. In 1997, a cooperative Inter-District report ("Exotic Plant Invasion on Florida's Water Management District Lands") was compiled that described the Districts' ongoing exotic species management activities and plans for the future.

Control operations on water management district waters and lands are currently aimed at achieving maintenance control of large-scale infestations of invasive non-native plants and elimination of new, small or isolated infestations when the potential for rapid infestation and reinfestation is unlikely. Maintenance control is achieved when invasive nonindigenous plant infestations are reduced to the lowest feasible level where they no longer significantly impact native plant communities or ecosystem functions and their potential spread is minimized. The additional funds and workforce needed to completely eliminate invasive species from a specific property often can not be justified when the property will likely be reinfested from adjacent unmanaged lands.

At present, each of the water management districts has

invasive exotic plant problems to varying degrees. The districts have developed active control programs commensurate with their needs. Levels of spending, therefore, range from thousands of dollars to millions of dollars annually.

## Findings

- \* Unmanaged areas often act as reservoirs for exotic species infestations, which allow the re-infestation of WMD and other conservation lands. Incentives or funding should be considered to address this problem in critical areas.
- \* The amount of state funding available to study invasive species ecology, to develop effective current control recommendations, to fund long term control options such as biological control and to develop standardized assessment methods to quantitatively assess infestation levels should be increased.
- \* The Districts and other land management agencies need to develop effective protocols to minimize spread of invasive species resulting from management activities, recreational utilization and agricultural operations on conservation lands.
- \* A standardized assessment method needs to be finalized and adopted to ensure compatibility between agencies in assessing and reporting infestation levels.
- \* The status of feral hogs on WMD lands ranges from game animal to pest species even though their negative impacts on habitat structure, plant and animal species abundance and composition, and ecological processes are well documented. This species should be considered a pest species and appropriate measures implemented to reduce populations to maintenance control levels on all WMD lands.
- \* A risk assessment procedure for newly introduced non-indigenous species should be initiated at the state and



*The South Florida Water Management District has removed large populations of the Australian melaleuca tree around Lake Okeechobee.*

federal level to assist in preventing new invasive species introductions and to help prioritize and gauge the response necessary to deal with escaped species.

## Florida Department of Transportation

Years ago, before the Florida Department of Transportation (FDOT) began working with FDEP and other agencies, invasive nonindigenous species were only addressed by roadway maintenance personnel. Now, the problem of invasive organisms, limited to invasive plant species, is addressed in roadway design, construction, and maintenance. The department's major problem associated with invasive plant species is the reinfestation of rights-of-way from adjoining private properties. FDOT is not authorized to control invasive species on private lands to prevent reinfestation. This problem has been particularly persistent with cogon grass. Another problem that FDOT is working to solve is the dissemination of invasive plant species through the movement of soil, hay, and sod on rights-of-way. These activities in highway construction can rapidly spread species throughout the state.

### Findings

- \* The plan should identify the state's top land management priorities; what species, where, and when.
- \* With priorities clearly established, FDOT's efforts can be placed where the state and department get the greatest benefit. Same for research priorities.
- \* FDOT requests increased cooperation from FDACS to verify that sod and hay are not contaminated with invasive species; some type of product grade or certification that can be relied upon and easily verified.

## University of Florida Institute of Food and Agricultural Science (IFAS)

The Institute of Food and Agricultural Sciences (IFAS) is a federal, state, and local government partnership dedicated to education, research, and extension. IFAS is administered through Florida's

Land-Grant and Sea-Grant programs. Invasive species (before they were called that) including weeds, animals, and diseases, which have become agricultural pests, have been traditionally addressed through this Land-Grant tripartite. Since their inception, land grant institutions have broadened out to encompass programs of on-campus instruction, research, and off-campus extension work in many areas beyond the initial needs of agriculture. Natural resources are now an important component of the Land-Grant mission. As the importance of invasive species in natural areas has increased, IFAS has responded with efforts to address this issue in education, research, and extension programs. At least eight courses at the University of Florida address invasive species. Four of these have their main focus on invasive species in natural areas. Research priorities include developing management programs and understanding ecology and physiology of the state's worst invasive species, environmental impacts of invasive species, and development of predictive indices for invasiveness. Extension efforts include a pesticide applicator certification training program for invasive plant management in natural areas, an assessment of invasiveness to help in making recommendations for horticultural commodities, providing information to increase the public's awareness of their role in helping solve invasive species problems, and training of County Extension Faculty. Some of these programs will be discussed in detail below.

### Current Efforts

#### School of Forest Resources and Conservation

The Natural Resources Education Program in the Department of Forest Resources and Conservation addresses invasive species in a variety of ways. Within the 4-H program, an activity is included in the 4-H project book, "Florida's Fabulous Forests," and the Leader Guide, about invasive exotic plants in natural areas. It encourages youth to find out more about the invasions in their region and how they can work to stem the tide. Invasive exotic plants are highlighted on a Web site and CD on Florida Forest Plants and Ecosystems being developed to assist audiences with identification of forest plants. A forest-based community service-learning program "Give



Forests a Hand” asks youth to explore their local forests and identify concerns they could address with service projects. Information on invasive species is provided to assist them. Invasive species are addressed in a summer undergraduate Natural Resource Communication course that explores the wildland-urban interface. Invasive plant species are addressed in “Restoring the Urban Forest Ecosystem” CD-ROM.

## Entomology and Nematology

Classical biological control programs against the citrus pests, citrus leafminer, Asian citrus psylla, and brown citrus aphid have been developed over the past nine years. Graduate students are trained in the methods of classical biological control through this research, and growers are taught about classical biological control. Studies are in progress for arthropod biological controls against Brazilian pepper, hydrilla, and *Solanum* spp. Invasion biology, including ecology and genetics of *Aedes albopictus* is under study.

Public information and education is provided on the use of host-specific insects to control invasive plant species. An extension program is being coordinated with Natural Resource County Agents and other faculty to provide critical information for end-users for the most effective and accurate use and monitoring of insect biological control agents.

## Environmental Horticulture Department

The Environmental Horticulture Department’s role in invasive plant species education, research, and extension is critical because of its close relationship with the horticulture industry. The department has increased its efforts extensively in recent years. Invasive plant species are addressed in courses such as “Florida Ecosystems and Landscapes” and “Florida Native Landscaping.” Several research projects are in progress that are studying the invasiveness of new and existing ornamental species and cultivars; nutrient use and efficiency and photosynthesis for evaluating potential invasiveness of ornamental species; and economic impacts of phasing out invasive ornamental plant species. Training and education material related to

invasive plant species are provided to County Horticulture Agents in cooperation with Agronomy Weed Science Extension programs.

## Plant Pathology Department

Efforts are directed at biological control of such invasive weeds as waterhyacinth, hydrilla, tropical soda apple, torpedograss, and cogongrass. Several bioherbicides (i.e., plant pathogens used as weed control agents) have been developed and field-tested against these weeds. A course titled “Microbiological Control of Plant Diseases and Weeds,” which deals with the theory and applications of the use of microbial agents as bioherbicides is offered.

## Department of Veterinary Medicine

Research has determined the exotic tick species introduced into Florida on imported reptiles; identified the optimal acaricide for the safe and efficacious treatment of tortoises, snakes and lizards for exotic tick infestations; established a safe and effective method for the eradication of exotic tick infestations from premises containing infested tortoises; determined that certain species of exotic ticks are efficient vectors of at least one disease (heartwater) that is highly pathogenic for cattle, sheep, goats, and deer; determined that at least one shipment of exotic ticks into Florida was infested with the rickettsia causing heartwater; and disseminated information to ended users and the scientific community.

## Agronomy Department

In addition to traditional agriculturally oriented weed science courses, two courses, “Biology of Invasive Species” and “Biological Invaders” are offered. The latter is a course for non-majors designed to educate students enrolled in non-biological curricula on the topic of invasive species.

Weed Scientists in the Agronomy Department conduct research on invasive species in crops and non-crop areas, including aquatic habitats and natural areas. Studies are in progress on seed and reproductive biology of several invasive plant species, examining the use of molecular tools for better understand the genetics of invasive plant species, reproductive biology of several aquatic plant

species, and developing control strategies and studying the biology of several upland invasive plant species.

The Agronomy Department has a statewide Extension program in “Ecology and Management of Aquatic, Wetland, and Upland Vegetation.” Through this program, current control methodologies for invasive plant species are made available to land managers. A curriculum, training manual, and testing were recently developed to certify land managers for application of herbicides to control invasive plant species in natural areas. Workshops will be held across the state to deliver this program and provide continuing education for re-certification. A program is also conducted for certification and re-certification of herbicide applicators that manage invasive aquatic plant species. Public education workshops are conducted in cooperation with Water Management Districts and other agencies.

## The Department of Fisheries and Aquatic Sciences

The Department of Fisheries and Aquatic Sciences (FAS) includes research or extension projects involving invasive species in Florida in all three of their major program areas, Aquaculture, Freshwater, and Coastal. Some non-native fish or shellfish have been legally imported into Florida as valued aquaculture species, while other species have been introduced without public support and are perceived as real or potential pests. In the case of aquaculture, FAS research and extension faculty are seeking to incorporate issues surrounding the culture of non-native fish and shellfish into state-approved best management practices. In the coastal environment, there has long been a perception that invasive species do not pose the same level of threat to Florida that they have in other parts of the United States, such as New England, Chesapeake Bay, and the West Coast. Two recent developments have challenged that assumption: First, the only careful review of coastal species in Florida revealed over 30 non-native invertebrates, a third of which had been observed but not previously recognized as non-native. Some of these invasive species, such as barnacles and shipworms, are abundant pests. Although Florida and its marine industries have adapted, it is obvious that Florida is not immune to significant invasions. Second, green

mussels have recently invaded Tampa Bay, a tropical Indo-Pacific species. The green mussel has rapidly attained very high abundance and is spreading from Tampa Bay to other parts of Florida. The economic and environmental impacts of this new invader, which is similar in some important ways to the notorious zebra mussel, have yet to be measured reliably. FAS will be committed to cooperation with state agencies in developing and implementing a statewide Invasive Species Management Plan and in cooperation with other Florida university departments, will develop components of Prevention, Rapid Response, Control and Management, and Public Education regarding invasive species.

FAS is conducting an EPA-funded study on spread and impacts of the invasive green mussel, which is currently the dominant benthic organism in many areas. The present distribution includes most of Tampa Bay and extends south to Charlotte Harbor. This species is conservatively expected to spread south through the Florida Keys and around the tip of Florida to the Indian River Lagoon. Potential economic impacts include increased costs associated with fouling of vessels, navigation equipment, and seawater intakes. Potential ecological impacts include altered benthic habitats, competition with native shellfish, and changed plankton dynamics by filter-feeding (as has been observed for zebra mussels, a common pest in other parts of the United States). Research efforts to date have focused on understanding the spread of green mussels, its impact on benthic habitats, and its role as an abundant filter feeder. Other issues have arisen, but funds are lacking for their study.

Florida Sea Grant has convened a marine invasive species working group, comprised of key researchers and managers in Florida. This group will determine needs for Florida and identify tools, expertise, and resources to address these needs.

Faculty of the FAS Tropical Aquaculture Lab in Ruskin, are engaged in developing and disseminating best management practices for ornamental aquaculture in Florida. Prevention of the release of non-native species is incorporated as a crucial part of best management practices.

Effects on Florida freshwater ecosystems of the

purposefully introduced peacock bass, which is native to South America, are under study. Peacock bass, a predator, consumes both native fish and invasive species such as spotted tilapia, but how it changes native fisheries is not understood. Research is intended to guide management by Florida state agencies, and optimize Florida's economically valuable recreational freshwater fisheries.

A survey of invasive marine species in Tampa Bay, on behalf of the Tampa Bay Estuary Program (also EPA-funded) is being conducted. This project will synthesize available information on invasive species in Tampa Bay. As a major seaport, Tampa Bay is among the most susceptible sites in Florida, and is also a secondary source of invaders for other parts of Florida. This project's results will be used to plan further research, extension, and management efforts.

A series of fact sheets describing important coastal invaders in Florida is being developed cooperatively between FAS and the University of Central Florida. These fact sheets will raise awareness of coastal invaders in Florida with the intention of reducing the risk of new invasions through public education, and gaining information from the public on the distribution and impacts of invaders in Florida. The Florida Sea Grant College Program funds this project.

Studies are being conducted on management of the freshwater Asian clam (*Corbicula*). *Corbicula* occurs throughout Florida, and greatly outnumbers native freshwater bivalves. *Corbicula*, which is an effective filter-feeder, has been proposed as the final stage in agricultural waste treatment in the Kissimmee-Okeechobee watershed. FAS researchers have a USDA-funded program at the Sam Mitchell Aquaculture Demonstration Farm (near Blountstown) to study management of *Corbicula* in the context of Best Management practices for agriculture, but plans to close the Mitchell Farm means that the project, including ponds and raceways, will have to be moved to a new location. Research is being conducted on the spread, populations, and impacts of the invasive Asian swamp eel in Florida.

## The Center for Aquatic and Invasive Plants

In 1978, the Center for Aquatic and Invasive Plants was established as a multidisciplinary unit within IFAS to promote and coordinate a statewide aquatic plant research program and to develop environmentally sound techniques for managing aquatic vegetation. During the years since the Center's initiation, much has changed about the methods and objectives of resource management within the state. The list of invasive, nonnative species has expanded, the economic and ecological benefit of efficient and systematic management of invasive vegetation has been demonstrated, and shifts in emphasis within state and federal programs have changed the funding available for academic programs. The continuing thread remains the attempt to match research interests, funding opportunities, and available personnel to the spectrum of problems and products that are the heart of invasive plant research, education, and extension. Base support for the Center is provided by an annual General Revenue allocation. Research and Extension programs are supported by funds allocated by IFAS Administration and the Dean's Office and driven predominantly by outside grants and contracts from other state and federal agencies.

Fifteen to twenty faculty from eight departments cooperate through the Center on invasive plant research. Examples of current research include: developing control methods (including biological, chemical, and mechanical) for integrated management of specific invasive species, community, physiological, and reproductive ecology of invasive plant species, invasiveness of horticultural cultivars, and population genetics. Center Extension Programs are aimed at public education and training of invasive plant management personnel. Fact sheets pertaining to invasive plant species are available to County Agents and the general public on the Center's Web site (<http://plants.ifas.ufl.edu>), and the IFAS publication Web site (<http://edis.ifas.ufl.edu>). Information pertaining to invasive plant species is delivered through existing programs with established audiences such as the Master Gardeners program and Florida Yards and Neighborhoods. The Center's Aquatic and Invasive Plant Information Office provides an "Aquatic and Invasive Plant Information Retrieval

System” and an abundance of teaching aids, which are available to high school teachers and other educators. The retrieval system provides a cataloged and instantly retrievable bibliographic database of aquatic and invasive plant literature, with searchable Internet access.

## IFAS Invasive Plants Working Group

Because of its multidisciplinary role, IFAS programs can have conflicting messages concerning invasive species. For example, recommendations can be found for landscape use of the same species which control methods are also provided. To address these issues, IFAS has a multidisciplinary Invasive Plant Working Group that is charged by the Deans of Extension and Research to develop sound science-based resolution of these conflicts. A major accomplishment of this Working Group has been development of the “IFAS Assessment of Nonnative Plants in Florida’s Natural Areas”, which is used for making recommendations on use of nonnative horticultural products.

### Findings

- \* IFAS faculty have the interest and expertise to conduct research needed to address invasive species problems in Florida and the nation and are conducting education, research, and Extension programs within the limitations of budget, personnel, and facilities. Research and Extension programs of faculty are supported principally by external grants and contracts from state and federal agencies, and programs are limited by available funding. Increased funding is needed for coordinated (with state agencies) development and printing of Extension educational materials and to enhance delivery of invasive species education programs. Increased funding is needed to expand invasive species research.
- \* Specific areas in which invasive plant research efforts need to be increased include the following: 1) Methods to determine invasiveness of potential new introductions, 2) Limiting the use and expansion of potentially invasive exotic plant species in the landscape by developing cultivars of native species to replace invasive exotics and development of sterile forms of exotics, and 3) Ecological impacts of invasive species.
- \* Statewide invasive species management can benefit from increased General Revenue funds provided directly to support research and additional cooperative agreements with state agencies to support invasive species research and Extension efforts.
- \* A new faculty position is needed for a botanist with expertise in pathways of introduction and to determine origins of introduced species by genetic methods.
- \* USDA-APHIS no longer evaluates risks associated with releasing parasitoids or predators of pest arthropods; therefore, there is no federal oversight for risk assessment of such introductions. IFAS Entomology and Nematology Department uses a voluntary, peer review system. More oversight is needed for entomologists carrying out classical biological control programs involving pest arthropods.
- \* There is a need for biotech business ventures to service small-market needs created by specific invasive species to help develop, register, and commercialize highly specialized bioherbicide products.
- \* Research and extension in areas of invasive freshwater and coastal species is currently conducted by faculty and staff who have additional responsibilities to other aquaculture, freshwater, and coastal constituencies. Adding to this pressure is the loss of several existing faculty through attrition, including the critical areas of fisheries and aquaculture genetics and aquaculture extension. Unless those positions are filled, some vital issues related to invasive species may slip through the cracks. The hiring process is limited both by lack of space for new personnel in the department and hiring freezes. In the interim, staff to assist in invasive species research and extension has been identified as a critical project need.
- \* Predicting the risk posed by recent invaders requires lab studies of environmental tolerances. FAS currently lacks environmental chambers that meet EPA requirements for working with invasive species. FAS has been offered space for these chambers outside the department, but the required chambers will cost \$10,000.
- \* Researchers of invasive species are currently borrowing trucks and vessels from a variety of other programs. Funding for a heavy-duty truck (\$25,000) and small vessel suitable for scuba operations

(\$20,000) is needed.

- \* The expected closure of the Sam Mitchell Demonstration Farm near Blountstown will force FAS researchers to relocate existing research facilities on *Corbicula* clams. A minimal system requires two 1-acre ponds and a catchment basin with research flumes. \$30,000 will be required to recreate ponds, and replacing the flume system will cost an additional \$30,000.
- \* Additional space to address FAS infrastructure limitations could take two forms. A permanent solution would be a multi-purpose research, education, and extension building capable of housing the entire department (projected cost \$15,000,000). In the interim, some of the most critical needs can be met by one or more smaller, multi-purpose buildings modeled after an existing structure recently built for FAS (projected cost \$300,000 per structure).
- \* Green Mussel Impacts on Fisheries: Green mussels may impact finfish negatively by covering benthic habitats required for feeding or spawning, or by feeding on plankton causing changes in the base of the food web. However, green mussels may also provide a new food resource for certain fish or crab species that have direct human value. Research needs in this area have been discussed by FAS and federal agency researchers, but funding is needed.
- \* Green Mussel Fishery Value: If green mussels remain abundant, one means to manage them may be through harvest for human consumption or animal feed. Harvest methods, food value, and market potential need to be determined specifically for Florida. Research and extension in this area would be driven by the findings of other research on green mussels (including potential human health threats).
- \* Green mussels and human health: The green mussel is an edible species, and occurs in provisionally approved shellfish waters, where it is certain to be harvested recreationally. It is not known whether this species feeds on toxic marine plankton, or whether it can accumulate toxins to the point of being a health hazard if consumed. Research requires collaboration within IFAS and among several

agencies. Additionally, if human health hazards are suspected, outreach efforts to educate the public should be mounted in areas where green mussels might be encountered and consumed. [To date, no human health problems associated with green mussels have been reported, and there are no data on the extent to which they are consumed in Florida.]

- \* Research has demonstrated the potential problems associated with introduced tick species. This research was terminated due to a lack of funding and technical support positions. Additional funding is needed to continue research and extension efforts to determine impacts and solve problems associated with invasive tick species.
- \* Funding is needed for a faculty position and start-up funds to study the potential of arbovirus transmission by invasive mosquitoes.
- \* A faculty position, biologist and operating funds are needed by the IFAS Tropical Aquaculture Laboratory (Ruskin) to adequately study potential invasiveness of introduced ornamental fish species.
- \* Funding is needed for additional faculty and skilled technical support positions for collaborative research extension programs among IFAS satellite campuses.

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