

Chapter 9: Status of Nonindigenous Species in the South Florida Environment

LeRoy Rodgers, Mike Bodle, David Black and
Francois Laroche

Contributors: Amy Ferriter¹, Bob Doren², Dan Thayer,
Paul Pratt³ and Jennifer Leeds

SUMMARY

In support of the collective activities of the many agencies involved in Everglades restoration, this chapter reviews the broad issues involving invasive nonindigenous species in South Florida and their relationship to restoration, management, planning, organization, and funding. This report follows last year's format by providing status updates for priority invasive species, programmatic overviews of regional invasive species initiatives, and a review of key issues related to managing and preventing biological invasions in the South Florida ecosystem. While detailed information on many nonindigenous species is not available, this document attempts to provide an update and annotations for 24 priority species (12 plant taxa and 12 animal taxa), including summaries of new research findings. In addition, overviews of several emerging threats are included. Additional supporting information for many of these species is presented in Chapter 9 of the *2008 South Florida Environmental Report (SFER) – Volume I*.

In addition to providing the status of nonindigenous species programs and outlining programmatic needs, this document summarizes what, if any, control or management is under way for priority nonindigenous species considered to be capable of impacting the resources that the District is mandated to manage or restore. Additionally, **Table 9-1** compiles the many invasive species management activities the District is currently engaged in and also serves to cross-reference region-specific coverage of invasive species issues of the Everglades, Lake Okeechobee, Kissimmee Basin, and coastal areas in other chapters of this volume, including Chapters 5, 6, 10, 11, and 12.

¹ Idaho Department of Agriculture, Boise, ID

² Florida International University, retired, Miami, FL

³ U.S. Department of Agriculture – Agricultural Research Service, Davie, FL

FISCAL YEAR 2010 HIGHLIGHTS FOR SOUTH FLORIDA'S INVASIVE SPECIES

- A total of 69 species of nonindigenous plants are District priorities for control. Old World climbing fern (*Lygodium microphyllum*), melaleuca (*Melaleuca quinquenervia*), and Brazilian pepper (*Schinus terebinthifolius*) continue to be priority species throughout the region, while aquatic plants such hydrilla (*Hydrilla verticillata*), water hyacinth (*Eichhornia crassipes*), and tropical American water grass (*Luziola subintegra*) are high priorities in the Kissimmee Basin and Lake Okeechobee.
- Widespread efforts to control invasive plants are continuing. The District has the country's largest aquatic plant management program, managing floating and submerged aquatic vegetation region-wide. The agency's successful melaleuca management program has become a national model for regional, interagency invasive plant control programs. Melaleuca has been systematically cleared from Water Conservation Areas 2 and 3 and Lake Okeechobee and is now under maintenance control in these regions.
- Biological control of several invasive plants is showing promising results, with new melaleuca- and water hyacinth-feeding insects approved for release in 2010. Such insects have been introduced across Florida to limit productivity of targeted invasive plant species. The CERP Melaleuca Eradication and Other Exotic Plants—Implement Biological Controls Project continued to move forward during 2010. The project will include construction of a mass rearing facility to the existing U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) biological control laboratory in Davie, FL, in support of implementing the rearing, field release, establishment, and field monitoring of approved biological control agents for melaleuca and other invasive nonindigenous species.
- Considerable numbers of nonindigenous animals are known to occur in South Florida, ranging from approximately 55 species in the Kissimmee Basin to over 150 species in the Greater Everglades. Ranking animals for control is a serious challenge and prioritizing animal-related threats across regulatory agencies is needed.
- The Florida Fish and Wildlife Conservation Commission (FWC) continues to build its nonindigenous animal management program and coordinates closely with the District and other partners to manage nonnative animal species in South Florida. During 2010, the FWC, the District, and other agencies implemented rapid response efforts to control a recently discovered northern African python (*Python sebae*) population in the Greater Everglades.
- Burmese python (*Python molurus bivittatus*) populations appear to have suffered a setback during record cold periods during January 2010. Unfortunately, this species continued to be observed in the summer of 2010, albeit in much reduced numbers. The District remains an active partner in regional efforts to halt the spread of this invasive reptile by conducting regional search and removal operations and supporting research for trap development and other management related research.
- Land managers are working to prevent the spread of the African Nile monitor lizard (*Varanus niloticus*) and the Argentine black and white tegu (*Tupinambis*

merianae), which have established populations in the vicinity of Cape Coral and Homestead Air Reserve Base.

- Progress toward eradication of several new invaders continued during FY 2010. The Gambian pouched rat (*Cricetomys gambianus*) is now eradicated from Florida. The joint eradication effort demonstrates the value of decisive, collaborative action during the early stages of biological invasions.
- Efforts to eradicate the sacred ibis (*Threskiornis aethiopicus*) and kripa (*Lumnitzera racemosa*), an invasive plant in mangroves, appear to be successful.
- The District continues to participate with regional collaborative groups such as the Everglades Cooperative Invasive Species Management Area, Lake Okeechobee Interagency Aquatic Plant Management, and the Florida Invasive Animal Task Team. During 2010, these cross-jurisdictional teams facilitated development of region-wide invasive species monitoring programs, rapid response efforts, standardized data management, and outreach programs.

INTRODUCTION

Invasive species are directly implicated in the loss of native species, biodiversity and ecosystem functioning, ecosystem services, and livelihoods worldwide (U.S. Congress, Office of Technology, 1993). Increasingly, technology and globalization are reducing the barriers that once allowed unique species and ecosystems to evolve without continuous disturbances from biological invasions. As a result, rates of biotic exchange are increasing on all continents and the trend is expected to continue despite heightened international awareness of the impacts of biological invasions (Millennium Ecosystem Assessment, 2005). The significant natural habitats that international conservationists are attempting to protect from additional human-induced disturbances are particularly vulnerable. A recent assessment of invasive species threats to global conservation efforts found that 487 protected areas of significance are currently impacted by biological invasions (GISP, 2007).

Nationally, more than 50,000 species of introduced plants, animals, and microbes cause more than \$120 billion in damages and control costs each year (Pimentel et al., 2005). Invasive nonindigenous plant species are known to displace native plant communities, reduce wildlife habitat and forage, decrease crop productivity, soil stability and water quality in agricultural systems, affect human health, and impact human infrastructure (Simberloff et al., 1997; DiTomaso, 2000; Zavaleta, 2000). Invasive nonindigenous animals compete for food and habitat, upset existing predator/prey relationships, degrade environmental quality, spread diseases, and threaten the integrity of flood protection levees and electrical power delivery (Taylor et al., 1984; Wilcove and Bean, 1994; Rodda et al., 1997; Pimentel et al., 2005).

With its mild climate, diverse environments, and dense human population centers, South Florida is particularly vulnerable to naturalization by nonnative species. At least 1,392 nonindigenous plant species are established in Florida (Wunderlin and Hansen, 2003), of which 67 are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives (FLEPPC, 2007). The impacts caused by the worst of these invasive plant species have resulted in widespread, and potentially irreversible, damage to some of South Florida's most sensitive ecosystems. For example, Old World climbing fern (*Lygodium microphyllum*), first collected as a naturalized plant in 1964, has rapidly spread across the Florida peninsula, causing localized displacement of native plant species and altering ecosystem processes. By 2005, in Water Conservation Area 1, Old World climbing fern blanketed most tree islands, which are important sources of plant species diversity in the Everglades and provide essential upland habitat for many wildlife species. Among animals, there

are at least 181 nonindigenous species established within the South Florida Water Management District (SFWMD or District) (Appendix 9-1 of this volume), but information regarding species presence and distribution is largely incomplete for most taxonomic groups of animals. Among South Florida's most threatening invasive animals are carnivorous reptiles, such as the Burmese python (*Python molurus bivittatus*) and the Nile monitor (*Varanus niloticus*), both of which were likely introduced via the exotic pet industry. The introduction of these top predators adds additional pressures on native wildlife populations, particularly threatened and endangered species, and may dramatically alter food web dynamics in South Florida ecosystems.

Even less understood are the biotic interactions occurring among nonindigenous and indigenous species and what these interactions mean for native populations and ecological functions. For example, although the Cuban treefrog (*Osteopilus septentrionalis*) established in the Florida Keys nearly 90 years ago and has now spread throughout most of the state, only rudimentary information on this species' impact is available. Ongoing research does indicate, however, that the Cuban treefrog aggressively competes with and preys upon native frog species (Johnson, 2007; Waddle et al., 2010), but the overall effect on population dynamics and trophic relationships at the ecosystem scale is unknown. The little research that has focused on the interactions between and among invaders and native species suggests that biological invasions often have direct and indirect effects on ecosystem processes. Documented examples of such interactions include disruption of plant-animal reproductive mutualisms (Traveset and Richardson, 2006), reduced fitness through habitat alteration (Pearson, 2009), and changes to abiotic factors such as fire (Roberts, 1997).

Risk assessment information for nonnative species not currently held to be invasive is monitored by several means. The Florida Exotic Pest Plant Council (FLEPPC) Plant List Committee updates its list of invasive plants every two years. Based on observations of committee members and others working in Florida's natural areas, plants may be added or moved up or down from Category I (most invasive) to Category II (less invasive). The committee also maintains an unpublished "To Be Watched" list.

The University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) maintains a risk assessment protocol for predicting invasion risk posed by nonnative plants. Risk is assessed by application of a predictive risk assessment tool (see <http://plants.ifas.ufl.edu/assessment/>). Plants judged as non-problematic at this time are reassessed in 10 years. Those ranked in the caution category are reassessed in two years. Invasive species may be approved for specific uses with reassessment in two years. Those ranked as truly invasive may be reassessed in 10 years.

Neither the FLEPPC Invasive Plant List nor the UF/IFAS risk assessment protocol has any regulatory authority. The Florida Prohibited Plant List [administered by the Florida Department of Agriculture and Consumer Services (FDACS)] and the Federal Noxious Weed List (administered by the U.S. Department of Agriculture) have implicit regulatory powers, but neither list is readily amended. Therefore, these tools are limited in their ability to place timely restrictions on new invasive plant discoveries. Also, the federal list was created to list serious threats to agribusiness, not natural areas.

While information on Florida's nonindigenous species is in many cases deficient, it is clear that the state of Florida faces significant and diverse threats from a large number of taxa. This chapter presents an update on the broad issues of invasive species in the South Florida environment with emphasis on priority nonindigenous plant and animals. Reference is made to Chapter 6 of this volume where an expanded discussion on priority nonindigenous species in the Everglades region is provided, with a special emphasis on these species' potential impacts on restoration objectives. For additional background information on invasive species in South Florida, see Chapter 9 of the *2008 South Florida Environmental Report (SFER) – Volume I*.

NONINDIGENOUS SPECIES IN THE RESTORATION CONTEXT

Successful restoration of South Florida ecosystems hinges on the ability to reverse the environmental degradation chiefly caused by human activities over the last 100-plus years and to prevent further degradation. While the Comprehensive Everglades Restoration Plan (CERP) and Restoration Coordination and Verification (RECOVER) restoration efforts involve numerous factors (e.g., water quantity, water quality, abundance of flora and fauna), the potential impact of invasive species has emerged as a high priority for CERP planning. Invasion of South Florida's natural habitats by nonindigenous plant and animal species has significantly changed the ecosystem, particularly by displacing native species. Without successful control of invasive nonindigenous plant and animal species, the benefits of restoration efforts will be reduced.

As both drivers and stressors of ecosystems, invasive species can alter ecosystem patterns and processes on both small and large scales and may result in unexpected successional trajectories as Everglades restoration proceeds (Ogden et al., 2005; Doren et al., 2009). Therefore, the presence of invasive nonindigenous species may greatly reduce certainty in the ability to predict restoration outcomes, particularly with regard to CERP performance measures. For example, the aggressive spread of two highly invasive grasses, torpedograss (*Panicum repens*) and tropical American watergrass (*Luziola subintegra*), on the Lake Okeechobee marsh may not be significantly reversed through improved hydroperiods and reduced nutrient loading alone. Left unchecked, these species would certainly affect Lake Okeechobee performance measures (e.g., recovery of the native vegetation mosaic or increased native fish recruitment), but the extent of impacts are not fully understood.

Other invasive plant species such as Old World climbing fern and Brazilian pepper (*Schinus terebinthifolius*) are expected to significantly affect Greater Everglades performance measures (e.g., ridge and slough community sustainability) if their continued spread across the landscape is not reversed. While less understood and more difficult to quantify, the impacts associated with the establishment and spread of invasive nonindigenous animals could also alter restoration outcomes and directly or indirectly impact CERP performance measures. For example, free-ranging Burmese pythons prey upon the American alligator (*Alligator mississippiensis*) as well as compete for similar prey in the Greater Everglades (Snow et al., 2007). The impact of these interactions has not been quantified, but the potential for Burmese pythons to alter American alligator abundance and distribution, a CERP performance measure, is a significant concern and warrants investigation (Mazzotti et al., 2009).

Doren et al. (2009) developed a conceptual ecological model (CEM) for invasive species to facilitate understanding of invasive nonindigenous species impacts on Everglades restoration activities. The model identifies effects of invasive species on plant and animal communities, geomorphology, biogeochemistry, disturbance regimes, resource competition, and hydrology. By providing a framework for synthesizing information about individual invasive species and their ecological impacts, the CEM will help those trying to restore the ecosystem identify attributes that will be improved with successful management of each invasive species.

It should be emphasized that the realistic expectation of “successful control” is limiting the impacts of biological invasions, not complete eradication. Nonindigenous species are rarely eradicated from the natural areas they invade (MacDonald et al., 1989; Bomford and O'Brien,



Figure 9-1. Torpedograss (*Panicum repens*) expands into sawgrass marsh within the East Coast Buffer lands (photo by the SFWMD).

1995). Ecosystems resulting from restoration will contain new species assemblages and biotic interactions relative to their predisturbance state, and these new biotic components and interactions are certain to include nonindigenous species (Norton, 2009). In the context of Everglades restoration, agencies must accept that invasions will continue to exert pressure on native species and ecosystem functions in the restored condition. Nonindigenous species are expected to respond differently to restoration and, in some cases, may continue to act as drivers of ecosystem change as restoration proceeds. Improved hydroperiods and water quality may reduce the competitiveness of aggressive plant species, such as Brazilian pepper and melaleuca (*Melaleuca quinquenervia*), but such plant species are likely to persist in the restored state. Other species, particularly many invasive animals, will continue to find suitable niches after restoration. Thus, without a long-term commitment to invasive species management, the goals of Everglades restoration are unlikely to be achieved. Fortunately, the importance of this issue continues to be elevated among state and federal agencies, public and private universities, state and federal task forces, and various other organizations. The consensus among these parties is that control and management of invasive nonindigenous species is a critical component of ecosystem restoration in South Florida.

Scientists and land managers face enormous challenges when attempting to address biological invasions across a landscape as vast as the Greater Everglades. Effective control and management requires an integration of effective control tools, monitoring, research, preventive regulations, and close interagency coordination (Masters and Sheley, 2001). Unfortunately, agencies lack sufficient financial and staffing resources to develop integrative management programs for the overwhelming number and diversity of established or emerging invasive species. For this reason, it is imperative that risk assessment tools be developed both to rapidly assess the likely impacts of newly discovered invasions as well as to determine which unestablished species should be subject to importation restrictions to reduce the number of costly invasions moving forward. Equally important is availability of sustained funding to support management programs for established invasive species. Consistent and dedicated funding for melaleuca control is identified as the primary factor contributing to the success of Florida's melaleuca management efforts (FLEPPC, 1999). Without similar dedicated funding for other priority invasive taxa, scientists and land managers are unlikely to develop sustainable management programs for these species, who will continue to negatively affect the outcome of restoration objectives.

SUMMARY OF INVASIVE SPECIES CONTROL TOOLS

Many different techniques are used to control invasive plants and animals in South Florida (Langeland and Stocker, 1997; Wittenberg and Cock, 2001). The District and other agencies typically use tools in an integrated fashion with the goal of minimizing impacts of invasive species by the most cost-effective and environmentally sound means. A detailed account of invasive species management tools and strategies is presented in Chapter 9 of the 2006 SFER – Volume I. The following is a brief summary of available management tools for controlling invasive species.

Invasive Plant Control Tools

Tools for controlling invasive plants are well developed and widely utilized although their application in natural areas has limitations. Researchers are refining these control methods to be more effective in natural areas. The following list provides a generalized description of available plant control techniques:

- **Biological Controls.** Use of living organisms, such as predators, parasitoids, and pathogens. “Classical” biological control seeks to locate host-specific pests from the plant’s native range and import these species to attack and control the plant in

regions where it has become invasive. For example, the alligatorweed flea beetle (*Agasicles hygrophila*) was introduced to North America in 1964 from Argentina to combat alligatorweed (*Alternanthera philoxeroides*). This insect continues to provide excellent alligatorweed control and has not caused damage to any other plants.

- **Herbicides.** Use of pesticides designed to control plants. Herbicides approved for aquatic use or in terrestrial natural areas are a vital component of most control programs and are used extensively for invasive plant management in South Florida. Two of the 20 herbicides employed to control invasive plants in South Florida include 2,4-D (2,4-dichlorophenoxyacetic acid), which has been used as an herbicide since the 1940s, and Imazamox (trade name CLEARCAST™). In 1985, the U.S. Environmental Protection Agency (USEPA) held that 2,4-D was eligible for re-registration, following a full re-registration review of its toxicology and environmental impacts. This re-registration included all prior application sites, including aquatic ones. It is very effective on water hyacinth (*Eichhornia crassipes*). Because 2,4-D is generally more active in dicots than monocots, it can selectively control dicots growing mixed within monocots, such as broadleaf weeds growing within grasses. Imazamox is among a number of herbicides recently receiving USEPA registration for use in aquatic settings. These new aquatic uses are important for invasive plant management in Florida since many invaded sites are at least temporarily flooded. Imazamox has been found to be effective on several weeds, including Chinese tallow tree (*Sapium sebiferum*) and wild taro (*Colocasia esculenta*).
- **Manual and Mechanical Controls.** Use of bulldozers, specialized logging equipment, aquatic plant harvesters, or hand pulling to control invasive plants. While costly, these methods are often used when other control techniques may cause unacceptable damage to native species or when removal of invasive plant biomass is necessary to achieve restoration objectives.
- **Cultural Practices.** Use of prescribed burning, water level manipulation, or native species plantings to control invasive plants. Fire can be used to suppress plant growth and kill both native and nonnative plants that are not fire tolerant. Regulating water levels may reduce invasive plant species in aquatic and wetland habitats. Planting native species may reduce the susceptibility of aquatic and wetland sites in some cases.

Invasive Animal Control Tools

Operational management tools to control invasive animals in Florida's natural areas are poorly developed or, in some cases, developed but not fully implemented. There is not a single agency in the state that has a dedicated program to deal with the operational-type control and management of nonindigenous wildlife or marine species (ISWG, 2003). The following list provides a generalized description of techniques for control of nonindigenous animal species:

- **Exclusion.** Use of barriers (e.g., electrical, hydraulic, sound) in terrestrial or aquatic environments to prevent target species from moving into unaffected areas. For example, electrical barriers are currently being utilized to limit movement of Asian carp from the Illinois River into the Great Lakes.
- **Habitat Manipulation.** Removal of food and/or water sources or breeding sites, or preventing the use of habitats by target species to reduce species population growth or tendency to occupy an area. For example, the District and the Florida Fish and Wildlife Conservation Commission (FWC) recently removed large

melaleuca slash piles in and around the area known to harbor the northern African python (*Python sebae*). These large debris stockpiles were thought to provide nesting habitat for this species.

- **Trapping.** Use of snares, nets, or cage traps to catch individuals of the target species to be relocated or disposed of humanely.
- **Hunting or Fishing.** Use of recreational hunting or fishing as a means to reduce populations of the target species. Hunting programs are frequently used to manage nutria (*Myocastor coypus*) populations in Louisiana and other states.
- **Biological Control.** The development of biological agents that can be introduced to reduce target species populations. Intentional releases of the Myxoma virus have successfully reduced invasive rabbit populations in Australia.
- **Chemical Control.** Use of direct chemical application or bait stations to dispatch target species or interrupt breeding.
- **Sterilization.** Reduce reproduction to phase out populations of the target species in specific areas. For example, new chemical fertility control technologies are being utilized in Australia and Asia to control invasive rodent species.

THE DISTRICT'S INVASIVE SPECIES PROGRAM

The District maintains 2,600 miles of flood protection and water management canals and levees in South Florida's 16 counties and is engaged in many ecosystem protection and restoration projects. The District's Strategic Plan provides the agency and the public it serves with a blueprint for meeting the challenges of balancing the needs of the natural environment with the demands of Florida's growing population and important agricultural industries. Controlling nonindigenous species is cited as an important strategy and success indicator in the agency's Strategic Plan. Nonindigenous species management is listed as a deliverable in five of the 11 overall Strategic Plan goals. Successfully managing these species also is tangentially key to many of the other Strategic Plan goals as nonindigenous species affect everything from evaluating environmental resource permits to managing Stormwater Treatment Areas (STAs) to restoring natural fire regimes.

The District spent roughly \$24 million in Fiscal Year 2010 (FY2010) (October 1, 2009–September 30, 2010) for overall invasive species prevention, control, and management in South Florida. The agency has played a key role in the invasive plant management program in Florida for many years. Achievements include the progress made regionally on melaleuca. Once covering hundreds of thousands of acres, this species now is only occasionally spotted by resource managers flying over Lake Okeechobee and Water Conservation Areas 2 and 3 (see Chapter 6 of this volume). What seemed to be an insurmountable invasive species is now successfully managed through sustained interagency commitment.

To address invasive species problems, the District takes a strategic approach utilizing the following components:

- **Management.** Control programs implemented by the District including regional field stations.
- **Monitoring.** Regional and site-specific monitoring for invasive species, often in partnership with other agencies.
- **Research.** Applied research aimed at developing or improving management tools for invasive species. These efforts are conducted both in-house and through contractual agreements with other agencies or private environmental firms.
- **Education and Outreach.** Outreach efforts involving interactions with the media and developing printed materials, such as weed identification cards and fact sheets.
- **Regulatory.** Frequent coordination with state and federal regulatory agencies to advocate prevention of intentional and accidental introductions of nonnative species. Additionally, the District's regulatory branch imposes invasive plant control requirements as part of the state/District's environmental resource permitting program.

Different species and projects often require coordination between multiple state and federal agencies and the District. Examples include separate regional interagency aquatic plant management groups for Lake Okeechobee and the Kissimmee Chain of Lakes. Acting with interagency concurrence, each group plans, reviews, and implements control efforts. Management of different species is often conducted by differently empowered agencies. For instance, the U.S. Army Corps of Engineers (USACE) manages floating weeds in Lake Okeechobee because the mobile nature of these plants threatens navigation in the Okeechobee Waterway. The USACE mandates do not empower that agency to manage many other invasive plants found elsewhere in the lake. The District manages these plants with internal and FWC funding.

Special considerations often arise, particularly with regard to endangered species. For example, during the past decade, Everglade snail kite (*Rostrhamus sociabilis plumbeus*) populations have fallen precipitously in Florida. Interagency coordination of aquatic plant control has included development of guidelines to avoid adverse impacts upon the bird's populations. Also, plant managers in Lake Okeechobee remain aware that control operations must avoid disturbing the endangered Okeechobee gourd (*Cucurbita okeechobeensis* ssp. *okeechobeensis*).

Regulatory coordination is also continual. Invasive plant control efforts within the District, such as in the STAs, need to proceed within the operational constraints and requirements of the Florida Department of Environmental Protection (FDEP) permits and mandates of the Everglades Forever Act.

Table 9-1 provides brief updates on the District's invasive species management activities and also serves to cross-reference coverage of invasive species issues in other chapters and volumes of the 2011 SFER.

Table 9-1. Summary of Water Year 2010 (WY2010) (May 1, 2009–April 30, 2010) District invasive species management activities in relation to the following operational mandates: Comprehensive Everglades Restoration Plan (CERP); Everglades Forever Act (EFA), Section 373.4592, Florida Statutes (F.S.); Long-Term Plan for Achieving Water Quality Goals in the Everglades Protection Area (LTP); Florida Aquatic Weed Control Act (AWCA), Section 369.20(2), F.S.; Florida Communities Trust Act (FCT), Section 380.501, F.S.; Invasive Nonnative Plants (INP), Section 369.251, F.S.; and Water Resources Act (WRA), Chapter 373, F.S.

Project	Outcomes/Findings	Agency Partners*	Mandates
Control Programs			
Systemwide			
Biological Control Implementation for Invasive Plant Species (see <i>Updates</i> section of this chapter)	<p><u>Melaleuca</u>: A fourth biological control agent, the <i>Melaleuca</i> gall midge, was released and is dispersing quickly. The previously released melaleuca weevil and psyllid remain widely established and together the three insects account for > 80% stem mortality in some areas.</p> <p><u>Old World climbing fern</u>: Three biological control agents have been released against the climbing fern. To date, the brown moth appears to be the most effective agent of this invasive weed.</p> <p><u>Water hyacinth</u>: A new insect, <i>Megamelus scutellaris</i>, was released into the field in February 2010, with more than 20,000 individuals released at Stormwater Treatment Area 1-West (STA-1W).</p>	USDA-ARS	EFA, CERP, INP
Aquatic Plant Control in the Regional Water System	Multiagency management has nearly eliminated water hyacinth and water lettuce from urban canal systems in Broward and Miami-Dade counties. "Newer" nonindigenous aquatic plants, including <i>Hygrophila</i> spp., <i>Rotala</i> spp., <i>Limnophila</i> spp., and floating heart, continue to pose greater management difficulties.	FWC, local drainage agencies	AWCA
Biological Control of Aquatic Weeds Using Asian Grass Carp (<i>Ctenopharyngodon idella</i>)	During Fiscal Year 2010, 48,851 grass carp were released in 16 canals for the control of hydrilla and other submerged aquatic vegetation.	FWC, local drainage agencies	AWCA

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
Control Programs			
Systemwide			
CERP – Implement Biological Controls Project	The Final Project Implementation Report/Environmental Assessment was approved and signed in June 2010. Execution of the Project Partnership Agreement and Cooperative Agreement on Lands is expected in July 2010, followed by the rearing facility design-build contract award in September 2010.	USACE, USDA-ARS	CERP
Kissimmee Chain of Lakes			
Aquatic Plant Control	Ongoing management aims to keep floating weeds at low levels for environmental, navigational, and water management functions. Hydrilla treatments are made in areas of highest priority.	FWC, USACE	AWCA
Region-wide Control of Upland Invasive Plants (see Volume II, Chapter 6B)	Aerial surveys for Old World climbing fern are conducted annually and treatments scheduled as new infestations are identified. There has been significant progress toward control of soda apple due to successful biological controls. Control efforts also continue for cogongrass, Chinese tallow, and Brazilian pepper.	Osceola Co.	WRA
Kissimmee/Okeechobee Region			
Invasive Plant Control for the Kissimmee River Restoration Project (see 2010 SFER – Volume I, Chapter 11)	Many priority invasive plant species are being successfully managed, although some difficult-to-control species continue to threaten restoration goals. Research to improve control tools for these species is ongoing.	FWC, USACE, FDEP	AWCA

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
Kissimmee/Okeechobee Region			
Region-wide Control of Upland Invasive Plants (see Volume II, Chapter 6B)	Aerial surveys for Old World climbing fern are conducted annually and treatments scheduled as infestations are found. New infestations of this species are increasing in number, and it is proving difficult to stay ahead of its spread.	FWC	WRA
Lake Okeechobee			
Invasive Grass Management (see Chapter 10 of this volume)	Ongoing treatments aim to manage invasive grasses and take advantage of seasons or conditions when best control can be gained. New arrivals to Florida, such as tropical American watergrass, Wright’s nutrush, and West Indian marsh grass, will likely continue to appear and pose new management problems	FWC, USACE	AWCA
East Coast Region			
Region-wide Control of Upland Invasive Plants (see Volume II, Chapter 6B)	The primary nonindigenous plant species targeted in this region are Old World climbing fern, melaleuca, and downy rose myrtle. Secondary nonindigenous plant species exotics in this region include cogongrass, Chinese tallow, soda apple, primrose willow, and Brazilian pepper. The District also assisted the FDEP with control of Java plum (<i>Syzygium cumini</i>) over 100 acres in the Loxahatchee River floodplain.	FWC, Martin Co., NRCS, Loxahatchee River Preservation Initiative, FDEP	CERP, EFA, FCT, WRA

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
West Coast Region			
Invasive Plant Control for Corkscrew Regional Ecosystem (see Volume II, Chapter 6B)	Sustained control efforts for priority invasive plant species continue. The focus remains on Old World climbing fern, melaleuca, cogongrass, and downy rose myrtle.	---	WRA
Everglades Region			
Giant Constrictor Snake Management	<p>District staff and agency partners continue to remove live pythons found during routine searches. Between January and October 2010, 255 Burmese pythons were removed from Everglades National Park and surrounding areas. The sharp reduction in removed Burmese pythons is attributed to record low sustained temperatures during January 2010.</p> <p>Northern African pythons were confirmed as established near the eastern boundary of Everglades National Park in 2010. Inter-agency rapid response efforts to eradicate this species are underway. The District and USDA-Wildlife Services have entered into a one-year agreement to conduct trapping and hunting activities in the region where this new invasive species has been found.</p>	FWC, NPS, UF, USDA-Wildlife Services	EFA
Everglades Invasive Plant Management	Systematic control of melaleuca, Brazilian pepper, Old World climbing fern, and other species continue in Water Conservation Areas 2 and 3 (WCA-2 and WCA-3). Maintenance-level control of priority species is now achieved for large expanses of the WCAs. The District, in close collaboration with Miami-Dade County, continued efforts to control shoebuttton ardisia and restore impacted tropical hardwood hammocks and freshwater marsh in the C-111 Project area.	FWC, Miami-Dade Co.	EFA, INP

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
Monitoring (see <i>Updates - Monitoring</i> section)			
Tree Island Surveys for Old World Climbing Fern in the Water Conservation Areas (see Volume I, Chapter 6)	During the reporting period, 20 islands were surveyed in WCA-3. Original expectations were that adjacency to other infestations would indicate risk. However, analysis of survey data revealed that tree islands with Old World climbing fern were located in areas where water depths were significantly higher and where depth variability was high; adjacency seems to be unimportant.	---	EFA
Digital Aerial Sketch Mapping (DASM) of Invasive Plants (see Volume I, Chapter 6)	The District and agency partners mapped invasive plant infestations in the entire Everglades Protection Area in 2009 and 2010. The distribution and abundance of Australian pine, Brazilian pepper, melaleuca, and Old World climbing fern were determined for the 2.8 million-acre survey area.	NPS	EFA
Invasive Animal Survey Team	District staff continues periodic exotic animal surveys along levees and roads throughout the region. The effort is intended to augment interagency invasive animal monitoring and control efforts.	NPS, FWC	EFA
Research in Support of Management			
Burmese Python Trap Development and Remote Tracking Assessments	Ongoing research under a UF contract for control of Burmese pythons includes (1) further field-based trap evaluations, (2) "Judas Snake" experiments using released snakes with transmitters to locate other snakes, and (3) methods development for use of implanted satellite transmitters to study fine scale animal movement and habitat utilization. While capable of capturing pythons, traps have limited capacity to capture animals at low population densities. Effective attractants are needed to draw snakes to traps. One male with a transmitter implant led to the capture of 1 female and 3 male pythons. An Argo satellite transmitter was successfully implanted into a python and field testing of fine scale movement measurements is under way.	NPS, UF/IFAS, USGS	EFA

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
Research in Support of Management			
Burmese Python Monitoring System	Research is underway to develop a cost-effective monitoring protocol using constructed refugia in combination with attractants. Unlike trapping systems, which require frequent inspection, strategically placed artificial refugia may provide a means to inexpensively create a regional monitoring network for large constrictors. To date, no constrictors have been observed utilizing the refugia, but results may be confounded by freeze-induced population decreases.	---	EFA
Herbicide Efficacy and Selectivity of Aquatic Weeds	Research to evaluate herbicide resistance and selectivity among invasive aquatic weeds common in Everglades Stormwater Treatment Areas (STAs) is ongoing. Seven recently approved aquatic herbicides and three experimental use herbicides are being tested in STA test cell ponds to determine efficacy and selectivity profiles for undesirable invasive plants in STAs.	UF	LTP, EFA
Development of Biological Controls for Priority Invasive Plant Species	Biological control research conducted by agency partners is focused on developing new control agents for Brazilian pepper, carrotwood, Chinese tallow, melaleuca, downy rosemyrtle, skunkvine, water hyacinth, water lettuce, wetland nightshade, and Jamaican nightshade.	UF/IFAS, USDA-ARS	EFA, CERP
Herbicide Evaluations for the Control of Tropical American Watergrass	Trials have found effective herbicide and surfactant mixtures for this plant, a recent discovery in North America in Lake Okeechobee. Lack of any prior experience with its biology and management confound control efforts. The plant is spreading; isolated new populations have been found in 2009 and are being treated.	FWC, UF/IFAS, USACE	AWCA, EFA, CERP

Table 9-1. Continued.

Project	Outcomes/Findings	Agency Partners*	Mandates
Research in Support of Management			
Herbicide Evaluations for the Control of Downy Rosemyrtle	Research is under way to compare control efficacy and selectivity of several widely prescribed herbicides and mechanical control techniques for this species. Recovery patterns of native plant communities are also being investigated. Preliminary results suggest that the herbicide dicamba in combination with pretreatment biomass removal (shredding) effectively controls downy rose myrtle with minimal damage to many common native species.	---	EFA, CERP
Bioherbicide for Old World Climbing Fern Using Established Pathogens	FIU researchers evaluated 78 fungal and 15 bacterial isolates collected from Old World climbing fern in Florida for pathogenicity. All bacterial isolates from disease samples were found to be non-pathogenic on Old World climbing fern, but 12 fungal isolates were highly pathogenic. Greenhouse inoculation experiments found that three of the fungal isolates caused more than 50% disease incidence. In a host range study on six native fern species, three of the fungal isolates that were found to be highly pathogenic to Old World climbing fern did not produce any symptoms on native ferns. Feasibility research for operational development of native pathogens is needed.	FIU	EFA, CERP

*Agency Partners include:

- FIU - Florida International University
- FDEP - Florida Department of Environmental Protection
- FWC - Florida Fish and Wildlife Conservation Commission
- NPS - National Park Service
- NRCS - United States Department of Agriculture – Natural Resources Conservation Service
- UF - University of Florida
- UF/IFAS - University of Florida/Institute of Food and Agricultural Sciences
- USACE - U.S. Army Corps of Engineers
- USDA-ARS - U.S. Department of Agriculture – Agricultural Research Service
- USGS - U.S. Geological Survey

Note: With the exception of Java plum (*Syzygium cumini*), tropical soda apple (*Solanum viarum*), West Indian marsh grass (*Hymenachne amplexicaulis*), and Wright’s nutrush (*Scleria lacustris*), scientific names for species in this table are given throughout this chapter.

UPDATES

LEGISLATIVE AND POLICY INITIATIVES

Plant Importation

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) added Old World climbing fern and maidenhair creeper (*Lygodium flexuosum*) to the Federal Noxious Weed List on April 27, 2010. Interstate movement and possession of these species are now prohibited in the United States, and scientists are now required to have a federal permit in order to grow and work with these species.

As reported in the 2010 SFER – Volume I, Chapter 9, APHIS is proposing important revisions to its regulations on the importation of plants for planting and propagation (nursery stock), familiarly known as Q-37. APHIS proposes to establish a new category of plants, Not Authorized Pending Plant Risk Analysis. These plant taxa would be prohibited for importation into the United States until a pest plant risk assessment is completed. The proposed rule changes were published in the Federal Register on July 23, 2009, with a public comment period extending through October 21, 2009. As of this writing, the APHIS is still in the process of analyzing and responding to public comments.

Animal Importation

Establishing compulsory risk assessments and a “clean list” of approved species at the federal level represents a much-needed shift in the approach to regulating the flow of potentially harmful nonnative wildlife into the United States. As reported in the 2010 SFER – Volume I, Chapter 9, the Nonnative Wildlife Invasion Prevention Act (HR 669), introduced in 2009, calls for the Secretary of the Interior to establish a risk assessment process to prevent the introduction into, and establishment in, the United States of nonnative wildlife species that will or are likely to cause economic or environmental harm or harm to other animal species’ health or human health. The Secretary would also be directed to create a preliminary list of species approved for importation, possession, and trade, and then classify remaining species as either approved, unapproved, or undetermined. Unapproved species could not be imported, transported across state lines, or possessed within a state.

HR 669 was referred to the House Natural Resources, Subcommittee on House Natural Resources, Subcommittee on Insular Affairs, Oceans and Wildlife in 2009. The House Natural Resources Committee, Subcommittee on National Parks, Forests and Public Lands, and Subcommittee on Insular Affairs, Oceans and Wildlife held a joint oversight hearing on “How to Manage Large Constrictor Snakes and Other Invasive Species” on March 23, 2010. The District participated in this hearing and provided information about the impacts of giant constrictor snakes on the State of Florida and current measures being taken to contain the population of nonnative python and other giant constrictor species within Florida. As of this writing, HR 669 remains in the House Natural Resources Committee.

In the absence of proactive regulations that would help prevent introductions of potentially invasive species, agencies and the public must rely on the Lacey Act (42 U.S.C. § 18), which allows the U.S. Fish and Wildlife Service (USFWS) to regulate international wildlife trade and addresses threats to native wildlife resources. A 1981 amendment to the Lacey Act allows for the regulation of importation or interstate commerce of animals that have been determined to be injurious to human beings or to wildlife resources. However, USFWS responses to petitions are slow, and it typically takes four or more years for a listing consideration. In 2006, the District’s Governing Board petitioned the USFWS to list the Burmese python as an injurious species. On

January 20, 2010, Secretary of the Interior Ken Salazar announced that the USFWS would propose to list the Burmese python and eight other large constrictor snakes that threaten the Everglades and other sensitive ecosystems as “injurious wildlife” under the Lacey Act. The initial public comment period on the proposed rule closed on May 11, 2010. However, the public comment period reopened for 30 days on July 1, 2010, to give the public time to provide additional biological, economic, and other data regarding the addition of these species to the list of injurious reptiles.

State Regulation of Nonindigenous Reptiles

The State of Florida made significant progress toward preventative regulation of nonindigenous animals in 2010. The Florida Non-native Wildlife Bill (Section 373.372, F.S.) was signed by Governor Charlie Crist in June 2010, resulting in the reclassification of eight species listed as Reptiles of Concern (seven giant constrictor snakes and the Nile monitor lizard) as conditional reptiles. Acquisition of these conditional snakes and lizards is now prohibited for personal possession in Florida, although dealers, breeders, exhibitors, and researchers may obtain a permit for procession and sale outside of Florida. Individuals in possession of these reptiles prior to rule implementation may keep their animal and must maintain a valid Reptile of Concern permit.

The FWC continued efforts to address risk management and risk assessment of potentially invasive reptiles by forming a Reptiles of Concern Technical Assistance Group (ROC TAG) in 2010. A District representative and seven other experts served on the ROC TAG, representing a broad spectrum of expertise in herpetology, scientific research and academia, conservation and land management, disease/bioterrorism, animal welfare and all facets of the reptile industry. Final recommendations of ROC TAG included (1) increasing biosecurity regulations for possessors of ROC species, (2) strengthening ROC identification requirements, (3) recommendations for a procedure to add species to the ROC list, and (4) recommendations for appropriate risk analysis methods for ROC, including ecological risks and mitigation measures.

During 2010, the FWC continued with two initiatives aimed at the removal of priority nonindigenous reptiles from South Florida natural areas. The FWC, in partnership with the District and in consultation with the National Park Service (NPS), began a pilot permitting program in 2009, which allowed permitted herpetology experts to enter state-managed lands in South Florida to hunt species formerly on the Reptiles of Concern list. The program was extended in 2010. As of this writing, 18 individuals have been permitted under this program with a combined result of 52 removed pythons. A second initiative, which allows licensed recreational hunters to harvest Burmese pythons and other conditional reptiles and lizards, was implemented in 2010. To date, no conditional reptiles have been removed through this hunting program.

INTERAGENCY COORDINATION

This section provides updates on key interagency coordination activities pertaining to invasive nonindigenous species in South Florida during Water Year 2010 (WY2010) (May 1, 2009–April 20, 2010). To be successful, regional management of nonindigenous species requires strategic integration of a broad spectrum of control measures across multiple jurisdictions. As such, numerous groups and agencies are necessarily involved with nonindigenous species management in Florida. For additional information on agency roles and responsibilities pertaining to nonindigenous species in Florida, see the Environmental Law Institute’s report, *Filling the Gaps: Ten Strategies to Strengthen Invasive Species Management in Florida*, available at www.elistore.org/reports_detail.asp?ID=11002&topic=Biodiversity_and_Invasive_Species.

Cooperative Invasive Species Management Areas

Florida has a long history of invasive species organizational cooperation including the FLEPPC, Noxious Exotic Weed Task Team (NEWTT), Florida Invasive Animal Task Team, and Invasive Species Working Group (ISWG). At more local levels, land managers and invasive species scientists have informally coordinated “across the fence line” for many years. These regional groups recently began formalizing their partnerships into Cooperative Invasive Species Management Areas (CISMAs) to further enhance collaboration and coordination. CISMAs are local organizations, defined by a geographic boundary, that provide a mechanism for sharing invasive plant and animal management information and resources across jurisdictional boundaries to achieve regional invasive species prevention and control (MIPN, 2006). Based on the success of CISMAs in Florida and in western states, the Florida Invasive Species Partnership (FISP), formerly the Private Lands Incentive subcommittee of ISWG, expanded its reach to act as a statewide umbrella organization for Florida CISMAs (www.floridainvasives.org/). The FISP is an interagency collaboration, made up of federal, state, and local agencies and non-governmental organizations and universities, focused on addressing the threat of invasive nonnative species to Florida’s wildlife habitat, natural communities, working agricultural lands, and forest lands. The FISP serves Florida’s CISMAs by facilitating communication between existing CISMAs, fostering the development of new CISMAs, and providing training and access to existing online resources and efforts. To date, 16 CISMAs are in Florida (www.floridainvasives.org/cismas.html).

The Everglades CISMA was formed in 2006. That year, the District and NPS co-hosted the Everglades Invasive Species Summit, an annual invasive species coordination meeting. The Everglades CISMA was established during the summit because attendees recognized the need for a more defined commitment to cooperation among agencies and organizations. The Everglades CISMA partnership was formalized in 2008 with a Memorandum of Understanding (MOU) between the District, USACE, FWC, NPS, and USFWS. The MOU recognizes the need for cooperation in the fight against invasive species and affirms the commitment of signatories to a common goal. Currently, the Everglades CISMA consists of 19 cooperators and partners, spanning the full spectrum of jurisdictions, including tribal, federal, state, local, and non-governmental conservation organizations. The Everglades CISMA has greatly improved coordination and collaboration since its inception. Major accomplishments include:

- Development of region-wide invasive species monitoring programs
- Successful rapid response efforts for the sacred ibis (*Threskironis aethiopicus*) and kripa (*Lumnitzera*)
- Standardized data management for invasive species control activities
- Production of training and outreach materials
- Production of an early detection/rapid response plan
- Creation of a web-based invasive species reporting system

More information about the Everglades CISMA is available at www.EvergladesCISMA.org.

Land managers along Florida’s Treasure Coast have also established a regional partnership to cooperatively address the threats of invasive plants and animals. The Treasure Coast CISMA partnership extends from Indian River County south through St. Lucie, Martin, and northern Palm Beach counties and includes representatives and land managers from local, state, and federal governments. Groups involved include the District, Florida Park Service, FWC, Indian River County, Martin County, Natural Resources Conservation Service, Palm Beach County Environmental Resources Management, Palm Beach County Solid Waste Authority, St. Lucie

County, St. Lucie County Mosquito Control District, The Nature Conservancy, the Treasure Coast Resource Conservation and Development, USFWS, and UF/IFAS.

The Treasure Coast CISMA has established goals centered around cross-jurisdictional efforts to (1) reduce and control the spread of existing invasive species, (2) prevent the establishment and spread of new invasive species, (3) build working relationships between public and private stakeholders to foster cost-effective control of invasive species, (4) provide education and information exchange about invasive species among stakeholders, and (5) promote applied research in invasive species management. In the past two years, the Treasure Coast CISMA has specifically focused its cooperative control efforts on one coastal species, beach naupaka (*Scaevola taccada*). Several acres of this species have been removed from ocean dune and back dune scrub on federal, state, and county conservation lands, as well as on a few private lands. The Treasure Coast CISMA has also provided invasive species outreach at county fairs, state park events, Earth Day events, and through involvement with UF/IFAS educational programs. This year, the CISMA will increase its work to include early detection and rapid response species ranking, subsequent training, and cooperative workdays.

In addition to Everglades and Treasure Coast CISMA, there are five other CISMAs either wholly or partially within the footprint of the Greater Everglades ecosystem: Florida Keys Invasive Species Task Force, Southwest Florida CISMA, Heartland CISMA, Osceola County Cooperative Weed Management Area, and the Central Florida CISMA. These CISMAs have also recognized many successes that have benefited the Everglades ecosystem by furthering the concept of a landscape level approach to invasive species management.

Early Detection and Rapid Response

Existing management programs are in place for well-established invasive plant species, but regional programs, which effectively address new invasions, are lacking. Should prevention programs fail and new invasions occur, short-term and localized efforts to contain and hopefully eradicate newly established species are more likely to be successful than dealing with long-term management after populations become more widespread. The ability to respond quickly to emerging threats depends upon awareness that the species is both establishing and represents a significant threat. As such, early detection and rapid assessment are critical precursors to the response. Monitoring programs, efficient interagency communication networks, assessment tools, and basic knowledge of the biology and ecology of targeted species must be integrated into a system that allows scientists and land managers to reach a consensus on whether prompt responses are justified.

In 2010, members of the Everglades CISMA completed an Early Detection/Rapid Response (EDRR) Plan to provide a framework and set of strategies to promptly act on emerging threats. The plan includes EDRR objectives and tasks, a list of priority species, decision making protocols to facilitate rapid completion of threat assessments and response plans, and guidelines for standardized training. This plan was greatly strengthened by incorporating knowledge gained from several Everglades CISMA EDRR initiatives. However, insufficient funding and slow budgeting processes are the primary limitations in achieving EDRR success. Everglades CISMA members are working to develop mechanisms to provide funding, staffing, and other resources needed to ensure swift action on emerging threats that do not fall within invasive species management programs. During 2010, members of Everglades CISMA worked with the Working Group of the South Florida Ecosystem and Restoration Task Force (SFERTF) to identify the next steps for regional invasive species prevention and management. Further refinement of regional EDRR efforts was identified by the group as a critical need. In October 2010, recommendations were made to the SFERTF to create a federal position for a regional EDRR coordinator and to establish dedicated funding for monitoring and rapid response efforts as new invasions are

identified. If approved, this EDRR coordinator would greatly enhance current ad hoc efforts to organize EDRR activities.

CERP BIOLOGICAL CONTROLS PROJECT

The CERP Melaleuca Eradication and Other Exotic Plants – Implement Biological Controls Project is dedicated to the implementation of biological control agents to address the spread of invasive nonindigenous plants throughout the CERP area. The project includes the construction of a mass rearing annex to the existing U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) biological control facility in Davie, FL, in support of implementing the mass rearing, field release, establishment, and field monitoring of approved biological control agents for melaleuca and other invasive nonindigenous species. The Final Project Implementation Report/Environmental Assessment, the Project Partnership Agreement and Cooperative Agreement on Lands, and the design-build contract were all executed in 2010. Construction of the mass rearing facility is scheduled to be completed by December 2012, at which time mass rearing and release operations will commence.

PROGRESS TOWARD MANAGEMENT AND CONTROL

Invasive Plant Management

The District and other agencies continue to make significant progress toward achieving maintenance control of priority, nonindigenous plant species on public conservation lands in South Florida. Large sections of the Greater Everglades have reached or are nearing maintenance-control levels where melaleuca once dominated sawgrass marsh. Recent funding increases for invasive plant management at the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) have resulted in substantial reductions in melaleuca infestations in Water Conservation Area 1. However, remote sections of the southeastern area of Everglades National Park (ENP or Park) and the Refuge remain moderately to heavily impacted by difficult-to-control invasive plants. In these areas, the challenges of invasive plant control are immense due to inadequate financial resources and heavy infestations in difficult-to-access areas. It will likely be decades until these areas are successfully under control.

In **Table 9-2**, the District's FY2010 expenditures for priority, nonindigenous plant control are summarized by module. In addition to these species, the District directs its contractors to control all invasive plant species identified by the FLEPPC as Category 1 species (FLEPPC, 2007). In FY2010, the SFWMD spent more than \$24 million for overall invasive species prevention, control, and management in South Florida. In anticipation of continued budget shortfalls, the District reevaluated invasive plant management priorities to assure that gained ground is not lost. Experience has shown that vigilant reconnaissance and re-treatment is necessary to maintain low levels of established invasive species. Biological controls are proving to be beneficial in this regard by reducing the rate of reestablishment for some species (Overholt et al., 2009; Rayamajhi et al., 2008). However, successful biological control programs are in place for only a handful of priority species, so land managers must persist with frequent monitoring and control efforts.

Additional efforts will need to focus on invasive microbes not previously considered factors in carrying out the District's mission. Citrus diseases (e.g., citrus canker, citrus greening) are overtaking fallow citrus groves on interim District lands acquired for future restoration projects. Vegetation management on these lands was previously considered a lower priority since vegetation would be cleared in the early stages of project construction. However, these sites have become breeding grounds for crop diseases that can spread to active groves on adjacent lands. Between 2009 and 2010, the District physically removed citrus from 260 acres and applied herbicide to another 3,100 acres on interim lands.

Table 9-2. Summary of priority, invasive plant species control expenditures by the South Florida Water Management District (SFWMD or District) in Fiscal Year 2010 (FY2010) (October 1, 2009–September 30, 2010) organized by the five land management regions: Upper Lakes (UL), Kissimmee/Okeechobee (KO), Everglades (EG), East Coast (EC), West Coast (WC), Lake Okeechobee (LO), and System-wide Biological Control (SW).

	UL	KO	LO	EG	EC	WC	SW	Total
Australian pine (<i>Casuarina equisetifolia</i>)			1,622	124,540	504	20		126,686
Brazilian pepper (<i>Schinus terebinthifolius</i>)	125,009	315,322	190,692	551,879	538,421	608,679	125,000	2,455,002
Cogongrass (<i>Imperata cylindrica</i>)	3,419		10	879	21,766	42,712		68,786
Downy rose myrtle (<i>Rhodomyrtus tomentosa</i>)					231,868	98,948		330,816
Hydrilla (<i>Hydrilla verticillata</i>)	119,795	1,185	26,453	14,709	201	170,636		332,979
Melaleuca (<i>Melaleuca quinquenervia</i>)			49,396	1,493,390	112,468	1,803	150,000	1,807,057
Old World climbing fern (<i>Lygodium microphyllum</i>)		308,962		309,421	379,655	12,630	150,000	1,160,668
Shoebuttan ardisia (<i>Ardisia elliptica</i>)				212,439	4,968			217,407
Torpedograss (<i>Panicum repens</i>)	7,449	17,148	831,272	16,860	1,901	34,027		908,657
Water hyacinth (<i>Eichhornia crassipes</i>)	78,647	89,022	64,846	221,336	6,267			460,118
Water lettuce (<i>Pistia stratiotes</i>)	78,647	89,022	64,846	8,897	1,299			242,711

Invasive Reptile Management

Intensified efforts to develop control tools and management strategies for several priority species continued in WY2010. These include the Burmese python and other giant constrictors, Nile monitor, and Argentine black and white tegu (*Tupinambis merianae*). Control tools are very limited for free-ranging reptiles, and the application of developed methods is often impracticable in sensitive environments where impacts to non-target species are unacceptable. Additionally, scant information on the species' natural history in its introduced range often prevents effective use of existing control methods. Available tools for removing reptiles generally include trapping, toxicants, barriers, dogs, and introduced predators (Witmer et al., 2007), as well as visual searching and pheromone attractants. Reed and Rodda (2009) provide a thorough review of primary and secondary control tools that may be considered for giant constrictors.

Progress in Fiscal Year 2010

Collaborative research to develop an effective trapping program for free-ranging pythons and other giant constrictor snakes is ongoing. District-funded research by UF has culminated in a trap capable of capturing free-ranging pythons, but capture rates are low (Cherkiss et al., 2009). The current focus is on developing effective attractants to draw these ambush predators to the traps. Concurrent with these efforts, the District is evaluating the use of artificial refugia in combination with scent attractants and self-baiting rodent feed. To date, these methods have not resulted in python captures, but are likely confounded by freeze induced declines in python densities. To improve knowledge of fine-scale movements and habitat use of Burmese pythons, researchers are developing methods for implanting satellite transmitters in adult pythons. If successful, this innovation will greatly enhance currently established remote tracking programs that rely on the “Judas snake” approach to locating new snakes.

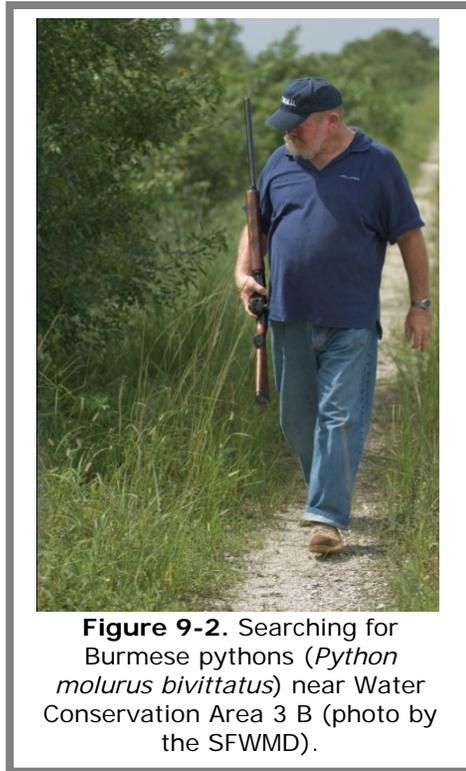


Figure 9-2. Searching for Burmese pythons (*Python molurus bivittatus*) near Water Conservation Area 3 B (photo by the SFWMD).

Detection dogs are another proposed tool for locating free-ranging pythons in South Florida (Reed and Rodda, 2009). Specially trained detection dogs have been used successfully to detect brown tree snakes (*Boiga irregularis*) in cargo shipments leaving Guam (Engeman et. al, 2002). Following initial consultation with dog training experts at Auburn University's Animal Health and Performance Program, the USACE, NPS, and District are proceeding with a one-year feasibility study with Auburn University for python detection using dogs. The preliminary plans are to train six detection dogs, and then deploy the dogs with their handlers for daily detection dog operations on District lands known to have Burmese and northern African pythons.

Researchers and land managers have initiated trapping efforts for the Nile monitor and Argentine black and white tegu, but progress is severely hampered by a lack of dedicated funding. Trapping techniques for the Nile monitor are providing reasonable capture rates in Southwest Florida (Todd Campbell, University of Tampa, personal communication), but these methods have been much less successful in Southeast Florida. Agency biologists initiated trapping efforts for the Argentine black and white tegu near Florida City in 2009. Between July 2009 and July 2010, 24 Argentine black and white tegus were captured between the eastern boundary of Everglades National Park and Florida City (Dennis Giardina, FWC, personal

communication). Anecdotally, the density and range of this tegu population appears to be increasing (Tony Pernas, NPS, personal communication), but systematic monitoring is needed to validate these observations. Unfortunately, current efforts are severely limited by funding constraints and are expected to exert minimal pressure on the established population. Chapter 6 of this volume provides additional information on the status of these priority invasive reptiles.

Biological Control of Invasive Species

Most nonindigenous species in Florida have limited or no predators, parasites, or pathogens. With few “natural enemies” in their new range, some nonindigenous species are able to grow larger, produce more offspring, spread more quickly, and dramatically degrade Florida’s sensitive habitats. The objective of “classical” biological control is to reunite host-specific natural enemies from the nonindigenous species’ native range and introduce them to Florida to reestablish a balance in the regulation of the nonindigenous pest population. The scope of biological control programs are broad, including foreign exploration, overseas screening, quarantine host range testing, field colonization and redistribution, and performance assessment. The principal objective of the foreign exploration portion of the project is to find effective agents and provide evidence of their safety. This is needed to support requests to the Animal Plant Health Inspection Service (APHIS) to import superior candidates into U.S. quarantine facilities. The quarantine process, a continuation of the initial foreign screening procedure, is designed to corroborate the safety of promising candidates, particularly addressing potential risk of collateral damage to non-target native and economically important plant species. The domestic phase of the project transforms “potential” biological control agents into actual, usable instruments of control. This step mandates that the agents first be established in nature. Realizing the full potential of the agents necessitates evaluation of their impacts as well as recognition and assessment of their shortcomings.

Biological control of natural area weeds is a relatively new application of this science, as much of the earlier efforts focused on agricultural pests. Recognizing the potential for biological control agents as a component of integrated weed management strategies in Florida, the District, FWC, USACE, and other agencies began funding biological research for priority invasives with the USDA-ARS, UF, and others with expertise in this area.

Biological control research and implementation has yielded great successes in Florida but it is not a panacea. Detailed and lengthy studies are required to ensure that potential biological control agents will only attack the targeted invasive species and not native or agronomically important species. Biological control agents that are determined to be safe must pass through a lengthy review by state and federal regulatory agencies before they can be introduced. Biological control agents that are approved (and permitted) are introduced into Florida, but a portion of these individuals may fail to establish due to incompatibilities with the local environment. Despite these hurdles, biological control research and implementation has led to important advances in invasive plant management. Updates on the status of the more recently introduced biological control agents are listed below.

Progress in Fiscal Year 2010

Melaleuca. The melaleuca snout weevil (*Oxyops vitiosa*) was introduced in 1997 and subsequently established on melaleuca throughout the region. Adult weevils can live more than a year, and females produce approximately 350 eggs during their lifetime (Wheeler, 2003). Weevils lay eggs on the surface of expanding foliar buds, young leaves, and elongating stems. Weevil larvae feed exclusively on young leaves and have voracious appetites. Feeding by the weevil reduces the tree's reproductive potential as much as 90 percent (Tipping et al., 2008), and the few trees that do reproduce have smaller flowers that contain fewer seeds (Pratt et al., 2005; Rayamajhi et al., 2008). Recent surveys indicate that the geographic distribution of the melaleuca weevil encompasses 71 percent of the melaleuca infestation (Balentine et al., 2009). Following establishment, common garden experiments confirmed that feeding and development by the melaleuca weevil was restricted to melaleuca species, as predicted in quarantine-based host range testing, and posed no threat to native or economically important plants (Pratt et al., 2009).

The melaleuca psyllid (*Boreioglycaspis melaleucae*) was released in 2002. Individuals in the first immature stage of this insect are active, but later stages are more sessile and congregate on leaves or stems, secreting copious amounts of white, waxy filaments from dorsal glands (Pratt et al., 2004). Adults and nymphs feed by inserting their needle-like mouthparts through stomatal pores in melaleuca leaves to gain access to the phloem (Purcell et al., 1997). Both adults and nymphs feed on expanding buds and leaves, but also exploit mature, fully expanded leaves. Initial field data indicate that feeding by psyllids induces leaf drop, eventually resulting in tree defoliation (Morath et al., 2006). USDA entomologists have determined that psyllid feeding on melaleuca seedlings results in 60 percent mortality in less than a year (Franks et al., 2006). Psyllids also disperse rapidly, spreading an average of 4.7 kilometers per year (km/yr) but ranging as high as 10 km/yr (Center et al., 2006). Field surveys indicate that the distribution of the melaleuca psyllid is slightly greater than that of the weevil, with a range that includes 78 percent of the melaleuca stands in Florida.



Figure 9-3. Gall fly (*Fergusonina turneri*) damage on a young melaleuca (*Melaleuca quinquenervia*) tree. (photo by the USGS).

The combined effect of feeding by the weevil and the psyllid has led to > 80 percent stem mortality in some stands as well as decreases in melaleuca canopy cover over a 10-year period (1997–2007), resulting in a fourfold increase in plant species diversity following the introduction of biological control agents (Rayamajhi et al., 2009). A recently completed five-year field study found that melaleuca re-invasion was reduced by 97.8 percent compared to pre-biocontrol population densities despite a large

fire that, in the past, would have promoted dense recruitment of seedlings. Seedling/sapling recruits were reduced in height by more than 63 percent over the course of this study because of weevil and psyllid feeding, and appeared unlikely to reproduce. To facilitate the landscape-level impacts of these biological control agents, state and federally supported collection and redistribution efforts have released over 1.9 million insects at 319 locations across 15 counties in South Florida (Balentine et al., 2009). The strategy concentrated on insect releases in environmentally sensitive restoration sites or melaleuca-dominated areas that were not currently slated for herbicide treatments. This approach aims to use biological control agents to reduce re-invasion of managed sites and halt continued melaleuca spread in untreated sites.

The melaleuca gall fly and its obligate mutualistic nematode *Fergusobia quinquenerviae*, was the third insect released against melaleuca. A permit for the gall fly was acquired in 2005, and releases were made at six sites in South Florida shortly thereafter (Blackwood et al., 2005). These initial releases did not result in the establishment of the fly; therefore, additional efforts were made in the winter of 2007, which culminated in three generations of the insect before the population went extinct. To date, there are no plans to make additional releases of the gall fly.

The melaleuca midge (*Lophodiplosis trifida*) is the most recent biological control agent for melaleuca. Adults live less than a week but can lay over 200 eggs in their short life spans. Larvae hatch from eggs and quickly burrow into tender green stems of melaleuca branches. The larvae feed on the internal structures of the stem, which damages the flow of nutrients to melaleuca buds and leaves. Feeding by the insect also causes the stems to produce galls or abnormal growths that dramatically alter the morphology of melaleuca stems. The midge was introduced to 24 locations in Florida during the summer of 2008 and successfully established at all sites regardless of the number of individuals released. Galls are observed throughout the canopy of even tall trees, but preliminary data indicate that the midge causes the greatest levels of damage (and mortality) among seedlings and saplings at sites with long hydroperiods.

Old World Climbing Fern. Releases of the brown lygodium moth (*Neomusotima conspurcatalis*) began during January 2008. Within the first year, the moth developed large populations of caterpillars that defoliated the vines at the release sites (Boughton and Pemberton, 2009). Defoliation occurred on Old World climbing fern blanketing forest understory vegetation and trees, and affected plants growing in shade and sun. Vegetation monitoring data have shown that ground cover of Old World climbing fern was reduced by about 50 percent during the first six months after the brown lygodium moth was first released, and that cover of the weed has been maintained at these lower levels for at least six to 12 months beyond the initial defoliation. Moving forward, a key question will be whether populations of the moth remain at high enough levels to continue defoliation of the weed and to subsequently suppress its regrowth. USDA-ARS scientists have established monitoring transects within and adjacent to release sites to measure the abundance of the agent and changes in Old World climbing fern and native plant species cover. Agents are also collected to determine rates of parasitism by wasps. Populations of this tropical moth declined during the winters of 2008 and 2009, likely in response to extended periods of cool weather, although populations recovered during the spring of 2009 and 2010 as the weather warmed up. Parasitism of caterpillars of the brown lygodium moth was first detected during the



Figure 9-4. The USDA-ARS, releases larvae of the brown lygodium moth (*Neomusotima conspurcatalis*) on SFWMD conservation lands in Palm Beach County (photo by the SFWMD).

fall of 2008, and parasitism rates appeared to peak during spring 2009 at about 20 percent, before declining by 10 to 15 percent during the summer and fall of 2009. To date, most of the parasitoid wasps recovered from caterpillars of the brown lygodium moth have been native wasp species belonging to the hymenopteran family Braconidae (Kula et al., 2010).

Releases of the brown lygodium moth have been made in Palm Beach, Martin, Monroe, Highlands, and Manatee counties in southern Florida; however, thus far, population establishment and successful over-wintering of moth populations have only been confirmed at sites in Palm Beach and Martin counties. To date, all releases have been from mass reared insects from the USDA-ARS Invasive Plant Research Laboratory, in Gainesville, FL. To augment the

dispersal rate of the brown lygodium moth, USDA-ARS and District biologists are planning a pilot project to determine the efficacy of transporting agents from established locations in the field to new areas of South Florida. Old World climbing fern with substantial numbers of feeding brown lygodium moth larvae will be collected in the field and transported to predetermined locations well beyond the perceived dispersal distance of the moth.

The white lygodium moth (*Austromusotima camptozonale*) was the first agent to be released against lygodium. Releases of this insect began in 2004 and continued through 2007 with more than 40,000 individuals being mass-reared and released (Boughton and Pemberton, 2008). No establishment was obtained, and predation of the larvae by ants appears to have been a factor. A recent reevaluation of the white lygodium moth release attempt concluded that inbreeding depression may have been a factor in establishment failure. The initial white lygodium moth colony was imported soon after federal approval to bring into quarantine, but final approval to release this insect was significantly delayed. This protracted period of laboratory rearing of the initial colony may have reduced the population's fitness, thereby limiting survivorship under field conditions. New collections of the white lygodium moth have recently been received into quarantine at the USDA-ARS Invasive Plant Research Laboratory in Fort Lauderdale, and a new program of field releases with this insect will be initiated during the summer of 2010 in an effort to establish field populations.

The lygodium gall mite (*Floracarus perrepa*) induces leaf roll galls on the leaves of *L. microphyllum* plants. These galls become swollen with sap and sugars, which diverts photosynthetic production away from plant growth and reproduction. In pre-release studies in Australia, gall mites were shown to significantly reduce growth of lygodium plants (Goolsby et al., 2004). The gall mite was released in 60 plots at five sites in South Florida during 2008 and 2009, and although the mite has marginally established at some sites, rates of successful gall induction on field plants were much lower than anticipated. Data from these field colonization studies and two years of colony maintenance in Fort Lauderdale indicate that a large proportion of Florida lygodium plants are not susceptible to gall induction by the introduced strain of the mite, suggesting that Florida lygodium populations may be more genetically diverse than was previously assumed. Similar problems of host plant resistance have been encountered with other eriophyid mites that have been released as weed biocontrol agents.

Water hyacinth (*Eichhornia crassipes*). Water hyacinth is an exotic floating plant that aggressively colonizes freshwater ecosystems in the southeastern and southwestern United States including the Everglades. This species can quickly cover the surfaces of slow-moving bodies of water and form thick mats. These mats disrupt or prevent recreational activities, such as boating and fishing; block drains, spillways, and intakes for irrigation and electrical generation; provide harborage for disease-carrying organisms like mosquitoes and snails; crowd out native aquatic plant species; and reduce the oxygen content of the water, which degrades fisheries. Further, water hyacinth can eliminate underlying submerged plants simply by blocking light penetration. Water uses and flows are greatly diminished. Decreased water/atmospheric gas exchange yields decreased water quality and greatly diminishes biological diversity. In addition, healthy water hyacinth rapidly produce and shed leaves into underlying aquatic habitats, causing heavy organic deposition.

Several biological control agents of water hyacinth introduced during the 1970s have provided partial control, but additional agents are needed. A new insect, *Megamelus scutellaris* (Hemiptera: Delphacidae), was developed over a four-year period and released into the field in February 2010, making it the first new agent on water hyacinth in more than 30 years. To date, more than 20,000 individuals have been released at Stormwater Treatment Area 1 West for establishment and evaluation. Numerous recoveries of nymphs have been made, indicating that

this species is reproducing on-site. Field-level evaluation of the impact of *M. scutellaris* on water hyacinth will take another two to three years of research.

Biocontrol Agents in Development

Additional biological control agents are awaiting permits. These include (1) *Lilioceris* sp., a leaf beetle from Nepal that causes serious defoliation of air potato vines (*Dioscorea bulbifera*) and (2) *Neostromboceros albicomus*, a Thai sawfly that attacks Old World climbing fern. In addition to these weed targets, biological control research is focused on Brazilian pepper, Australian pine (*Casuarina equisetifolia*), hydrilla (*Hydrilla verticillata*), carrotwood (*Cupaniopsis anacardioides*), skunk vine (*Paederia foetida*), water hyacinth, water lettuce (*Pistia stratiotes*), wetland nightshade (*Solanum tampicense*), Jamaican nightshade (*Solanum jamaicense*), lobate lac scale (*Paratachardina pseudolobata*), and the bromeliad weevil (*Metamasius callizona*).

INVASIVE SPECIES MONITORING

Baseline monitoring programs are important to establish the extent of a problematic species and can offer valuable benchmarks once operational control programs begin. Similarly, long-term, repeatable monitoring is key to answering questions related to the impacts of invasive species. The general distributions of most invasive nonindigenous plants in South Florida are fairly well understood (Wunderlin and Hansen, 2003; FNAI, 2009). Programs to track the distribution of certain target invasive plant species regionally are in place. However, the availability of spatial data for most other invasive taxa in natural areas is lacking or not readily available. The FWC maintains a database for reptiles, amphibians, birds, and terrestrial mammals (www.myfwc.com/WILDLIFEHABITATS/Nonnative_index.htm). FWC biologists compiled these data from published and unpublished sources. The U.S. Geological Survey (USGS) maintains an extensive database of nonindigenous aquatic species by watershed (Pam Fuller, USGS, personal communication). Additionally, the Everglades CISMA maintains a regional database of nonindigenous species field reports through its web-based reporting system (www.evergladescisma.org). These resources are valuable and have been used extensively in this report, but it is difficult to glean information about population dynamics of these species without more specific locations and historical spatial data. Updates on specific monitoring efforts are presented in the following sections. Additional background information on regional monitoring efforts is presented in the 2008 SFER – Volume I, Chapter 9.

Invasive Plant Monitoring

Digital Aerial Sketch Mapping

To be operationally useful for invasive species management efforts, invasive species monitoring information should have high positional accuracy, high species detection accuracy (particularly for low-density infestations), rapid turnaround time, relatively low cost, and the ability to quantify the degree of infestation. To address the need for more detailed geospatial information on priority invasive plants and to meet Everglades Forever Act requirements to prepare biennial surveys of priority nonindigenous species within the Everglades Protection Area, the District and the NPS are now utilizing digital aerial sketch mapping (DASM) for regional invasive plant surveys. District and NPS biologists evaluated this mapping technology for several years and determined it met the cost, accuracy, and turnaround criteria for region-wide application in the Everglades. Results of 2009–2010 DASM efforts within the Greater Everglades region are presented in Chapter 6 of this volume.

Ground Surveys of Invasive Nonindigenous Plant Species

While extremely cost-efficient for large landscapes, DASM and other remote sensing mapping techniques are limited in their ability to detect sub-canopy infestations. For this reason, ground-based assessments are a critical complement to the District's DASM program, particularly for early detection and containment of aggressive invaders, such as Old World climbing fern, downy rose myrtle, and shoebutton ardisia (*Ardisia elliptica*). The District continued its tree island ground survey program in Water Conservation Area 3 (WCA-3) during 2010. Results of this monitoring effort are presented in Chapter 6 of this volume.

The District, in partnership with the Florida Natural Areas Inventory (FNAI) and FWC, also initiated new ground-based invasive plant monitoring on District-owned conservation and interim lands in 2009. The first phase of this project involved desktop mapping interviews with the District's land stewardship partners. FNAI and District biologists met with these land stewards to identify known infestations of priority invasive plant species on the properties they manage. The identified infestations were sketched on large format maps with high-resolution imagery, assigned known attributes, and then digitized. The second phase of this project will involve field validation by District biologists beginning in fall 2010 and creation of an invasive species base map for District lands. Future proposed efforts include systematic ground surveys on conservation lands, with an emphasis on closed-canopied plant communities where DASM has the lowest detection accuracy.

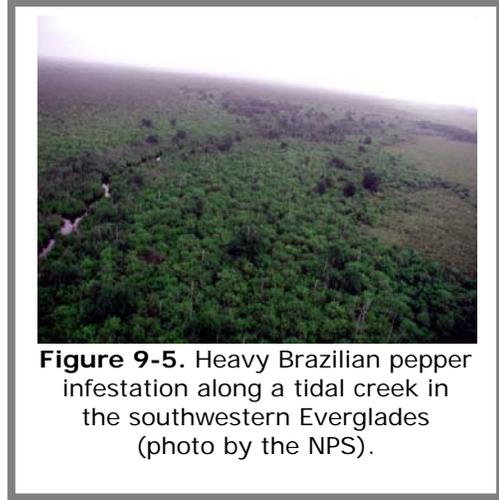


Figure 9-5. Heavy Brazilian pepper infestation along a tidal creek in the southwestern Everglades (photo by the NPS).

Invasive Animal Monitoring

Systematic tracking of invasive animals in South Florida remains a significant challenge. Monitoring programs have not been established for the majority of invasive animals in the region. When monitoring is conducted, data are often collected using a wide range of methods, spatial scales, and variables across jurisdictional boundaries. The resulting patchwork data on invasive animal populations are not readily comparable, making it difficult to establish reliable baseline information on the status of most invasive animals. Agencies should work toward uniform and consistent monitoring methodologies and reporting scales to build regional monitoring frameworks. In order to better characterize the threat posed by certain invasive species, agencies should also work together to initiate population estimation studies. Such interagency coordination could lead to much-needed baseline population and long-term data to gauge the success of management strategies.

In a small step toward that goal, the NPS, FWC, District, and The Nature Conservancy (TNC) have developed a protocol for systematic visual searches of large constrictor snakes and other invasive reptiles. Borrowing from the experiences of agencies engaged in brown tree snake management in Guam (Campbell et al., 1999), this collaborative effort has resulted in the creation of a common monitoring and database protocol that can be adopted by agencies and parties interested in assisting with monitoring efforts. In July 2009, the District formed an invasive animal search team to assist with regional monitoring of Burmese pythons and other priority invasive animals. Composed of District staff that regularly traverse the Everglades for their normal job duties, the team conducts systematic searches along levees, canals, and roadways and reports their findings to District and FWC responders. This effort is intended to complement

similar efforts at the ENP, the Florida Keys, and the FWC python bounty program. Working through regional CISMAs, it is hoped that the regional effort can be expanded to include other interested parties.

Invasive Species Data Tracking

Agency efforts to track and control invasive species in South Florida vary widely. Without a “clearinghouse” of agency programs, gathering information on invasive plant and animal species activities is challenging. Based on an extensive review of several invasive species programs, the NEWTT developed a web-based, database-oriented system called ECOSTEMS that organizes and tracks agency activities in the Everglades (www.ecostems.org). ECOSTEMS is intended for use by the agencies working with the South Florida Ecosystem Task Force on Everglades restoration to input, track, and update invasive species project information. Since 2008, Everglades CISMA cooperators who attend the annual Everglades Invasive Species Summit have given operational updates on their invasive species programs. The updates are presented in a consistent manner that allows Everglades CISMA to easily enter programmatic data for regional projects into ECOSTEMS.

The District continues to promote region-wide adoption of the Weed Data and Reporting (WEEDDAR) database. WEEDDAR is a comprehensive invasive plant management database that allows agency project managers and their contractors to easily enter detailed information on day-to-day control efforts. As previously reported, WEEDDAR is now available to registered agency users of www.cerpzone.org. Working through the Everglades CISMA, regional partners are encouraged to adopt WEEDDAR to further standardize data collection and tracking related to invasive plant management. During 2010, the District offered a free training class to agencies interested in this software. Eventually, WEEDDAR could be adapted for use with invasive animal control efforts.

Education and Outreach

The nature of the problem of invasive nonindigenous plants and animals makes education and public outreach crucial to effective prevention and management. Intentional and accidental releases of nonnative plants and animals are an ongoing part of the problem, so changes in behavior of individuals must be part of the long-term management strategy. These changes will happen only when more people know about the environmental consequences of releasing exotic pets and plants. But the benefits of an educated public extend beyond reducing releases of nonindigenous species. Ongoing support of the difficult and expensive government efforts to manage established invasive species depends on public understanding of environmental costs of these invasions. Additionally, much-needed changes to regulations affecting nonindigenous species will require political support of an educated public.

An array of public and private agencies and organizations is involved in education and public outreach concerning invasive species. Although not rigidly organized, the various educational efforts are somewhat coordinated with much cooperation among the different entities in developing educational tools to raise public awareness about the problems associated with invasive species. For example, the Everglades CISMA produced a set of identification field cards with a hotline number to assist field personnel in identifying priority reptile species, and provide direction regarding how and where to report such observations. Field personnel in turn can impart this information to the public.

Information on invasive species is frequently integrated into general environmental education activities at parks and nature centers, where staff interacts with visitors and school groups. For example, environmental educators typically point out invasive plants or animal signs, such as feral hog rooting, during guided walks and use them as segues for short lessons. Training the

public to recognize invasive nonindigenous species and report observations is key to early detection and rapid response.

Most importantly, pet buyers are a critical target audience for educational and outreach programs, and informing people about responsible pet ownership is a means to deter illegal intentional or accidental releases. Many pets are deceptively small at the time of purchase, and people may not be prepared to care for them when they grow to their full adult size. If unable to care for a pet, people need to be aware of the options available, such as finding the pet a new home or donating it to a wildlife center, rather than release it into the wild.

The following summarizes the agencies and organizations actively involved in invasive species educational and outreach programs:

United States Fish and Wildlife Service. This agency provides information about invasive species on its website (www.fws.gov/invasives/). Two recent initiatives designed to reduce the introduction and spread of nonnative species are Stop Aquatic Hitchhikers, an educational program that concentrates on fishermen and boaters, and Habitade, which targets aquarium hobbyists, water gardeners, and backyard pond owners.

U.S. Army Corps of Engineers. The Jacksonville District Invasive Species Management Branch is responsible for managing aquatic invasive plants on Lake Okeechobee, the Okeechobee Waterway, and associated tributaries. Other invasive species responsibilities include managing invasive animals and terrestrial plants for the Okeechobee Waterway and Central and Southern Flood Control Projects. The USACE's website provides additional information (<http://www.saj.usace.army.mil/Divisions/Operations/Branches/InvSpecies/index.htm>).

Everglades National Park (ENP). An important function of the ENP is educating people about the environment and preserving it for future generations. The ENP's Don't Let it Loose curriculum focuses on invasive species found in the ENP and features an electronic field trip. The ENP also developed a middle school activity guide on the same theme (<http://www.nps.gov/ever/forteachers/dlil.htm>).

University of Florida/Institute of Food and Agricultural Sciences. The UF/IFAS Center for Aquatic and Invasive Plants is a major contributor to invasive species education and outreach in the state. This multi-disciplinary unit focuses on research and teaching, and provides a variety of invasive species educational materials for students, professionals, and the public including classroom curricula, recognition cards, and online content (<http://plants.ifas.ufl.edu/>).

UF Department of Wildlife Ecology and Conservation. The UF Wildlife – Johnson Lab provides information about invasive animals through its free, online course, Reptile Early Detection and Documentation (REDDy), to help people report invasive reptile sightings. (<http://ufwildlife.ifas.ufl.edu/reddy.shtml>).

Florida Fish and Wildlife Conservation Commission. The FWC provides information on invasive species, distributes Weed Alert fact sheets on invasive plants, and offers private landowners advice on control of invasive species (<http://myfwc.com/>).

Florida Department of Agriculture and Consumer Services. The FDACS has long protected croplands from introduced weeds and agricultural diseases, which also tend to protect natural areas. In the case of laurel wilt, spread by an invasive nonindigenous ambrosia beetle, agricultural interests align with ecological ones. The disease kills avocado (*Persea* spp.) trees and native swamp bay (*Persea palustris*), an important tree in the Everglades. The disease is now spreading down the Florida peninsula. The FDACS recently introduced the Save the Guac! (guacamole) campaign to educate the avocado industry about the threat of laurel wilt.

South Florida Water Management District. The SFWMD has established numerous environmental education centers on SFWMD properties. All of the educational programs at these

facilities include invasive species. The District's website (www.sfwmd.gov/) provides an informative multimedia presentation about invasive species. In addition, the agency offers a variety of informational outreach materials, including the WaterWise plant guide for landscaping, and publications on key invasive plant species, aquatic weed control, and biological control programs for melaleuca and Old World climbing fern. On October 1, 2010, the District launched the Legacy Program, an environmental education program for high school students that connects water resource and environmental education with land management activities on District lands.

Florida Public High Schools. Students learn about invasive species in public high school classrooms to meet the Sunshine State Standard SC.912.L.17.8, which requires that students "Recognize the consequences of the losses of biodiversity due to ... the introduction of invasive, nonnative species."

Florida Exotic Pest Plant Council. The FLEPPC is responsible for Wildland Weeds, an important quarterly journal, and maintains a list of invasive plants that are altering native plant communities in Florida (Category I) or showing potential to alter them (Category II) (www.fleppc.org/).

Everglades Cooperative Invasive Species Management Area. The Everglades CISMA maintains a website (www.evergladescisma.org) that provides educational resources and invasive species information. The organization's recent contributions include producing billboards advising residents not to release unwanted pets into the wild and sponsoring the first "Nonnative Fish Roundup" to raise public awareness about the negative impacts of releasing nonnative fish into Florida waters.

Florida Native Plant Society. This organization plays an important role in encouraging homeowners to landscape with native plants rather than nonindigenous species.

Print and Broadcast Media. The media provides important educational services on invasive species issues. The introduction of pythons to the Everglades, particularly, has drawn national media attention and focused concern on invasive species in general. In 2010, the Outdoor Channel launched an effort called Conservation Tour of Duty, which inspired many local viewers to volunteer for work in the Everglades, including removal of invasive plants (www.outdoorchannel.com/Conservation/News/13710.aspx).

Arthur R. Marshall Foundation. This foundation encourages the restoration and preservation of the Greater Everglades ecosystem through science-based outreach programs and hands-on activities including events for volunteers to get involved and help remove invasive plants from the Everglades (<http://www.artmarshall.org/getinvolved/youngfriends.php>).

Everglades Foundation. This foundation maintains a website containing newspaper clips and other information on Everglades restoration (www.evergladesfoundation.org/).

Florida Power and Light (FPL). The utility's website provides information on protecting Florida's environment (www.fpl.com/environment/commitment.shtml).

Summary of Major Accomplishments

Halting further expansion of melaleuca on public lands stands as a major accomplishment. When the Melaleuca Task Force was convened in 1990, its interagency members were confronted with a formidable problem. In 1993, nearly 500,000 acres of melaleuca existed in the region. Yet monitoring efforts estimate the tree's regional coverage at only 273,000 acres (Ferriter et al., 2008). Reaching this achievement has cost nearly \$40 million in physical and herbicidal melaleuca management and biological control initiatives, resulting in an Everglades Protection Area that is largely free of melaleuca. Much of the remaining population is now found on private lands. The melaleuca biocontrol agents that have established in Florida are exerting strong inhibitive pressure on the tree, and seed production and seedling establishment are diminishing.

Further, the integrated endeavor by the task force agencies has served as a paradigm for other species control efforts. Methods to share funding, resources, and technology, which were developed as strategies for melaleuca management, have bolstered planning and implementation of control for other invaders. Background information about the melaleuca program can be found in previous SFERs.

Hydrilla management has not eliminated the weed from any water body; however, the application of new herbicide management strategies continues to deter the growth of hydrilla in the Kissimmee Chain of Lakes. In the past, extensive hydrilla monocultures have overtaken Lakes Kissimmee, Hatchineha, and Tohopekaliga. Although hydrilla in each of these lakes remains a major component of the plant community, it is present at much lower and relatively acceptable levels for essential primary water management functions, navigation, and fish and wildlife habitat quality. Several new herbicides have recently received USEPA approval for use in water. Several more are slated for upcoming approvals. Together, these numerous materials increase the potential methodologies available for hydrilla management. However, several years of laboratory research and field trials will be needed to judge whether any of these materials can effectively manage hydrilla, either alone or in combination with others.

Broad expanses of torpedograss have been managed with herbicides in the marshes surrounding Lake Okeechobee. Thousands of acres of diverse plant communities have been regained in former impenetrable torpedograss monocultures. However, occasional variability of control remains problematic. Also, dependence on a single herbicide mixture could potentially lead to chemical resistance if repetitive treatments are applied to areas where there is minimal control. Newly emerging aquatic herbicides will also be tested for torpedograss activity, which could possibly increase herbicide control efficacy and/or reduce non-target plant mortality.

Early Detection and Rapid Response Successes

Early detection and rapid response (EDRR) efforts have resulted in the eradication or near eradication of several species. One of these species is the Gambian pouched rat (*Cricetomys gambianus*), which is considered to be eradicated from the Florida Keys (Scott Hardin, FWC, personal communication) due to the collaboration of several agencies. Similarly, the eradication of the sacred ibis (*Threskiornis aethiopicus*) appears to be successful, with no substantiated sightings in over one year (Mike Avery, USDA, personal communication). Additionally, a collaborative effort between the Everglades CISMA and Fairchild Tropical Gardens to eradicate the recently discovered invasive tree, kripa, is nearing a successful conclusion.

Feathered mosquitofern (*Azolla pinnata*) is a Federal Noxious Weed that was first discovered in Florida in 2007. This plant was brought under control very quickly using herbicide treatments. In addition, the plant was found to be supporting a Florida-native *Azolla*-feeding flea beetle. Research has shown this insect to be an effective biological control for the plant elsewhere in the world. Further, a second Florida native *Azolla*-feeding insect, a weevil, has served as a biocontrol agent for *Azolla filiculoides* in South Africa (Pemberton and Bodle, 2009). These findings indicate that feathered mosquitofern could be significantly controlled by these insects without becoming serious invaders to Florida's ecosystem.

Second only to prevention, EDRR provides the most cost-effective and environmentally sound approach to managing biological invasions, as illustrated by the following example. The cost for eradicating the Gambian pouched rat totaled only \$350,000 (Scott Hardin, FWC, personal communication) in comparison to the \$69 million needed to suppress nutria (*Myocastor coypus*) from damaging 15,000 acres of Louisiana coastal marsh (Coastwide Nutria Control Program—LA-03b). Paradoxically, the successes of EDRR often go unrecognized because they promptly and inexpensively avert long-term and environmental impacts. Moving forward, the District and its partner agencies will continue to promote EDRR as a priority management focus in South Florida.

PRIORITY NONINDIGENOUS SPECIES

OVERVIEW

The following section provides a summary of nonindigenous species that threaten the success of the District's mission. Twelve plant species were selected by District staff based on potential and current implications to the District's infrastructure and ecological concerns. These species are presented with a "District-centric" justification for listing, and priority plant species may differ for other agencies, depending on regional factors and agency priorities and goals. Thirteen priority nonindigenous animal species presented in this section are in close alignment with the species identified by the Florida Invasive Animal Task Team (FIATT) as eradication, control, and research priorities for the state (www.sfrestore.org/issueteams/fiatt/index.html). For this report, there are two species additions and one species omission. Tropical American watergrass and red bay ambrosia beetle (*Xyleborus glabratus*) were elevated to District priority status because of their continued spread and growing concern over their potential impacts on regional restoration goals. The Gambian pouched rat was removed from this section due to its apparent eradication from Florida. Omitting specific mention of other nonindigenous species in the following priority summaries does not imply that the species are not problematic or that control is not important. On the contrary, the need is urgent for distribution and biological data for many of these organisms.

Each of the 25 priority species is summarized in a one-page synopsis that highlights key management issues and provides general distribution information. Additionally, each species synopsis includes an indicator-based stoplight table that gauges the status of the species in each RECOVER module. The stoplight table technique was established through coordination among the Science Coordination Group, the NEWTT, and the FIATT of the South Florida Ecosystem Restoration Task Force (see Doren et al., 2009). Similar to its application in previous reports (e.g., 2008 SFER – Volume I, Chapter 9), the indicator table assesses each species by module according to the following questions: (1) how many acres within the module does this species occur in? (2) are the acres of the species in the module documented to be increasing, decreasing, or static? and (3) if the species is decreasing in coverage, is it a direct result of an active biocontrol or chemical/mechanical control program? While the development of an assessment and monitoring program specifically designed for this purpose would be ideal, the exotic species indicator is currently constrained to data from existing monitoring and research programs. The table below provides a brief explanation of stoplight indicators provided for each priority species in the following species summaries.



Red = Severe negative condition, or expected in near future, with out-of-control situation meriting serious attention.



Yellow = Situation is improving due to control program and is stable or moving toward stabilizing, or species is very localized but expected to spread if sufficient resources or actions are not continued or provided.



Green = Situation is under control and has remained under control for several years, particularly where biocontrol is found to be effective.

The county (or coastline) distribution maps provided for each species were compiled from a variety of resources, but in only a few cases are data from systematic, statewide monitoring efforts. As such, these maps should be viewed as provisional and only intended to give general instruction on a species' distribution. Primary data sources for the distribution maps and the module occurrence table in Appendix 9-1 of this volume include Early Detection and Distribution Mapping System (www.eddmaps.org/distribution/), Everglades CISMA (www.evergladescisma.org/distribution/), FWC – Florida's Nonnative Species (myfwc.com/WildlifeHabitats/Nonnative_index.htm), USGS Nonindigenous Aquatic Species (nas.er.usgs.gov/), and University of South Florida Atlas of Florida Vascular Plants (www.plantatlas.usf.edu/).

Together, the species summaries and indicator tables are intended to inform readers of known impacts, describe ongoing agency efforts to deal with individual species, and highlight needs for management resources. A more complete list of nonindigenous plant and animal taxa known to be established in each RECOVER module is included in Appendix 9-1. Within the geographic areas, animal species are divided into broad taxonomic groups of amphibians, reptiles, birds, mammals, fish, and invertebrates. In addition, the animal table indicates whether a species is widely or locally distributed (i.e., occurring in all modules or all but one module, or in only one module). This distribution information indicates the scope of the problem and, in the future, may help agencies prioritize animal species for control and management in the region.

Due to limited availability of distribution data, Appendix 9-1 of this volume may not be comprehensive or entirely accurate. For instance, some nonindigenous species listed for a module may occur outside of the module noted in the table because the listing relies on incomplete county data as the most specific location data available. The lists have been developed and refined through peer review by taxonomic experts and land managers to reflect regional considerations (such as coastal versus inland habitats), but should be used with the knowledge that animal distribution data, especially across taxa, is deficient in Florida. **Table 9-3** lists the District's priority species as presented in the following species synopsis section.

Table 9-3. The District's species ranked by taxonomic group and then alphabetically by common name.

Plants	Amphibians
Australian pine*	Cuban treefrog*
Brazilian pepper*	
Cogongrass	
Downy rosemyrtle	
Hydrilla	
Melaleuca*	
Old World climbing fern*	
Shoebuttan Ardisia*	
Torpedograss	
Tropical American watergrass	
Water lettuce	
Water hyacinth	
Mollusks	Birds
Asian green mussel	Purple swamphen
Island applesnail*	Sacred ibis*
Insects	Reptiles
Mexican bromeliad weevil	Argentine black and white tegu*
Red bay ambrosia beetle	Burmese python*
	Nile monitor*
Fishes	Mammals
Asian swamp eel	Feral hog
Lionfish	

*Additional assessments of these species, with an emphasis on their impacts to restoration of the Greater Everglades ecosystem are provided in Chapter 6 of this Volume.

Australian Pine (*Casuarina* spp.)

SUMMARY: Three nonindigenous species in Florida are commonly and collectively referred to as Australian pine: *Casuarina equisetifolia*, *C. glauca*, and *C. cunninghamiana*. Australian pine is a fast-growing tree that readily colonizes rocky coasts, dunes, sandbars, islands, and inland habitats (Morton, 1980). This large tree produces a thick litter mat and compounds that inhibit growth of other plant species. These characteristics make Australian pine particularly destructive to native plant communities and can also interfere with sea turtle and American crocodile nesting (Klukas, 1969).

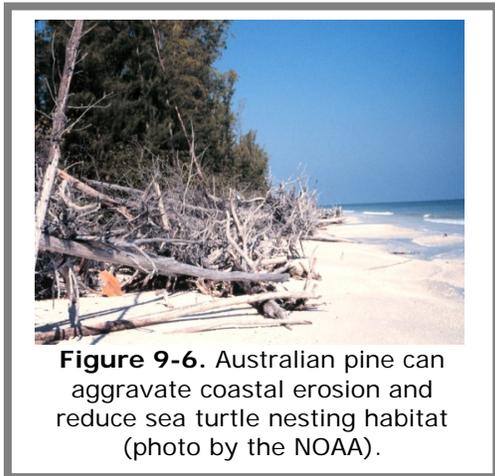
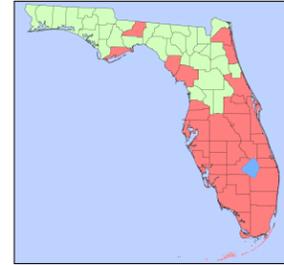


Figure 9-6. Australian pine can aggravate coastal erosion and reduce sea turtle nesting habitat (photo by the NOAA).

KEY MANAGEMENT ISSUES

Distribution: These trees are still common along District berms, in the District’s southern saline glades (C-111 basin), and Biscayne National Park. They are under maintenance control throughout most of the Everglades Protection Area (EPA) and most District-managed conservation lands. Australian pine infests an estimated 207,197 acres within the District (Ferriter et al., 2008).

Control Tools: Herbicide controls are well-established for this species. There are currently no biological controls.

Monitoring: Agencies monitor for this species in high priority public lands region-wide. DASM is conducted biannually within the EPA. Systematic reconnaissance flights (SRFs) were conducted throughout Florida in 2007 to map the distribution of certain nonindigenous species, including Australian pine.

Interagency Coordination: Agency-sponsored control efforts are ongoing but are complicated by local and state initiatives to allow plantings of this genus in certain situations or prevent control of the species for aesthetic reasons. Such actions hinder agency abilities to control these species regionally.

Regulatory Tools: *Casuarina* species are designated as Florida Prohibited Aquatic Plants. *C. equisetifolia* and *C. glauca* are designated as Florida Noxious Weeds. There are no federal regulations regarding these species.

Critical Needs: State and local restrictions on planting and maintaining *Casuarina* species and state-wide private lands initiatives to reduce propagule pressure on conservation lands.

2011 Status of Australian Pine by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Brazilian Pepper
(*Schinus terebinthifolius*)

SUMMARY: Brazilian pepper is an aggressive weed found throughout most of South and Central Florida. This shrub rapidly establishes in disturbed areas and then expands into adjacent natural areas (Cuda et al., 2006). Once established, Brazilian pepper severely reduces native plant and animal diversity (Workman, 1979; Curnutt, 1989) and alters fire regimes (Stevens and Beckage, 2009). Some progress has been made in managing this species in more accessible areas, but many remote regions of the Everglades remain infested. Resource managers face almost insurmountable obstacles in treating these populations due to the breadth and remoteness of the sites. Additionally, this prolific seed producer remains abundant on rights-of-way and adjacent private lands, facilitating constant reestablishment on conservation lands.

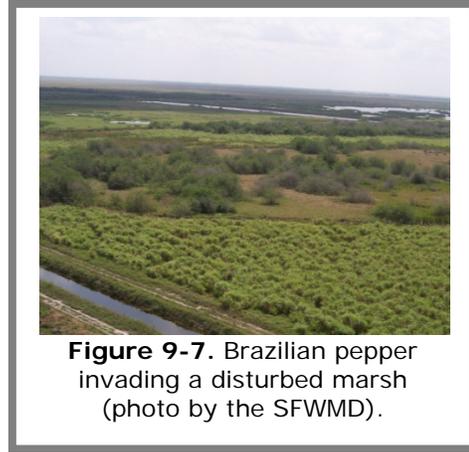
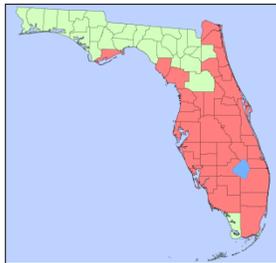


Figure 9-7. Brazilian pepper invading a disturbed marsh (photo by the SFWMD).



KEY MANAGEMENT ISSUES

Distribution: Brazilian pepper is the most widespread and abundant nonindigenous species in the District, occupying an estimated 700,000 acres (Ferriter and Pernas, 2005).

Control Tools: Managers use herbicides and physical and mechanical controls. Wide distribution on private lands and rapid colonization via bird dispersal make it difficult to achieve sustained control in management areas. Biological controls have been under development since 1993 but no effective agents have been released in the state.

Monitoring: DASM is conducted biannually within the EPA. SRFs were conducted in 2007 to map the distribution of Brazilian pepper throughout Florida.

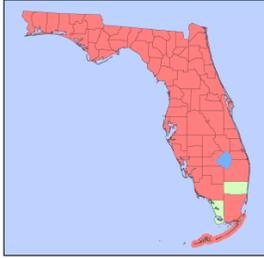
Interagency Coordination: An interagency management plan was developed that called for the need for coordination but little progress has been made.

Regulatory Tools: Brazilian pepper is designated a Florida Noxious Weed and Florida Prohibited Aquatic Plant. There are no federal regulations regarding this species.

Critical Needs: Successes in biological control efforts and state-wide private lands initiatives to reduce propagule pressure on conservation lands.

2011 Status of Brazilian Pepper by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Cogongrass (*Imperata cylindrica*)

SUMMARY: Cogongrass is a fast-growing perennial grass native to southeastern Asia and is now among the top 10 worst weeds internationally. Widely planted for forage in the early 20th century, it is now estimated to infest 1,000,000 acres in Florida (Miller, 2007). Cogongrass aggressively invades pine flatwoods, disturbed sites, and marshes where it often displaces entire understory plant communities and alters ecosystem processes such as fire regimes (Lippincott, 2000)

and biogeochemical cycling (Daneshgar and Jose, 2009; Holly et al., 2009). In 2010, the Florida Division of Forestry initiated its Pilot Cogongrass Treatment Cost- Share Program for private, non-industrial land owners to limit the spread of cogongrass across property ownership lines. Approved applicants who treat cogongrass infestations for two years will be reimbursed for 75 percent of control costs.

KEY MANAGEMENT ISSUES

Distribution: Cogongrass is documented in natural areas throughout most of Florida. Within the District boundaries, cogongrass is most prevalent in the Kissimmee and Caloosahatchee watersheds. Cogongrass infests an estimated 6,897 acres in the District (Ferriter et al., 2008).

Control Tools: This species is difficult to control and requires judicious implementation of integrated controls. These include repeated herbicide applications in conjunction with prescribed fire, mechanical controls, and in some cases, native revegetation efforts. Investigations into biological control have produced only a few candidate control agents (Van Loan et al., 2002), but none have been approved for release.

Monitoring: Agencies monitor for this species in high priority public lands region-wide. SRFs were conducted in 2007 to map the distribution of cogongrass throughout South and Central Florida.

Interagency Coordination: A strategy to address management of cogongrass throughout the southern United States was developed at the Regional Cogongrass Conference in 2007. The outcome of this meeting was a cogongrass management guide that provides guidance for control strategies, research priorities, and approaches to regional coordination.

Regulatory Tools: Cogongrass is designated as both a Federal and Florida Noxious Weed.

Critical Needs: Development of successful biological control agents would greatly improve regional control of this species. Increased control efforts on linear utilities (e.g., railroads, power line corridors) are needed to reduce its spread into new areas.



Figure 9-8. Cogongrass overtaking pine flatwoods (photo by the USDA).

2011 Status of Cogongrass by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Downy Rose Myrtle (*Rhodomyrtus tomentosa*)

SUMMARY: Downy rose myrtle is an ornamental shrub of Asian origin. It now occurs in natural areas throughout South and Central Florida. This fast-growing shrub spreads prolifically, even in the absence of disturbance. Once established, downy rose myrtle is capable of forming monospecific stands, resulting in local displacement of understory plant communities. Downy rose myrtle typically invades pine flatwoods, coastal scrub, baygalls, and drained cypress strands. Relatively little is known about the biology, distribution, and control of downy rose myrtle.

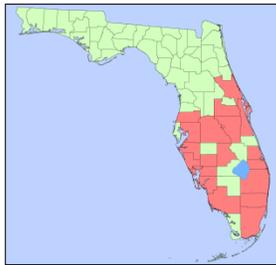


Figure 9-9. Shredding and herbicides are used to control downy rose myrtle (photo by the SFWMD).

KEY MANAGEMENT ISSUES

Distribution: Downy rose myrtle occurs throughout Central and South Florida, but the extent of infestation is poorly understood on a regional basis. Significant infestations are known to occur on conservation lands in coastal counties on the Atlantic and Gulf coasts.

Control Tools: This species is difficult to control, but recent improvements in herbicide control show promise. Fire appears to aggravate infestations, which is particularly troublesome since it commonly invades fire-adapted communities. There are currently no biological controls for this species, but a candidate agent has been imported into quarantine for testing and other insects are being evaluated overseas (Ted Center, USDA-ARS, personal communication).



Monitoring: There is no systematic monitoring program for this species; monitoring is currently limited to observations by land managers. Downy rose myrtle is difficult to detect using aerial mapping techniques. Predictive models to identify ground-based monitoring priorities are needed.

Interagency Coordination: Interagency coordination is generally lacking for this species. The newly formed Treasure Coast Cooperative Invasive Species Management Area plans to make this species a priority for regional coordination.

Regulatory Tools: Downy rose myrtle is designated a Florida Noxious Weed.

Critical Needs: Feasibility studies for biological control; statewide private lands initiatives to reduce propagule pressure on conservation lands; plans to guide regional, integrated management.

2011 Status of Downy Rose Myrtle by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Hydrilla (*Hydrilla verticillata*)

SUMMARY: Hydrilla is a rooted submerged plant that can grow to the surface and form dense mats. It has a broad native distribution in the Old World and Indo-Pacific. Hydrilla was likely first introduced to Florida in the 1950s as an aquarium plant and has since spread throughout the state. Hydrilla overwhelms Florida’s native aquatic plant communities, displacing valued native aquatic plants. This aggressive weed spreads to new waters mainly as fragments on boat trailers and boat parts. By the 1990s, hydrilla was widely distributed in the state, occupying more than 140,000 acres of public lakes and rivers.



Figure 9-10. Part of a hydrilla mat (photo by USACE).

KEY MANAGEMENT ISSUES

Distribution: Hydrilla is found in all types of water bodies in Florida. Since the 1980s, it has often dominated much of the Kissimmee Chain of Lakes. Hydrilla has been in Lake Okeechobee for about 20 years, but has not been a consistent problem. In some years, hydrilla has expanded rapidly to cover thousands of acres and required mechanical harvesting to open up boat trails.

Control Tools: Hydrilla management has primarily depended on herbicide applications. This weed developed resistance to a commonly used systemic herbicide, so agencies now use a contact herbicide. Several new systemic herbicides are being evaluated. Several hydrilla biocontrol agents have been released in Florida, but none have exerted

significant control. The USEPA has recently approved several other herbicides for aquatic use, with several more to come in the future. However, it will take years of laboratory and field research to see whether any of these newly approved herbicides control hydrilla on their own or when combined with other compounds.

Monitoring: FWC monitors hydrilla throughout Florida’s public waters and ranks these waters according to environmental and societal factors to prioritize funding distribution for treatment.

Interagency Coordination: FWC coordinates management of hydrilla by allocating funds from the FWC Invasive Plant Management Control Trust Fund to local agencies for control.

Regulatory Tools: Hydrilla is listed as a Federal Noxious Weed and a Florida Prohibited Aquatic Plant.

Critical Needs: Continued research on effective systemic herbicides. Decades of research have failed to produce a successful biological control agent for this species. However, this element of integrated management is needed for long-term control.

2011 Status of Hydrilla by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Melaleuca (*Melaleuca quinquenervia*)

SUMMARY: Before organized state and federal nonindigenous plant control operations were initiated in 1990, melaleuca was widely distributed throughout the WCAs, the ENP, Big Cypress National Preserve, Lake Okeechobee, and the Refuge. Overall, agency efforts to control melaleuca are succeeding in containing and reducing its spread. Still, melaleuca remains widely distributed on private lands throughout South and Central Florida, but the successful biological control program has reduced its rate of spread (Pratt et al., 2005). Melaleuca infests an estimated 273,000 acres of public and private lands within the District (Ferriter et al., 2008).



KEY MANAGEMENT ISSUES

Distribution: Melaleuca has been systematically cleared from Lake Okeechobee, WCA-2, WCA-3, and Big Cypress National Preserve. These areas are now under maintenance control. Significant infestations still remain in the Refuge, eastern sections of the ENP, and the East Coast Buffer lands.

Control Tools: The region’s melaleuca management program is integrated. Herbicidal, mechanical, physical, and biological controls are all used. Two additional biological controls for melaleuca were approved for release during this reporting period.

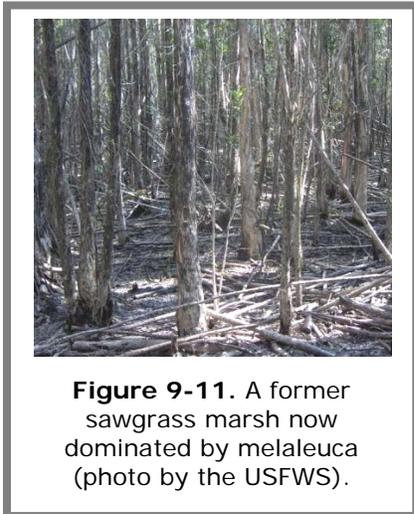


Figure 9-11. A former sawgrass marsh now dominated by melaleuca (photo by the USFWS).

Monitoring: Agencies monitor for this species in high priority public lands region-wide. Monitoring is critical for long-term maintenance control. DASM is conducted biannually within the EPA. SRFs were conducted in 2007 to map the distribution of melaleuca throughout Florida.

Interagency Coordination: Interagency coordination has proven successful for this species.

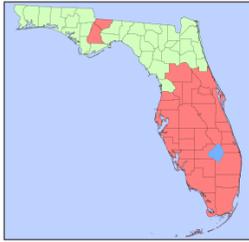
Regulatory Tools: Melaleuca is listed as a Federal Noxious Weed, a Florida Noxious Weed, and Florida Prohibited Aquatic Plant.

Critical Needs: Private lands initiatives to reduce remaining infestations adjacent to conservation lands.

2011 Status of Melaleuca by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Old World Climbing Fern (*Lygodium microphyllum*)



SUMMARY: Perhaps no other plant species poses a greater threat to South Florida’s mesic upland and wetland ecosystems than Old World climbing fern. This highly invasive fern smothers native vegetation, severely compromising plant species composition, destroying tree island canopy cover, and dominating understory communities. This species could potentially overtake most of South Florida’s mesic and hydric forested plant communities (Gann et al., 1999; Lott et al., 2003; Volin et al., 2004).

KEY MANAGEMENT ISSUES

Distribution: Old World climbing fern dominates many tree islands, strand swamps, mesic to wet flatwoods, and other forested wetlands throughout South and Central Florida. First collected in Martin County, this species has now expanded as far north as Volusia County. Old World climbing fern infests an estimated 159,220 acres of public and private lands within the District (Ferriter et al., 2008).

Control Tools: Herbicides are used to control this species, but rapid reestablishment from abundant spores makes herbicide control costly and unlikely to succeed alone in regional control. Biological control is a critical component to effective long-term management of Old World climbing fern. Three agents have been released in Florida; one is becoming established, exhibiting localized reductions in the invasive fern (Boughton and Pemberton, 2009). New research on the flooding effects on Old World climbing fern indicates a high tolerance to short-term hydroperiod alterations, suggesting that hydroperiod manipulation is not a viable management tool (Gandiaga et al., 2009).

Monitoring: Agencies monitor for this species in high priority public lands region-wide. DASM is conducted biannually within the EPA and annual tree island surveys are conducted in WCA-3. SRFs were conducted in 2007 to map the distribution of Old World climbing fern throughout South and Central Florida.

Interagency Coordination: An interagency management plan was developed for this species. Agencies and tribes are coordinating regional control and monitoring efforts.

Regulatory Tools: In April 2010, the USDA-APHIS added Old World climbing fern to the Federal Noxious Weed list. This species is also listed as a Florida Noxious Weed.

Critical Needs: Successes in biological control efforts, ground-based monitoring programs, and private lands initiatives to reduce propagule pressure on conservation lands.



Figure 9-12. Old World climbing fern overtaking a tree island plant community in the Everglades (photo by the SFWMD).

2011 Status of Old World Climbing Fern by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Torpedograss (*Panicum repens*)

SUMMARY: Torpedograss is an Old World grass originally introduced to Florida as a forage crop. This species forms dense, single-species stands that easily out-compete native plants. Rhizomes, in which the plant accumulates significant energy reserves, make up the majority of this species’ mass. These nutrient stores enable the plant to recover from disturbance events including fire, herbicide application, and frost. Although no viable seed has been proven to have been produced in Florida, torpedograss readily spreads to new sites and within water bodies.

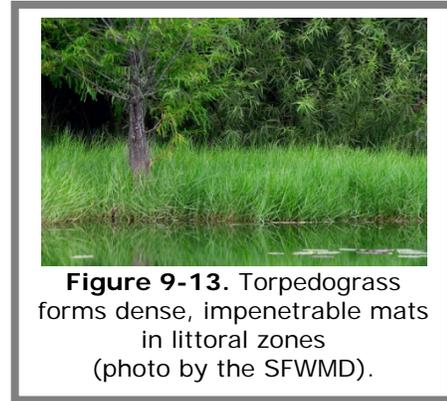
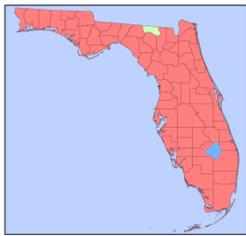


Figure 9-13. Torpedograss forms dense, impenetrable mats in littoral zones (photo by the SFWMD).

KEY MANAGEMENT ISSUES

Distribution: Torpedograss is ubiquitous in most regions of South Florida, but is most dominant in disturbed wetlands. For the past 10 years, more torpedograss has been present in Lake Okeechobee more than any other water body in South Florida. This weedy grass currently infests an estimated 9,000 acres on the lake (see Chapter 10 of this volume).

Control Tools: The District’s initial control efforts on Lake Okeechobee aim to limit the plant’s further expansion into new areas of the lake. Annually from 2003 to 2009, between 2,500 and 5,000 acres of torpedograss were treated in the lake’s 100,000-acre marsh via aerial and ground herbicide application. Some treatments have provided years of control while others have been less effective. Ongoing evaluations aim to reduce this variability. Treatments on Lake Okeechobee are coordinated through the Lake Okeechobee Interagency Aquatic Plant Management Group and performed by the SFWMD with funding from the FWC Invasive Plant Management Control Trust Fund. Development of selective biological control of torpedograss is not likely to be successful because of the broad similarities of grass species. Numerous herbicides have recently received approval from USEPA for use in aquatic sites.



Some are expected to have activity on grasses, including torpedograss. Trials are planned for the immediate future.

Monitoring: The District and FWC have tracked the expansion of torpedograss in Lake Okeechobee since the 1980s. Outside of the lake, there is no systematic monitoring program for this species, and monitoring is limited to ground-based observations by land managers.

Regulatory Tools: There are no federal or state prohibitions for this species.

Critical Needs: Effective alternative treatments need to be developed to prevent possible induction of torpedograss resistance to the current sole herbicide mixture.

2011 Status of Torpedograss by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Tropical American Watergrass (*Luziola subintegra*)

SUMMARY: Tropical American watergrass was first discovered in the United States by a District biologist on Lake Okeechobee in 2007. Since its first appearance, more than 1,800 acres of the plant have been treated. Native to Central and South America, this invasive grass exhibits aggressive, weedy behavior in littoral zones of Lake Okeechobee. Biologists are concerned that tropical American watergrass has expanded beyond its currently known locations to other regions of Florida. This species produces hundreds of viable seeds per plant but seeds lose viability if dried.



KEY MANAGEMENT ISSUES

Distribution: In Lake Okeechobee, tropical American watergrass primarily persists in Fisheating Bay, where it was first discovered, although several small, disjunct populations have been found and treated elsewhere in the lake. Another population was discovered and immediately treated in Miami-Dade County in 2009. This occurrence may have resulted from contamination with propagules from Lake Okeechobee.

Control Tools: District staff has screened various herbicides to manage this grass species, which has proven difficult to control.

Monitoring: The Lake Okeechobee interagency aquatic plant management group continues active surveillance for the plant as an early detection and rapid response project. Also, other public and private land managers in the Lake Okeechobee region have been shown the plant. None have reported finding it.

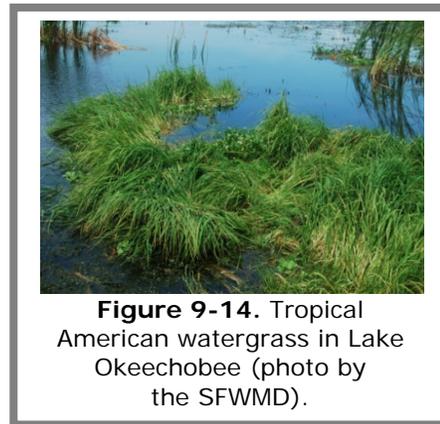


Figure 9-14. Tropical American watergrass in Lake Okeechobee (photo by the SFWMD).

Interagency Coordination: Agencies and universities are collaborating to facilitate EDRR and research for this species in the Lake Okeechobee region. Additional coordination is needed in other areas to facilitate regional containment.

Regulatory Tools: To date, there have been no actions regulating transport or possession of this species, such as declarations as a Florida prohibited plant or Federal Noxious Weed. Given the extent of the current population and the plant’s apparent fecundity, this species was added to the FLEPPC Category I invasive plants list.

Critical Needs: Continued herbicide efficacy research; expanded regional monitoring and outreach activities.

2011 Status of Tropical Watergrass by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Figure 9-15. Shoebuttan ardisia thicket in the southern Glades region (photo by the SFWMD).

Shoebuttan Ardisia (*Ardisia elliptica*)

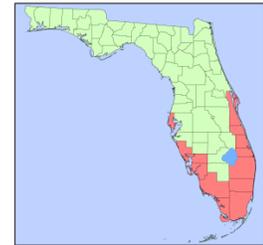
SUMMARY: Imported as an ornamental shrub as early as 1900 (Gordon and Thomas, 1997), shoebuttan ardisia is now established in South and Central Florida. It aggressively invades understories of hammocks, tree islands, and disturbed wetlands. This species often forms single-species stands, resulting in local displacement of native plants. Early infestations may go unnoticed due to its physical similarity with the common native marlberry (*Ardisia escallonioides*).

KEY MANAGEMENT ISSUES

Distribution: Shoebuttan is well-established in natural areas in southeastern Florida, particularly in the southern Glades region and eastern portions of the ENP. This species is documented as far north as Brevard County and westward to Collier County.

Control Tools: High seed viability, dispersal by mammals and birds, ability to establish in undisturbed sites, and close resemblance to Florida’s native *Ardisia* make control of shoebuttan very challenging. Land managers currently use herbicides for control, but are limited to costly ground applications in remote understories. There are currently no biological controls or investigations into possible biological controls for this species.

Monitoring: There is no systematic monitoring program for this species and monitoring is currently limited to ground-based observations by land managers. Shoebuttan is extremely difficult to detect using aerial mapping techniques and may be overlooked by land managers.



Interagency Coordination: While there is no region-wide strategic coordination for this species, biologists from the District, Miami-Dade County, and ENP are working closely to address major infestations in the southern Glades region.

Regulatory Tools: Shoebuttan ardisia is listed as a Florida Noxious Weed.

Critical Needs: Increased funding to remove dense infestations in eastern Everglades region. Regional ground-based monitoring efforts are needed to identify incipient populations.

2011 Status of Shoebuttan by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Water Lettuce (*Pistia stratiotes*)

SUMMARY: Water lettuce is a floating aquatic plant native to Africa. Rapid production of vegetative daughter plants occurs during all but the coolest months. New plants are also readily produced from seed and found to be up to 80 percent viable (Dray and Center, 1989). Water lettuce was reported by William Bartram in 1765 as forming dense mats on the St. Johns River.

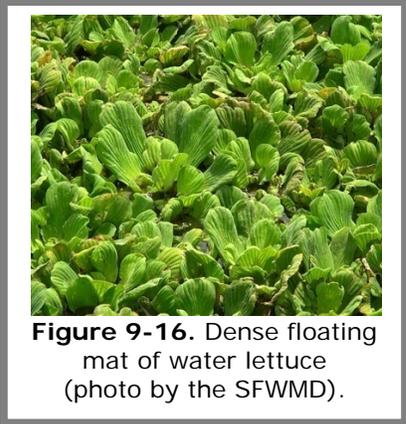


Figure 9-16. Dense floating mat of water lettuce (photo by the SFWMD).

These mats continue to occur, clogging waterways and water management structures.

KEY MANAGEMENT ISSUES

Distribution: Water lettuce inhabits all water body types in South Florida. Herbicide control efforts have virtually eliminated water lettuce from many canal systems, including urban Miami-Dade and Broward counties. However, most large lakes continue to harbor significant populations requiring frequent control.

Control Tools: Water lettuce is readily controlled by herbicides, but rapid reestablishment of this species in some water bodies necessitates frequent re-treatments. Biocontrol

agents for this species have been released in Florida, but none have significantly controlled the plant. Of these, the South American water lettuce weevil, *Neohydronymus affinis*, is widely established yet causes only numerous minute holes in the leaves of the plant.

Monitoring: The FWC monitors water lettuce in all public waters. The District routinely monitors its canals for large populations of this and other floating aquatic weeds.

Interagency Coordination: The FWC coordinates interagency management of water lettuce and other aquatic plants via solicitation of annual work plans from local public agencies and then allocates funds from the FWC Invasive Plant Management Control Trust Fund.



Regulatory Tools: Water lettuce is listed as a Florida Prohibited Aquatic Plant.

Critical Needs: Continued development of biological controls is needed to complement regional herbicide control programs.

2011 Status of Water Lettuce by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Water Hyacinth (*Eichhornia crassipes*)



SUMMARY: Water hyacinth is a floating plant native to tropical South America. Introduced into Florida in 1884, the plant quickly filled miles of the St. Johns River, halting navigation and waterborne commerce. Daughter plants are readily produced vegetatively by budding and stolon production. Rapid production of vegetative daughter plants occurs during all but the coolest months. New plants are also readily produced from seed, which often germinate copiously on moist soils as water bodies refill following drawdowns. Water hyacinth reproductive capacities, adaptability, low nutritional requirements, and resistance to adverse environments make it impossible to eradicate and difficult to control.

KEY MANAGEMENT ISSUES

Distribution: Water hyacinth inhabits all water body types in South Florida. Herbicide control efforts have virtually eliminated water hyacinth from many canal systems, including urban Miami-Dade and Broward counties. However, most large lakes continue to harbor significant populations requiring frequent control.

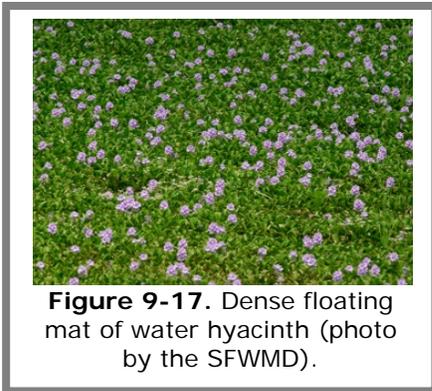


Figure 9-17. Dense floating mat of water hyacinth (photo by the SFWMD).

Control Tools: Water hyacinth is readily controlled by herbicides, but rapid reestablishment of this species in some water bodies necessitates frequent re-treatments. The USDA has released several water hyacinth biocontrol insects in Florida, including two weevils of the genus *Neochetina*. Despite reports of these weevils effectively limiting water hyacinth populations elsewhere in the world, no such decreases have occurred in Florida. In 2010, a new water hyacinth-feeding insect was released in Florida, *Megamelus scutellaris*, the water hyacinth plant hopper. USDA-ARS researchers found that this South American

insect thoroughly controlled water hyacinths in quarantine lab trials. Whether it establishes in Florida and exerts any control on the plant remains to be seen.

Monitoring: FWC monitors water hyacinth in all Florida public waters. The District routinely monitors its canals for large populations of this and other floating aquatic weeds.

Interagency Coordination: FWC coordinates interagency management of water hyacinth and other aquatic plants via solicitation of annual work plans from local public agencies and then allocates funds from the FWC Invasive Plant Management Control Trust Fund.

Regulatory Tools: Water hyacinth is listed as a Florida Prohibited Aquatic Plant.

Critical Needs: Continued development of biological controls is needed to compliment regional herbicide control programs.

2011 Status of Water Hyacinth by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Figure 9-18. Asian green mussels (photo by the NOAA).

Asian Green Mussel (*Perna viridis*)

SUMMARY: The Asian green mussel was first found in Florida waters in 1999 (Tampa Bay) and has since spread to major estuaries along both Florida coasts. Originating in the Indo-Pacific region, Asian green mussels are a threat to native marine fauna, coastal industries, and recreation. This species disperses easily and grows quickly, often forming dense mats. Of particular concern is the evidence that Asian green mussels may become abundant on eastern oyster (*Crassostrea virginica*) beds (Baker and Benson, 2002). Like other mussels, this species is capable of clogging seawater intakes and fouling boat hulls and engines.

KEY MANAGEMENT ISSUES

Distribution: The Asian green mussel is now found in most coastal regions of Florida. Within the District, this species is found in the Caloosahatchee Estuary south to the waters of the ENP near Everglades City. The first record of the Asian green mussel in Lake Worth Lagoon occurred in January 2009. Experts believe this species will continue to spread throughout Florida’s coastal waters, but it is less clear to what extent this species will impact native fauna.



Control Tools: Nonnative marine invertebrates are extremely difficult to control, and little can be done if green mussels overtake native oyster beds. Intensive mechanical and chemical control is possible in closed systems, such as power plants, but these methods are not feasible in a natural ecosystem.

Monitoring: The USGS and FWC maintain location records obtained from researchers, field biologists, fishermen, and others, but there are no coordinated monitoring programs for this species.

Interagency Coordination: Interagency coordination is limited to the exchange of reporting information and some coordinated research. There is little to no research being conducted to assess the impacts of this species on estuarine ecosystems.

Regulatory Tools: The U.S. Coast Guard initiated mandatory ballast management for all ships entering U.S. waters in 2004, which may limit the frequency of new introductions.

Critical Needs: Increased research and monitoring to better assess the extent of potential ecological impacts.

2011 Status of the Asian Green Mussel by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys
N/A	N/A			N/A	N/A		

Island Apple Snail (*Pomacea insularum*)

SUMMARY: The island apple snail is a large (up to 10 centimeters), South American freshwater mollusk now established in Florida. Introduced globally through discards from aquaria and intentional releases as a food crop, this species is considered by the Global Invasive Species Database to be one of the 100 World’s Worst Invasive Alien Species. Likely impacts in Florida include destruction of native aquatic vegetation and competition with native aquatic fauna. The island apple snail may continue to spread and out-compete the native apple snail, *P. paludosa*, which is the primary food of the endangered Everglade snail kite (*Rostrhamus sociabilis*). Juvenile snail kites have difficulty handling mature island apple snails and experienced significantly lower net daily energy balances when feeding on nonindigenous snails (Cattau et al., 2010).

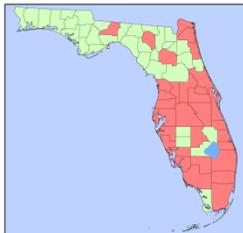


Figure 9-19. The large size of island apple snail may suppress prey consumption of juvenile snail kites (photo by the USGS).

KEY MANAGEMENT ISSUES

Distribution: The island apple snail has been reported widely throughout South Florida, typically along the edges of canals, ponds, and small rivers. The snail was found within WCA-3A in July 2009 (Marsha Ward, FWC, personal communication). The ENP and the Miccosukee Tribe monitoring results indicate that this species’ abundance is increasing in many canals near or within the Everglades (e.g., Tamiami Trail Canal), and distributions may be expanding into open marsh habitats of the ENP.

Control Tools: There are few control tools for this species with applicability in large natural areas. State and federal agencies need to dedicate resources to develop effective control strategies.



Monitoring: State and federal monitoring programs are either limited to focused geographic areas or participatory monitoring through outreach. State and federal agencies need to coordinate monitoring programs in support of a comprehensive management strategy.

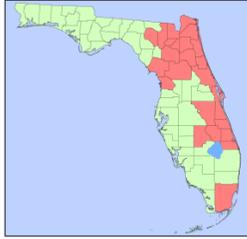
Interagency Coordination: Limited interagency coordination has yielded little information and few attempts to understand this species’ distribution, potential impacts, and possible control.

Regulatory Tools: This species is widely sold in the aquarium trade. Additional regulations are needed to curb the release of this and other nonnative *Pomacea* species while management efforts are under way.

Critical Needs: Development of control tools; research to better understand impacts of this species; continued and expanded regional monitoring efforts.

2011 Status of the Island Apple Snail by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Red Bay Ambrosia Beetle (*Xyleborus glabratus*)

SUMMARY: The red bay ambrosia beetle and its fungal symbiont (*Raffaelea* sp.) are devastating red bay populations over much of Florida and the Southeast. The wood boring beetle attacks native red bays (*Persea borbonia*) and other members of the family Lauraceae (Hanula et al., 2009) including swamp bay (*Persea palustris*), an important species of Everglades tree island plant communities. The beetles carry

spores of the *Raffaelea* fungus, which causes laurel wilt disease. Once infected, susceptible trees rapidly succumb to the pathogen and die. Laurel wilt is causing up to 90 percent mortality of red bay in areas where it is established (FDACS, 2008).

KEY MANAGEMENT ISSUES

Distribution: First detected in 2002 near Port Wentworth, GA, (Fraedrich et al., 2008), the red bay ambrosia beetle has rapidly expanded its range in coastal regions of the southeastern United States and has moved as far south as Martin County, FL. (Dixon and Smith, 2009). In March 2010, laurel wilt was found in Miami-Dade County, infecting an avocado tree (FDACS, 2010), immediately adjacent to the Bird Drive Basin and less than 5 kilometers from WCA-3B.

Control Tools: There is currently no feasible method for controlling this pest or associated disease. A systemic fungicide (propiconazole) can protect individual trees for up to one year, but widespread utilization in natural areas is impractical (Mayfield et al., 2008).

Monitoring: State and federal agencies are monitoring the spread of laurel wilt disease and the red bay ambrosia beetle through the Cooperative Agricultural Pest Survey (CAPS) program.

Interagency Coordination: Interagency coordination is limited to the exchange of reporting information and some coordinated research. There is little to no research being conducted to assess the ecological impacts of laurel wilt disease.

Regulatory Tools: The red bay ambrosia beetle is considered a plant pest, so screening for additional introductions is carried out but is inadequate. Federal screening needs improvement to prevent new introductions. Additionally, improved export screening is needed to prevent transport from Florida to other vulnerable regions.

Critical Needs: Continue regional trap monitoring. Critical research areas include: (1) evaluating *Persea* resistance, (2) *Persea* seed/genetic conservation efforts, (3) potential chemical or biological control tools, (4) impacts on native plant communities, and (5) impacts on the Palamedes swallowtail butterfly (*Papilio palamedes*) and other host-specific commensals.

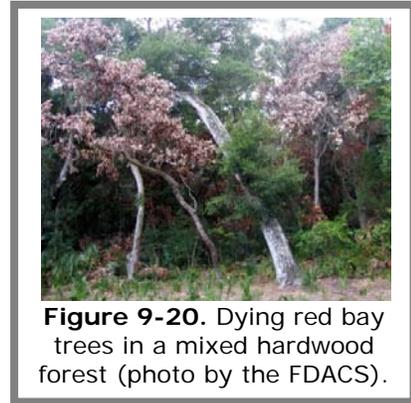


Figure 9-20. Dying red bay trees in a mixed hardwood forest (photo by the FDACS).

2011 Status of the Red Bay Ambrosia Beetle by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys
	N/A					N/A	

Mexican Bromeliad Weevil (*Metamasius callizona*)

SUMMARY: The Mexican bromeliad weevil was originally introduced to Florida via a shipment of bromeliads imported from Mexico. It was first detected in 1989, and is now found in many parts of South and Central Florida (Frank and Cave, 2005). Larvae of the weevil destroy bromeliads by mining into their stems. This damaging insect is documented to attack 12 native bromeliad species, 10 of which are state-listed as threatened or endangered, and one endemic species. Two of these bromeliad species were listed due to damage done to their populations by the weevil [Chapter 5B-40, Florida Administrative Code (F.A.C.)].

KEY MANAGEMENT ISSUES

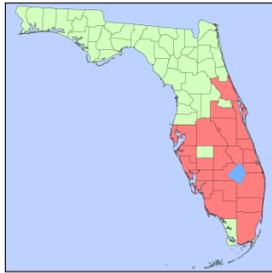
Distribution: The Mexican bromeliad weevil now infests bromeliads in the Sebastian, St. Lucie, Loxahatchee, Caloosahatchee, Peace, Myakka, and Manatee river systems as well as non-riverine sites. It is in the Big Cypress National Preserve, Rookery Bay National Estuarine Preserve, the Refuge, Fakahatchee Strand State Park, Myakka River State Park, and several other state parks (Howard Frank, UF, personal communication).



Figure 9-21. Larva of *M. callizona* feeding on native bromeliad (photo by UF).

Control Tools: The only practicable control tools for this species are biological control and prevention of new introductions. One agent, a parasitic fly (*Lixadmontia franki*), has been approved for release in the United States, but the insect has yet to become established. UF scientists continue to explore other potential biological control agents.

Monitoring: Regional monitoring of this species is limited to under-funded but determined efforts of university scientists engaged in biological control research.



Interagency Coordination: Interagency coordination is limited to exchange of reporting information and some coordinated research.

Regulatory Tools: The Mexican bromeliad weevil is considered a plant pest, so screening for additional introductions is carried out but is inadequate. Federal screening needs improvement to prevent new introductions. Additionally, improved export screening is needed to prevent transport from Florida to other vulnerable regions (e.g., Puerto Rico).

Critical Needs: Development of biological controls; conservation measures for impacted native bromeliad species; containment in Florida through effective export screening.

2011 Status of the Mexican Bromeliad Weevil by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Asian Swamp Eel (*Monopterus albus*)

SUMMARY: Swamp eels are versatile animals, capable of living in extremely shallow water, traveling over land when necessary, and burrowing into mud to survive periods of drought. The eels are generalist predators with a voracious appetite for invertebrates, frogs, and fishes. Wild populations in Florida originated as escapes or releases associated with aquaculture, the pet trade, or live food markets. Regional biologists are concerned that this species may become widely established, since the diverse wetland habitats of the Greater Everglades are ideal for the species. Additionally, Asian swamp eels have a broad salinity tolerance giving concern that this species could also establish populations in estuaries (Schofield and Nico, 2009).



KEY MANAGEMENT ISSUES

Distribution: During the late 1990s, three reproducing populations of Asian swamp eel were discovered in Florida: North Miami canals, canal networks near Homestead adjacent to the ENP, and in water bodies near Tampa (Fuller et al., 1999; L.G. Nico, USGS, personal communication). Unfortunately, recent monitoring efforts confirm the spread of this species into the ENP from adjacent canal systems (J. Kline, ENP, personal communication).

Control Tools: Given the abundance and wide distribution of swamp eels in Florida’s canals, elimination is probably impossible; however, various control methods are currently under investigation. The USFWS conducted a swamp eel removal project utilizing electrofishing techniques in 2006. The project was conducted on C-111 and C-113 canals and resulted in 53 percent efficiency with the removal of 905 Asian swamp eels and 82 peacock eels (J. Galvez, USFWS, personal communication).

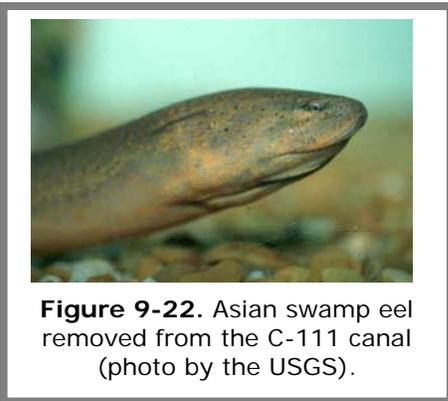


Figure 9-22. Asian swamp eel removed from the C-111 canal (photo by the USGS).

Monitoring: There is no regional, coordinated monitoring program for Asian swamp eels, but USFWS and NPS biologist conduct periodic surveys in the eastern Everglades region.

Interagency Coordination: No significant interagency coordination presently aims to manage this species.

Regulatory Tools: There are currently no regulations that prohibit the importation or possession of this species in Florida.

Critical Needs: Research to better determine potential impacts and spread of this species; research and development of control techniques; increased collaboration with CERP planners to integrate prevention measures for this and other aquatic invasive species in CERP-related projects.

2011 Status of the Asian Swamp Eel by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Figure 9-23. An adult lionfish (photo by the NOAA).

Lionfish (*Pterois volitans*)

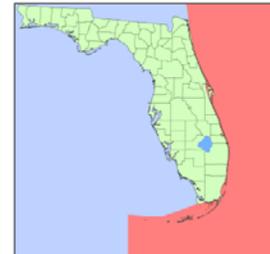
SUMMARY: The lionfish is a non-lethal, venomous marine fish native to the Indian and Pacific oceans. Introduced to the region in the mid-1990s via aquarium releases in the United States (Hamner et al., 2007; Freshwater et al., 2009), the fish is now spreading throughout Caribbean and U.S. coastal waters at an alarming rate (Schofield et al., 2009). This predatory fish poses a significant threat to coral reef and mangrove ecosystems by significantly decreasing survival of fauna through predation and competition (Albins and Hixon, 2008; Barbour et al., 2010). Such reductions of herbivorous species could lead to overgrowth of seaweeds and subsequent coral decline (Hixon et al., 2009).

KEY MANAGEMENT ISSUES

Distribution: Currently, the lionfish is distributed from the southeastern Caribbean to North Carolina (Whitfield et al., 2007), which is believed to be the species’ northern limit for overwintering survival. This invasive fish is now commonly observed along South Florida’s Atlantic coast from the Florida Keys to Jupiter Inlet. Pelagic eggs and larvae spread on ocean currents. Populations densities reported in the Atlantic are much higher than in their native Indo-Pacific range (Morris and Whitfield, 2009).

Control Tools: Control options are limited for this species. National Oceanic and Atmospheric Administration (NOAA) researchers are developing trapping techniques, which may have utility in deep or remote habitats. Fishery management strategies to recover predator populations (e.g., over-fished grouper) may help, but more information about potential predators is needed. Fish are actively collected by divers, but this method will unlikely reduce numbers regionally. Lionfish are edible, so specialty fisheries are being promoted.

Monitoring: Web-based reporting systems maintained by governmental agencies and non-governmental organizations are used to compile observations. Several research programs also conduct surveys throughout the Caribbean and U.S. coastal waters.



Interagency Coordination: There is ongoing collaboration between government agencies, universities, conservation groups (e.g., REEF), and commercial enterprises to educate the public, maintain reporting programs, and promote research and control efforts.

Regulatory Tools: This species is widely sold in the aquarium trade. Additional regulations are needed to curb the release of this and other *Pterois* species.

Critical Needs: Dedicated funding for research and development of control methods are needed. The development of fisheries to suppress populations should be pursued. Increased outreach and education targeted at the pet industry and consumers may reduce future releases.

2011 Status of the Lionfish by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys
N/A	N/A			N/A	N/A		

Cuban Treefrog (*Osteopilus septentrionalis*)

SUMMARY: The Cuban treefrog is native to Cuba, the Cayman Islands, and the Bahamas. First reports of its presence in Florida were from the Florida Keys in the 1920s. The frogs may have been transported in cargo or ornamental plant shipments. The Cuban treefrog can be identified by its size; females may be more than 6 inches long, much larger than Florida’s native treefrog species. Cuban treefrogs consume a variety of invertebrates and native treefrog species (Maskell et al., 2003). It is likely that Cuban treefrogs become dominant over native anurans through some combination of predation and competition for prey (Waddle et al., 2010). Given the Cuban treefrog’s wide distribution and habitat tolerances, mounting evidence of direct impacts to native anuran species, and lack of regional monitoring and control programs, the status of this species has been changed to red in all RECOVER modules.



Figure 9-24. Cuban treefrog feeding on native green treefrog (photo by UF/IFAS).

KEY MANAGEMENT ISSUES

Distribution: Cuban treefrogs inhabit natural and human-modified habitats throughout most of South and Central Florida. Natural habitats invaded by this

species include pine forests, hardwood hammocks, and swamps. In urban and suburban settings, they are most commonly found on and around homes and buildings, and in gardens and landscape plants. They also occur in agricultural settings, orange groves, and plant nurseries (Johnson, 2007).

Control Tools: There are currently no agency-sponsored, coordinated control efforts for the Cuban treefrog in South Florida.

Monitoring: To date, little comprehensive monitoring has been done to determine the distribution of this species. The UF/IFAS maintains a small research, monitoring, and outreach program, but state and federal agencies need to assist with coordinating a state-wide management program.



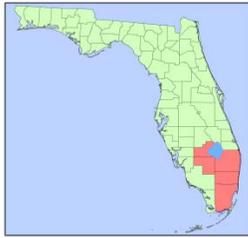
Interagency Coordination: No significant interagency coordination presently aims to manage this species.

Regulatory Tools: Local governments may need to regulate this species due to the lack of federal initiatives.

Critical Needs: Basic research on extent and severity of impacts to native species; development of control techniques.

2011 Status of the Cuban Treefrog by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Purple Swamphen (*Porphyrio porphyrio*)

SUMMARY: The purple swamphen is a rail native to Australia, Europe, Africa, and Asia. It feeds on shoots and reeds, invertebrates, small mollusks, and the eggs and young of waterfowl. Known to be highly aggressive and territorial, the purple swamphen could impact native water birds through competition for food and space and through direct predation. The FWC and District rapid response efforts between 2006

and 2009 did not successfully reduce the abundance or distribution of this species. The management goal for this species has shifted from eradication to suppression (Jenny Ketterlin, FWC, personal communication).

KEY MANAGEMENT ISSUES

Distribution: The original southern Florida purple swamphen population is believed to have established in Pembroke Pines in 1996 (Scott Hardin, FWC, personal communication). In recent years, purple swamphens have been sighted in the WCAs, Big Cypress National Preserve, and in STA-1W, STA-1E, STA-5, STA-3/4, and Lake Okeechobee.

Control Tools: To date, the removal of more than 3,000 birds by hunting has not significantly depleted the population. No other control tools are currently developed for this species. Future management actions may include special recreational hunts in the District’s stormwater treatment areas.

Monitoring: The FWC has conducted surveys to document the absence or presence of this species on Florida’s conservation lands. Radio tracking is under way to improve knowledge of the birds’ movements.

Interagency Coordination: Local and state agencies have attempted to analyze this species’ population and implement control. However, efforts to date have not halted the further spread of the species, and eradication is no longer considered feasible.

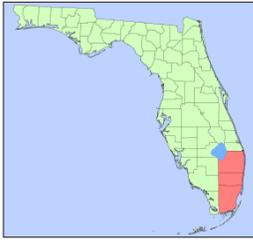
Regulatory Tools: Previous federal protection of this species under the Migratory Bird Treaty Act, which hindered control options, was removed by the USFWS in 2010. Federal and state regulations to restrict the possession of this species are needed to avoid future releases. There are currently no regulations that prohibit the importation or possession of this species in Florida.

Critical Needs: Additional monitoring to assess population expansion; basic information on impacts of this species on native species; federal and state regulations to restrict possession of this species.



2011 Status of the Purple Swamphen by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Sacred Ibis (*Threskiornis aethiopicus*)

SUMMARY: The sacred ibis is a large omnivorous wading bird with life cycle requirements similar to those of egrets, herons, and wood storks in Florida (Rodgers et al., 1996). Wild populations are believed to have originated from unintentional releases during Hurricane Andrew, possibly from the Miami Metro Zoo. This opportunistic feeder consumes insects, fishes, molluscs, crustaceans, small mammals, bird eggs, and refuse (Yésou, 2006). The sacred ibis is known to raid nests of threatened shorebirds, at times destroying whole nesting colonies (Yésou, 2005). Recent gut analysis indicates that anthropogenic refuse is the principal component of the South Florida population’s diet (Calle, 2010). Interagency eradication efforts, organized by the Everglades Cooperative Invasive Species Management Area, are producing promising results with only two unconfirmed reports in the last year (John Humphrey, USDA, personal communication).

KEY MANAGEMENT ISSUES

Distribution: Nesting and roosting sacred ibis have been reported in several locations in Miami-Dade and Palm Beach counties, including the Refuge, landfills, Miami Metrozoo, and residential areas. A single individual was observed in the ENP in 2008 (Skip Snow, NPS, personal communication). The Everglades CISMA and USDA Wildlife Services began removing sacred ibis from known locations in 2008, and no substantiated observations of the sacred ibis have been reported since 2009. No other wild populations of this species are known to occur in the United States. or Caribbean islands.

Control Tools: USDA Wildlife Services has refined control techniques for this species. Night (dusk) hunting and decoy traps are effective methods for removal.

Monitoring: The USDA Wildlife Services and Everglades CISMA are collaborating on monitoring this species. Currently, one radio-tagged male is being tracked Monitoring will continue for at least two years before eradication efforts are deemed successful.

Interagency Coordination: Agencies, universities, and non-governmental organizations are coordinating to report new sightings and implement control measures for this species. An eradication program coordinated by Everglades CISMA began in 2008. Monitoring efforts suggest that the program is successfully eliminating free-ranging sacred ibis.

Regulatory Tools: Currently, no regulations prohibit the importation or possession of this species in Florida.

Critical Needs: Tighter regulatory restrictions to limit importation of this species and continued monitoring to determine population status.



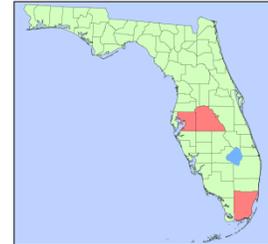
Figure 9-26. Radio-tagged sacred ibis are used to locate others (photo by Judd Patterson, used with permission).

2011 Status of the Sacred Ibis by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Argentine Black and White Tegu (*Tupinambis meriana*)

SUMMARY: The Argentine black and white tegu is a large, omnivorous reptile of South American origin, typically reaching 1.5 meters in length in the wild. The tegu is a generalist predator with a diet that includes a variety of vertebrates and invertebrates (Toledo et al., 2004). As an egg predator, the tegu now threatens shorebirds and sea turtles on the island of Fernando de Noronha (Ramalho et al., 2009). In Florida, it could prey upon the eggs and hatchlings of the American crocodile (*Crocodylus acutus*), Cape Sable seaside sparrow (*Ammodramus maritima mirabilis*) (Kevin Enge, FWC, personal communication), as well as all other ground-nesting birds and reptiles. This species is now a priority species for eradication by regional invasive species biologists.



KEY MANAGEMENT ISSUES

Distribution: Two established populations of the Argentine black and white tegu are known—Hillsborough and Polk counties (Enge et al., 2006), and southern Miami-Dade County. In its native range, this species prefers savannas and other open grassy areas and nests in burrows (Winck and Cechin, 2008). Recent increases in sightings suggest that the population near the ENP is expanding (Tony Pernas, NPS, personal communication), but systematic surveys are needed to validate this supposition.

Control Tools: Trapping and hunting are may be effective control methods, but only preliminary efforts have been made to evaluate the efficacy of these methods for this species. Given the increasing likelihood that this species is well-established on the eastern boundary of the ENP and that control tools are not yet developed, eradication from Florida may soon be unachievable.

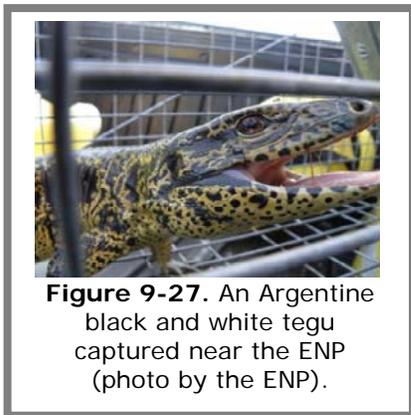


Figure 9-27. An Argentine black and white tegu captured near the ENP (photo by the ENP).

Monitoring: Interagency members of the Everglades CISMA have initiated monitoring, assessment, and control efforts, but lack dedicated funding and staffing resources.

Interagency Coordination: Coordination is increasing for this emerging threat through the FIATT and the Everglades CISMA. A cross-jurisdictional early detection and rapid response team is needed for both known populations of the tegu if containment is to be achieved.

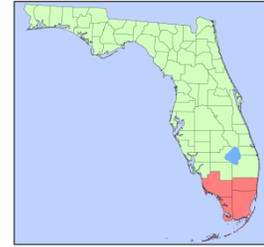
Regulatory Tools: This species should be considered for Reptile of Concern or Conditional Reptile designation by the State of Florida. Given its popularity in the pet trade, federal importation regulations are needed to further curtail releases.

Critical Needs: Dedicated funding for EDRR initiatives; research on severity of impacts; federal and state regulations to restrict possession of this species.

2011 Status of the Argentine Black and White Tegu by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Burmese Python (*Python molurus bivittatus*)



SUMMARY: The Burmese python is now well established in South Florida. This large constrictor is a top predator known to prey upon more than 20 native Florida species (Snow et al., 2007), including the federally endangered Key Largo wood rat and wood stork. Control of this species is a top priority among agencies and policy makers. Record cold temperatures during January 2010 caused widespread mortality of Burmese pythons in South Florida (Mazzotti et al., 2010). However, during the summer and fall of 2010, 24 hatchlings were removed from the region. This is on par with the number of hatchlings found during the previous summer (Skip Snow, NPS, personal communication). A total of 246 Burmese pythons were removed between January–October 2010. This compares to 291 pythons removed by October 2009 during the last reporting period.

KEY MANAGEMENT ISSUES

Distribution: The Burmese python is found throughout the southern Everglades, particularly in the ENP and adjacent lands (e.g., East Coast Buffer lands; north ENP boundary along Tamiami Trail). Sightings also continue in the Key Largo region.



Figure 9-28. Record cold temperatures caused significant Burmese python mortality (photo by the SFWMD).

Control Tools: Control options for this species are limited. Reed and Rodda (2009) review control tools and their applicability to large constrictors in Florida. Potential controls include visual searching, traps, detection dogs, “Judas snakes,” pheromone attractants, and toxicants. Research and development for many of these tools is ongoing. The development of a trap capable of capturing free-ranging pythons represents a significant milestone toward implementing region-wide management (Cherkiss et al., 2009), but effective attractants are still needed.

Monitoring: A regional python monitoring network of agency staff, reptile enthusiasts, and other interested parties continues to develop and expand in South Florida.

Interagency Coordination: There is excellent interagency coordination for this species, but efforts to implement controls are constrained by limited resources and few control tools. A research advisory panel should be established to facilitate prioritization and coordination.

Regulatory Tools: The Burmese python is listed as a Conditional Reptile by the State of Florida. A federal ban on importation of this species is needed to help reduce additional releases.

Critical Needs: Development of effective attractants for trapping; technology to improve detection in the field; increased understanding of fine-scale movement patterns to improve search protocols; federal regulations to restrict possession of this species to limit new releases.

2011 Status of the Burmese Python by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

Nile Monitor (*Varanus niloticus*)

SUMMARY: The African Nile monitor is a carnivorous lizard capable of reaching 7 feet in length (Faust, 2001). This species is a voracious egg eater, raising serious alarm for many of Florida’s threatened native animals that are egg-bearing or occupy burrows (Todd Campbell, University of Tampa, personal communication). Wildlife biologists consider the Nile monitor to be a serious threat to gopher tortoises, burrowing owls, Florida gopher frogs, and other ground-nesting species. Although this large reptile species is an ill-suited pet, it is a popular novelty in the exotic pet trade. This species should be the immediate focus of a determined, interagency control effort.



Figure 9-29. Nile monitor at Homestead Air Force Base (photo by the Homestead Air Reserve Base).

KEY MANAGEMENT ISSUES

Distribution: The Nile monitor is well-established in and around Cape Coral. This species has dispersed to nearby islands and the coastal mainland. A breeding population also exists in and around Homestead Air Force Base in Miami-Dade County.

Control Tools: Snares, traps, and hunting are the only immediately available control tools for this species. Wildlife biologists have developed trapping techniques for this species, but refinements are needed to make trapping cost-effective. Control efforts are piecemeal, consisting of citizen reporting programs (Cape Coral) and limited efforts by agency biologists involved with the Everglades CISMA Rapid Response Team.



Monitoring: There is no regional, coordinated monitoring program for Nile monitors.

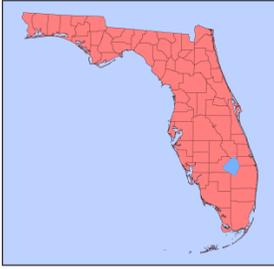
Interagency Coordination: Agency biologists are coordinating to some degree, but higher-level coordination to develop an interagency control program is needed.

Regulatory Tools: The Nile monitor is listed as a Conditional Reptile by the State of Florida. Federal importation regulations are needed to further curtail releases of this invasive species.

Critical Needs: Dedicated funding for aggressive control measures; federal regulations to restrict possession of this species to avoid additional releases.

2011 Status of the Nile Monitor by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys



Feral Hog (*Sus scrofa*)

SUMMARY: Feral hogs have existed on the Florida landscape since their introduction four centuries ago. This omnivorous species competes with and preys on native fauna. Feral hogs consume a variety of vegetation, invertebrates, insects, reptiles, frogs, bird eggs, rodents, small mammals, and carrion (Laycock, 1966; Baber and Coblenz, 1987). This invasive mammal is also known to prey on sea turtles, gopher tortoises, and other at-risk wildlife (Singer, 2005).

Rooting by feral hogs can severely affect plant communities and may facilitate establishment of invasive plant species (Belden and Pelton, 1975; Duever et al., 1986). Although the ecological impacts of this species are apparent, proposals for aggressive feral hog control are controversial because they are a valued game species.

KEY MANAGEMENT ISSUES

Distribution: Wild hogs are reported in all 67 Florida counties. Within the District, feral hog populations are particularly high in the counties immediately north and west of Lake Okeechobee, and in the Big Cypress and Northern Estuaries-East RECOVER modules.

Control Tools: Hunting, trapping, and the use of toxicants may be used to control feral hogs. Feral hogs are considered legal game on state and federal lands and may be hunted during designated seasons. Agencies also maintain trapping programs for some natural areas.

Monitoring: There is no regional, coordinated monitoring program for the ubiquitous feral hog. Monitoring is limited to efforts associated with trapping programs and game management.

Interagency Coordination: Agencies coordinate control efforts to varying degrees at the local level. Scientists and land managers also exchange information related to control techniques. However, higher-level coordination is necessary to direct regional strategies for maintaining feral hog populations at the lowest feasible level.

Regulatory Tools: Existing feral hog management practices and policies for public conservation lands could be revised with the aim of maintaining feral hog populations at the minimum feasible level.

Critical Needs: Development of target specific toxicants or contraceptives; less-restrictive hunting regulations on conservation lands to maximize hunting pressure; initiatives for control on private lands.



Figure 9-30. A pair of feral hogs at Lake Okeechobee (photo by the FWC).

2011 Status of the Feral Hog by RECOVER Module

Kissimmee	Lake Okeechobee	Northern Estuaries-East	Northern Estuaries-West	Greater Everglades	Big Cypress	Florida Bay & Southern Estuaries	Florida Keys

EMERGING THREATS

Numerous nonindigenous plants and animals loom as emerging threats in South Florida. While the list is too long to allow all threatening species to be discussed, this chapter covers a selection of species currently of high concern. Many of these species are the focus of early detection and rapid response efforts by land managers, regulators, and other entities. As with the priority species listed in **Table 9-3**, these emerging threats are presented with a “District-centric” justification for listing, and it should be noted that priorities may differ for other agencies, depending on regional factors and agency priorities and goals.

Mile-a-Minute Weed (*Mikania micrantha*)

Mile-a-minute weed is a major environmental and agricultural threat that has recently appeared in South Florida. This vine, which is native to parts of tropical and subtropical America, has turned into a disastrous weed where it was introduced to Asia, Australia, Africa, and other warm parts of the world. It rapidly overgrows and smothers cultivated and native plants. This dangerous weed was discovered near Homestead in 2008, and an aggressive reconnaissance and eradication project was begun immediately. Fighting the fast-growing pest, however, is challenging. It roots freely from stems, and small fragments can grow into new plants. Vast numbers of airborne seeds can spread the infestation. In early growth stages, mile-a-minute may be overlooked because it resembles the harmless native climbing hemp vine (*Mikania scandens*). Hope for eradication depends on identification of outlier populations quickly enough to destroy them before they spread. The Florida Division of Plant Industry has issued a pest alert to make people aware of mile-a-minute and help with identification (available at http://www.doacs.state.fl.us/pi/pest_alerts/mikania-micrantha-pest-alert.html). Although mile-a-minute is clearly a threat to South Florida, the actual extent of potential damage to the Everglades is uncertain. The weed is apparently not adapted to prolonged inundation; for example, it does not grow well in rice paddies. On the other hand, it destroys rice crops by encroaching from the edges and smothering them (Global Invasive Species Database available at www.issg.org/database/species/ecology.asp?si=42). Therefore, at least marginal areas of natural wetlands are likely at risk. In addition, loss of natural uplands reduces productivity of the system.



Figure 9-31. Mile-a-minute weed blanketing bushes and trees near Homestead (photo by the Institute for Regional Conservation).

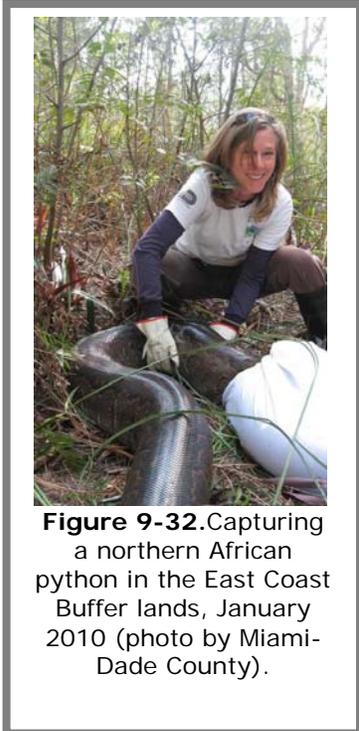


Figure 9-32. Capturing a northern African python in the East Coast Buffer lands, January 2010 (photo by Miami-Dade County).

Northern African Python (*Python sebae*)

Since 2002, 19 northern African pythons have been found in the Bird Drive Basin in Miami-Dade County, including multiple large adults, a pregnant female, and two hatchlings. This giant constrictor shares many natural history traits with the Burmese python and is considered a high risk for establishment and expansion throughout southern Florida (Reed and Rodda, 2009). Rapid response efforts to delineate and eradicate this population of northern African pythons are now of highest priority to local, state, and federal agencies. The District and Miccosukee Tribe of Indians, the primary land owners of the Bird Drive Basin, are working closely with the FWC and other agencies to address this emerging threat. The FWC now regularly deploys trained python surveyors to the area and, in mid-January 2010, more than 70 members of the Everglades CISMA conducted a three-day rapid response effort in the area. All captured pythons are transported to the ENP or USDA Wildlife Services laboratories where they are either euthanized or utilized for telemetry or trap development research.

Scientists recently determined that melaleuca slash piles from past invasive plant management efforts in the Bird Drive Basin were providing productive nesting habitats for the northern African python. To address this unfortunate irony, the District and agency partners removed this nesting habitat in 2010 by salvaging melaleuca trees for landscaping mulch and shredding the remaining slash on site. During this operation, two northern African pythons were found in the melaleuca piles and removed. Planned rapid response efforts in the near term include deployment of traps and trained detection dogs (see previous *Invasive Animal Management* section) and continued visual searches by permitted FWC python hunters and wildlife specialists from USDA Wildlife Services through a new agreement with the District.

Pigeonwood (*Trema orientalis*)

Pigeonwood is a tree native to a wide area including parts of Asia, Africa, and Australia. It is a fast-growing pioneer species widely planted for erosion control and soil conservation or when rapid shade is needed, as in growing coffee or cacao. It grows to about 60 feet tall, but may mature as a smaller shrub under harsh conditions. The leaves look somewhat like those of hackberry but consistently have numerous, tiny, blunt teeth on the edges, whereas hackberry leaves have fewer, larger teeth that are highly variable in number even on the same branch, but never as many or as even as the *Trema*.

This species is extensively naturalized on Hawaii and on certain other Pacific and Indian Ocean Islands. It is present on all of the six largest Hawaiian Islands, typically in mesic woods. Because of this record of invading natural communities, pigeonwood is suspect as a potentially dangerous invasive species in Florida. Pigeonwood has been present in limited numbers for several years in Miami-Dade County, but has recently been noticed growing in substantial quantities along roads near Lake Okeechobee in Martin, Palm Beach, and Okeechobee Counties. Since the seeds are capable of being distributed by birds and the tree resembles certain native species with no outstanding visual distinctions, pigeonwood may well have spread to other parts of South Florida where it has not yet been recognized.

CONCLUSIONS

The elements of a comprehensive management program for nonindigenous plant species — legislation, coordination, planning, research, education, training, and funding — have been in place in Florida for many years. The majority of plants identified in this chapter as priority species are being managed on public lands by local, state, or federal agencies. That is not true of most nonindigenous animal species. The threat of nonindigenous animals is becoming an important ecological and restoration issue for many agencies in Florida. Meaningful legislation to significantly limit new invasions, funding for control programs, and coordination at all levels are needed for a comprehensive nonindigenous animal management program for Florida. The number of nonindigenous animals is overwhelming, and agencies charged with managing natural systems have a responsibility to understand the distribution and impacts of these species and either initiate management operations or accept their occurrence and consequences in natural areas.

Given the documented impacts of nonindigenous organisms in South Florida, scientists are obliged to factor these species and their impacts into restoration models, and research is needed to understand the distribution, biology, and impacts of these nonindigenous organisms. Controlling and managing nonindigenous organisms in an all-taxa approach is a nascent idea, even among ecologists, but it is sure to emerge as an important field of science given global trade and the virtual “open barn” situation. Organisms will continue arriving and establishing breeding populations in new environments, especially in South Florida.

Regardless of taxa, the process of biological invasion—from introduction to establishment to ecosystem engineer—is complex, involves many environmental factors, and may take many decades to complete. Relatively few nonindigenous species become invasive in their new environments, but a very few species can wreak major economic and ecologic havoc. Species that appear benign for many years or even decades may suddenly spread rapidly following floods, fires, droughts, hurricanes, long-term commercial availability, or other factors. Resource managers must recognize these species during the early, incipient phase to maximize the potential for containing or eradicating them. As part of this effort, an “applied monitoring” program and a tracking system for nonindigenous plant and animal species are needed before their introduction.

Species like the purple swamphen in the Everglades and the Gambian pouched rat in the Florida Keys illustrate the need for state and federal agencies to act quickly to contain and attempt to eradicate animals that have the potential to become widespread and difficult to control. Recent additions to nonnative wildlife rules (Chapter 68-5, F.A.C.) increase the scope of existing rules (limiting the trade of the red-eared slider, for example). However, many more restrictions are needed to curb the purposeful and accidental release of nonindigenous animals into the South Florida environment. While definitive research is lacking to support the immediate management of these particular species, it is widely accepted in the invasive species literature that catching a species in its incipient phase is advantageous, even where research may be inadequate or lacking. This is one of the most important reasons to develop a biological risk assessment “tool box” for nonindigenous species to help discern which species are most likely to become invasive both prior to introduction and during the earliest phases of their establishment when eradication is most feasible.

The use of an EDRR program increases the likelihood that invasions will be controlled while the species is still localized and population levels are so low that eradication is possible (National Invasive Species Council, 2003). Once populations of an invasive species are widely established, eradication becomes virtually impossible and perpetual control is the only option. In addition, implementing EDRR programs is typically much less expensive than a long-term invasive species management program. Given the risks associated with waiting for research and long-term monitoring to “catch up,” some agencies have opted to initiate control programs concurrently

with biological or ecological research programs. Biological risk assessments are being developed (Gordon et al., 2006; Simons and De Poorter, 2009) to enable agencies to determine which species are most likely to become problems. Many states struggle with how to implement an EDRR approach because awareness and funding often lag, preventing a real “rapid” response. For South Florida, groups such as the Everglades CISMA, NEWTT, and FIATT are attempting to initiate EDRR efforts.

During 2010, an interagency team of invasive species scientists and land managers met with representatives of the South Florida Ecosystem Restoration Task Force Working Group to discuss next steps for addressing the impacts of nonindigenous, invasive species in the Everglades restoration footprint. Through these discussions, scientists and land managers developed a list of priority recommendations for improvements in prevention, EDRR, and control efforts, with an emphasis on interagency coordination on each of these elements. Key recommendations to the Task Force included (1) promotion of comprehensive federal prevention initiatives for nonnative wildlife (risk assessment and screening); (2) increased research focus on risk assessment models to support prevention initiatives; (3) development of sustainable resource sharing and reimbursement mechanisms across agencies (federal, state, and local levels), particularly for EDRR; (4) research and development of tools for invasive animal EDRR protocols; and (5) the establishment of Everglades EDRR Regional Coordinator(s) to facilitate coordinated rapid response programs in the region.

An overarching theme in this chapter is describing the alarming extent and impacts of some nonindigenous species and stating the need for increased coordination and control. While these observations are valid, control efforts against certain nonindigenous species have proven successful and demonstrate that effective management is possible with effective interagency support and adequate funding. For instance, melaleuca once was thought to be unmanageable in the state because it was so widespread and difficult to control. The District-led melaleuca management program is entering its 19th year, and resource management agencies estimate this program has cost nearly \$40 million to date. However, melaleuca now is under maintenance control on Lake Okeechobee and in the majority of the Everglades. Florida’s melaleuca management program is a model for invasive species management nationally. Few states can point to species-based management efforts that are as well planned and executed.

The success of Florida’s melaleuca management program is largely attributed to integrated management approaches, sustained funding, and close interagency coordination, all of which foster information and technology transfer, regional strategic planning, increased financial efficiency, and improved public awareness. Interagency coordination on other invasive species has also produced successful outcomes. Sustained coordinated management of Australian pine has substantially reduced infestations regionally and the species is now considered under maintenance control in the Greater Everglades region. Prompt cooperative action to eliminate emerging populations of Gambian pouched rats, sacred ibis, and kripa also appear to be successful. These EDRR efforts may have prevented widespread ecological harm by these new invaders and also saved significant public resources required to manage more widespread invasions. For the nonindigenous species that are already widely established, long-term commitments to integrated control programs are the only feasible means of containing and reversing impacts. Effective management of entrenched and difficult-to-control species, such as Old World climbing fern and the Burmese python, will require sustained resource allocation for development and implementation of control programs if Everglades restoration is to be successful. Further, many biological invasions are likely to be permanent and may easily reestablish dominance if maintenance-control management is not sustained. For this reason, preventing importation of potentially invasive species through improved regulatory programs and regional monitoring programs should be a priority focus of policy makers, regulators, scientists, and land managers moving forward.

ACKNOWLEDGMENTS

This chapter was produced with the help of several individuals who contributed their time and knowledge to the content and format of this document. The authors wish to thank Terri Bennett (SFWMD), Teresa Cooper (UF), Ellen Donlan (SFWMD), Howard Frank (UF), Scott Hardin (FWC), Mike Renda (TNC), Art Roybal (USFWS), Skip Snow (NPS), and many others for their helpful contributions.

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