Chapter 7: Status of Invasive Species

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Highlights

Quite a few accomplishments related to invasive species were made just prior to or during Fiscal Year 2024 (October 1, 2023–September 30, 2024). Several are highlighted here.

Brazilian pepper thrips (photo by USDA-ARS).

Releases of biological control agents for Old World climbing fern, Brazilian pepper, and melaleuca continued within the footprint of the Comprehensive Everglades Restoration Plan (CERP). Since 2013, there have been over 3,800 release events resulting in the release of over 46 million biological control agents. A fourth insect for biocontrol of melaleuca was approved in 2022 and has begun being released. This past fiscal year, nearly 200,000 thrips were released to control Brazilian pepper within the CERP footprint, as of June 2024. Thrips establishment and feeding damage on the plants has been noted at many of these release sites. In some cases, damage to the Brazilian pepper canopy has been severe, with significant defoliation and secondary infestations of other insects. In general, the thrips have persisted at up to 60% of survey sites. There are now at least 30 sites where thrips have been detected despite having not had a release in over a year. Natural dispersal has also been noted as thrips have been found at new sites up to 2 kilometers from the nearest established release site. Moreover, while the thrips primarily feed on growing branch tips, they have been shown to feed on reproductive tissues of the weed when flushing branch tips are scarce, with potential to directly impact Brazilian pepper reproduction.

Several outreach activities were conducted during FY2024. The Everglades Cooperative Invasive Species Management Area (ECISMA) partners held invasive species training events targeting technicians and other field workers who spend time in the Everglades. These are the strategic "eyes on the ground" personnel who are most likely to observe these animals in the field. ECISMA also hosted its annual Everglades Invasive Species Summit on June 25 and 26, 2024. This two-day meeting provided a forum for exchanging updates on invasive species management activities, new research, and outreach efforts as well as planning workshops to organize future collaborations and projects. Treasure Coast Cooperative Invasive Species Management Area (CISMA) members planned and participated in three workdays that all focused on early detection monitoring for plant species including missiongrass, Tropical nutrush, and Cerulean flaxlily. These types of workdays provide unique hands-on experience for partners to

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identify and potentially managing EDRR species. For the Southwest Florida CISMA, both the Weed Wrangle and Invasive Fish Roundup had record attendance.

Hydrilla removed from the Homestead canal system as part of the IPM case study.

During FY2024, the South Florida Water Management District (SFWMD) conducted an Integreted Pest Management (IPM) case study on vegetation control in canal systems using mechanical control, herbicide, and sterile grass carp. In spring 2024, hydrilla grew out of control in 29 kilometers of the Homestead canal system and become a risk to flood control. Specialized mechanical harvesting equipment was deployed for immediate removal of the hydrilla to facilitate water movement. In addition to the harvesters, a tow boat dragged a large metal plow on the bottom of the smaller adjacent inflow canals to forcefully remove the hydrilla. The uprooted biomass floated downstream where it was collected by the harvesters. The removal of hydrilla initially enhanced water conveyance; however, by the time harvesting was complete, hydrilla had already started regrowing in the canal. To maintain control of the hydrilla, an herbicide was administered. One month after treatment, hydrilla was visually undetectable indicating the treatment was effective. Past reports on hydrilla treatments have shown initial success, but hydrilla often reestablishes dominance within three years necessitating similar large-scale management interventions. To counteract the boom-and-bust cycle typical of hydrilla management, 2,500 sterile grass carp were released into this canal system in early summer 2024 to serve as a biocontrol agent for hydrilla. This IPM approach provides tools to keep hydrilla populations from becoming a risk to flood control while also reducing its spread into adjacent Homestead waterways.

Several new publications containing important information related to invasive species became available during 2023 and 2024. These publications cover the following topics:

- Recommendations for incorporating invasive species into U.S. climate change adaptation planning and policy (Brewington et al. 2024)
- Using unmanned aircraft systems to investigate the detectability of Burmese pythons in South Florida (Cerreta et al. 2023)
- A new repellent for redbay ambrosia beetle (Coleoptera: Curculionidae: Scolytinae), primary vector of the mycopathogen that causes laurel wilt (Cloonan et al. 2023)
- Two potential candidates for biological control of cogongrass in quarantine (Gazdick et al. 2024)
- Evaluation of novel triclopyr formulations for control of Old World climbing fern (*Lygodium microphyllum*) (Glueckert et al. 2023)
- What is the potential for extirpating spectacled caiman from Comprehensive Everglades Restoration Plan Projects in South Florida? (Godfrey et al. 2023)
- Burmese pythons in Florida: A synthesis of biology, impacts, and management tools (Guzy et al. 2023)
- Selective method for invasive plant removal enhances restoration (Hinkson et al 2024)
- Eradication of African sacred ibis (*Threskiornis aethiopicus*) from South Florida, USA: A collaborative early detection and rapid response case study (Kluever et al. 2023)
- Population genetics comparison of *Lilioceris cheni* (Coleoptera: Chrysomelidae) colonies released onto *Dioscorea bulbifera* in southeastern USA (Madeira et al. 2023)
- When to target control efforts? Using novel GPS telemetry to quantify drivers of invasive Argentine black and white tegu (*Salvator merianae*) movement (Mason et al. 2024)
- Mammalian lures monitored with time-lapse cameras increase detection of pythons and other snakes. (McCampbell et al. 2024).
- Development of a tetraplex digital PCR (dPCR) assay for the detection of invasive snake species in Florida, USA (Miller et al. 2024)
- The Brazilian peppertree biological control agent *Pseudophilothrips ichini* (Thysanoptera: Phlaeothripidae) displays a flexible feeding strategy between foliage and reproductive tissues (Nestle et al. 2023)

- Skin lipids alone enable conspecific tracking in an invasive reptile, the Argentine black and white tegu lizard (*Salvator merianae*) (Parker et al. 2023)
- Not one but two: examining the genetic origin and characterization of the non-native spectacled caiman (*Caiman crocodilus*) in Florida (Parks et al. 2024)
- Contrasting invasion histories and effects of three non-native fishes observed with long-term monitoring data (Pintar et al. 2023a)
- Hydrology-mediated ecological function of a large wetland threatened by an Asian swamp eels (Pintar et al. 2023b)
- Asian swamp eels (Synbranchidae, *Monopterus*) in Florida: Distribution, spread and range of hydrologic tolerance over twenty-seven years (1997–2023) (Pintar et al. 2024)
- Mammal declines correspond with increasing prevalence of Burmese pythons at their southern invasion front in the Florida Keys (Redinger et al. 2024)
- Sethoxydim performance on torpedograss (*Panicum repens*) and sand cordgrass (*Spartina bakeri*) as affected by carrier volume and rate (Sperry et al. 2023)
- Spatial-temporal shifts in submersed aquatic vegetation (SAV) community structure resulting from a selective, in-water herbicide treatment in Lake Sampson, Florida (Thayer et al. 2024)
- Giant African snail cooperative eradication program in Florida final environmental assessment May 2024 (United States Department of Agriculture 2024)
- Drivers of invasion by laurel wilt of redbay and sassafras in the southeastern United States (Ward and Riggins 2023)
- Inhibition of invasive plant *Mikania micrantha* rapid growth by host-specific rust (*Puccinia spegazzinii*) (Zhang et al. 2023)
- Significant changes in soil microbial community structure and metabolic function after *Mikania micrantha* invasion (Zhao et al. 2023)

SUMMARY AND INTRODUCTION

Invasive species present serious challenges to ecosystem community structure and function throughout South Florida. Controlling invasive species is cited as a critical resource management activity in the South Florida Water Management District (SFWMD) *Strategic Plan, 2021–2026* (SFWMD 2020). Successfully managing invasive species is also important to other strategic goals as their far-reaching effects must be considered during many SFWMD activities—from evaluating Environmental Resource Permits to managing the Everglades Stormwater Treatment Areas (STAs) to restoring natural fire regimes. In support of collective activities of the many agencies involved in Everglades restoration, this chapter reviews the broad issues involving invasive species in South Florida and their relationship to restoration, management, planning, organization, and funding. The report provides updates for many priority invasive species, programmatic overviews of regional invasive species initiatives, and key issues linked to managing and preventing biological invasions in South Florida ecosystems. While detailed information on many invasive species is not available, this document attempts to provide an update and annotations for priority plant and animal species, including summaries of new research findings. As part of continued efforts to streamline reporting, this year's update emphasizes new information obtained during Fiscal Year 2024 (FY2024; October 1, 2023–September 30, 2024).

COLLABORATION

In addition to providing the status of invasive species programs and outlining programmatic needs, this document summarizes what, if any, control or management is under way for priority invasive species considered capable of impacting the resources SFWMD is mandated to manage or restore. SFWMD continues to collaborate with the Lake Okeechobee Interagency Aquatic Plant Management Team, South Florida Ecosystem Restoration Task Force (SFERTF), Florida Python Control Plan (FPCP) Working Group, regional cooperative invasive species management areas (CISMAs), and other cross-jurisdictional teams. These critical collaborations have facilitated the implementation of regionwide invasive species monitoring programs, rapid response efforts, standardized data management, and outreach initiatives. As such, this report includes a great deal of information and summaries of accomplishments attributed to the efforts of these collaborative teams. Active partners in invasive species management within the South Florida ecosystem include but are not limited to the following entities: Miami-Dade County, Broward County, Collier County, Palm Beach County, Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Agriculture and Consumer Services (FDACS), Miccosukee Tribe of Indians of Florida, The Nature Conservancy, Seminole Tribe of Florida, United States Army Corps of Engineers (USACE), United States Department of Agriculture (USDA) – Agricultural Research Service (ARS), United States Department of the Interior, United States Geological Survey (USGS), National Park Service (NPS), United States Fish and Wildlife Service (USFWS), and University of Florida (UF).

A NOTE ON TERMINOLOGY

To standardize terms associated with invasive species and improve communication with stakeholders, this chapter follows terminology guidelines proposed by Iannone et al. (2021). Specifically, the term "invasive" is defined as "*a species that (a) is nonnative to a specified geographic area (in this context the state of Florida), (b) was introduced by humans (intentionally or unintentionally), and (c) does or can cause environmental or economic harm or harm to humans.*" This term accurately describes all species highlighted in this chapter. The term "nonnative" is also used to describe any species that does not occur naturally within the South Florida ecosystem (SFWMD boundaries) but does not necessarily imply environmental, economic, or human harm by its presence in Florida.

INVASIVE SPECIES IN THE RESTORATION CONTEXT

When Everglades restoration planning began, it was assumed that once historic water flow patterns were reestablished, ecological restoration goals would be largely achieved. However, our improved understanding of resilient, alternative stable states resulting from biological invasions has led ecologists to conclude many invasive species will be a direct threat to restoration success unless management of these species is directly addressed (Doren et al. 2009).

As restoration proceeds, existing and new invaders can act as both a cause of ecosystem degradation and a driver of ecosystem change (Norton 2009). Additionally, the unique responses of each invasive species to changing abiotic and biotic conditions further complicates our predictions of restoration outcomes. For example, removal of canals and levees may limit the spread of some of species that have exploited niches resulting from altered hydroperiods, while other species (e.g., invasive fish) may find new habitats to invade.

To address these unique challenges, SFWMD and USACE have worked to incorporate invasive species management into restoration programs. In 2012, Comprehensive Everglades Restoration Plan (CERP) Guidance Memorandum (CGM) 62 was put into place, making invasive species management mandatory within CERP projects. Since this memorandum was put into place, invasive species management has been required within every phase of Everglades restoration: planning, construction, operations, and maintenance. To facilitate this effort, invasive species management plans are developed for all CERP projects.

Despite the challenges biologists and land managers face regarding Everglades restoration and invasive species management, significant accomplishments have resulted from CERP-related activities and initiatives. For example, SFWMD and USACE partner with USDA to fund a biological control program focused on integrated invasive plant control within the CERP footprint. Because of this partnership, more than 40 million insects and mites have been released in South Florida, helping to control hundreds of acres of invasive plant species.

The USACE Invasive Species Management Branch also worked to implement CGM-62 in the following projects during the planning phase: Western Everglades Restoration Plan (WERP), Lake Okeechobee Watershed Restoration Plan (LOWRP), Biscayne Bay and Southeastern Everglades Ecosystem Restoration Project (BBSEER), Loxahatchee River Watershed Restoration Project (LRWRP), and the Central Everglades Planning Project (CEPP). Invasive Species management plans have been included in these projects from the very beginning, with the additional inclusion of invasive animals. Having an invasive species management plan in place during the planning phase makes management processes and funding capabilities more feasible in that management actions are proactive rather than reactive. USACE is conducting invasive species management in several other projects currently in the construction phase but without invasive species management plans. These projects include the Kissimmee River Restoration Project, Modified Water Deliveries to Everglades National Park and several CERP projects: Biscayne Bay Coastal Wetlands, C-44 Reservoir and STA, Site 1 Impoundment, and Picayune Strand Restoration Project.

Although the incorporation of CGM-62 into Everglades restoration has made invasive species management more consistent, there are still challenges land managers and biologists face when it comes to managing invasive species. Successful restoration is incumbent upon the public being aware of their role in keeping the Everglades in its natural state. Enhancing education and outreach efforts to make the public more aware of their impact on the Everglades ecosystem, specifically regarding the introduction of new and invasive species, will be integral in maintaining the restored state of the Everglades. However, when prevention fails and a new species is introduced into the system, a strategy to stop the spread immediately is vital. Controlling existing target species is a repeated management action that is funded year after year. However, when it comes to early detection and rapid response (EDRR) species, funding becomes more clouded. The field of invasive species biology is always developing and changing. New plants and animals will be introduced into Florida each year, and it is impossible to predict which of those species will be the

next to persist and spread throughout the landscape, and thereby impact restoration gains or goals. Having the capability to quickly respond to such species is integral in restoring the Greater Everglades ecosystem to its historic state. In the future, having flexible EDRR funds available to respond to new introductions in combination with additional prevention efforts (i.e., education and public outreach) will allow for the Everglades to not only remain as it was, but return it to its natural state.

INVASIVE PLANTS

- Ninety-four invasive plant species are SFWMD priorities for control. Old World climbing fern (*Lygodium microphyllum*), melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolia*), and Australian pine (*Casuarina* spp.) continue to be systemwide priorities in terrestrial natural areas, while aquatic plants such as hydrilla (*Hydrilla verticillata*), water hyacinth (*Pontederia crassipe*s), and tropical American watergrass (*Luziola subintegra*) are priorities in the Kissimmee Basin, Lake Okeechobee, and SFWMD's STAs and canal systems.
- Efforts to control invasive plants continue throughout SFWMD-managed natural areas, STAs, project lands, lakes, and flood control canals and levees. SFWMD and partner agencies continue ongoing efforts to refine invasive plant management strategies with the goal of achieving cost-effective and environmentally responsible maintenance control of the most harmful species.
- The Interagency Melaleuca Management Program is a national model for regional, interagency invasive plant control programs. Melaleuca has been systematically controlled in Water Conservation Area (WCA) 2, WCA-3, northern Everglades National Park (ENP), and Lake Okeechobee and is now under maintenance control in these regions.
- SFWMD, FWC, and USFWS are actively engaged in aggressive control efforts in WCA-1 (part of the Arthur R. Marshall Loxahatchee National Wildlife Refuge [LNWR]) where melaleuca and Old World climbing fern remain problematic. NPS resource managers are collaborating with FWC and SFWMD invasive species biologists to leverage resources towards achieving maintenance-level control of melaleuca, Brazilian pepper, and other aggressive invaders in ENP and Big Cypress National Preserve (BCNP). Biologists with Palm Beach County, FWC, and SFWMD are coordinating treatments of missiongrass (*Cenchrus polystachios*), a recently discovered federal noxious weed in Palm Beach County. USACE, FWC, and SFWMD continue to manage invasive plants on Lake Okeechobee. In addition, USACE manages Brazilian pepper, Old World climbing fern, several invasive grass species, and melaleuca on private easements for the Natural Resources Conservation Service (NRCS).
- Biological control of several invasive plants is showing promising outcomes. The CERP's Biological Control Implementation project continues rearing and releasing approved agents at the USDA-ARS biological control laboratory in Davie, Florida. During FY2024, the program continued releases of biological control agents for Old World climbing fern, Brazilian pepper, and melaleuca. Since the CERP project's inception in 2013, there have been over 3,800 release events resulting in the release of over 46 million biological control agents.
- Range expansions of nonnative plant species into new areas remain a concern for resource managers. Agencies charged with invasive plant control are assessing the threats posed by new introductions and are monitoring and controlling these populations, when deemed appropriate, based on threat prioritization and financial resource availability. Interagency

groups are utilizing and curtailing screening tools to aid in prediction of potential introductions of new nonnative or invasive species.

INVASIVE ANIMALS

- Considerable numbers of nonnative animals are known to occur in South Florida, ranging from approximately 62 species in the Kissimmee Basin to over 130 species in the Greater Everglades. Ranking invasive animal species for control is a technical challenge though recent efforts to develop risk assessment tools are helping with prioritization.
- Burmese pythons (*Python molurus bivittatus*) continue to be observed and removed in the Everglades and surrounding rural areas. SFWMD remains an active partner in regional efforts to halt the spread of this invasive reptile by conducting regional search and removal operations. In addition to an established systemwide monitoring program for Burmese pythons and other priority invasive reptiles, SFWMD and FWC began independent python removal contractor programs in March 2017. As of September 30, 2024, the two programs have resulted in the removal of 15,272 Burmese pythons (number to be provided in the final version of the chapter).
- FWC continues to build its invasive animal management program and coordinates closely with SFWMD, NPS, USFWS, USACE, and other partners to manage nonnative animal species in South Florida. During FY2024, federal, state, local, and tribal partners continued efforts to control populations of several priority invasive animal species including northern African pythons (*Python sebae*), Argentine black and white tegus (*Salvator merianae*), Nile monitors (*Varanus niloticus*), and the spectacled caiman (*Caiman crocodilus*).
- UF continues to operate the Everglades Invasive Reptile and Amphibian Monitoring Program (EIRAMP) in cooperation with and with support from SFWMD and USACE. The purpose of EIRAMP is to develop a system-wide monitoring program to assess status and trends of priority invasive reptiles and amphibians within Greater Everglades ecosystems.

PROGRESS TOWARD MANAGEMENT AND CONTROL

This section provides updates for FY2024 on control, research, monitoring, and coordination activities on invasive species that threaten the success of SFWMD's mission.

SUMMARY OF INVASIVE SPECIES CONTROL TOOLS

Many different techniques are used to control invasive plants and animals in South Florida (Wittenberg and Cock 2001, Enloe et al. 2018). SFWMD and other agencies typically use multiple tools in an integrated fashion with the goal of minimizing impacts of invasive species by the most cost-effective and environmentally sound means. The following is a 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 and land managers are refining these control methods to be more effective in natural areas. The following list provides a generalized description of available plant control techniques:

- **Herbicides** are 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. There are over 20 herbicides employed to control invasive plants in South Florida. Commonly used herbicides for control of broadleaf species in wetlands include dichlorophenoxyacetic acid (2,4-D), triclopyr, and imazamox. Glyphosate and imazapyr are non-selective herbicides and are used for a variety of plant types. Fluazifop-p-butyl is used to selectively control perennial grass species. Floating and submerged aquatic plants are controlled using several herbicides with 2,4-D, diquat, fluoridone, endothall, and triclopyr being the most used. Collaborative research is underway to evaluate the use of newer herbicides in combination with novel application methods with the goal of reduced use rates and management costs.

- **Biological controls** include the use of living organisms, such as predators, parasitoids, and pathogens. "Classical" biological control seeks to locate host-specific natural enemies from a plant's native range and import these species to attack and stress the plant in regions where it has become invasive. Some of the most notable successes include the alligatorweed flea beetle (*Agasicles hygrophila*) used to control alligatorweed (*Alternanthera philoxeroides*), the melaleuca weevil (*Oxyops vitiosa*), melaleuca psyllid (*Boreioglycaspis melaleucae*), and melaleuca gall midge (*Lophodiplosis trifida*) used to control melaleuca, and the giant salvinia weevil (*Cyrtobagous salviniae*), which attacks giant salvinia (*Salvinia molesta*).
- **Manual and mechanical controls** include the 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 or management objectives.
- **Cultural practices** include the use of prescribed burning, water level manipulation, or native species plantings to control invasive plants. Fire can be used to suppress plant growth, reduce aboveground biomass, 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. In some cases, planting native plant species may reduce a site's susceptibility to invasion by invasive species.

Invasive Animal Control Tools

Operational management tools to control invasive animals in Florida's natural areas have only been developed within the past two decades and, in many cases, are developed but not fully implemented. Agencies within the Everglades restoration footprint began collaborating on invasive animal management tool development in the early 2000s through partnerships with limited funding or staffing resources. Early initiatives through SFERTF's Florida Invasive Animal Task Team (FIATT) and the Everglades Cooperative Invasive Species Management Area (ECISMA) organized and leveraged resources for initial research in control tool development for emerging priority species. By creating the Nonnative Fish and Wildlife Program in 2010, FWC became the first agency in the state with a dedicated program to deal with the operational-type control and management of invasive wildlife or marine species. The program has since grown considerably and is now housed within the FWC's Wildlife Impact Management Section. The SFWMD has had a small, dedicated invasive animal team since 2017, which primarily focuses on contracting invasive animal research and control services. The following list provides a generalized description of techniques for control of invasive animal species:

- **Exclusion** is the use of barriers (e.g., electrical, hydraulic, and 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 (*Hypophthalmichthys* and *Ctenopharyngodon* spp.) from the Illinois River into the Great

Lakes. This specific technique has yet to be tested for controlling invasive species in the Greater Everglades.

- **Habitat manipulation** is the removal of cover, 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. An example is the SFWMD removal of large melaleuca slash piles in and around the area known to harbor the northern African python. These large debris stockpiles were thought to provide nesting habitat for this species.
- **Trapping** is the use of snares, nets, or cage traps to catch and remove individuals of the target species. Cage traps, or "live traps," are the primary control tool for Argentine black and white tegus.
- **Expert catchers** are trained and managed members of the public who have the proclivity and ability to catch target species. Expert catchers are contracted for Burmese python management in Florida.
- **Hunting or fishing** is the use of recreational hunting or fishing to reduce populations of the target species. Hunting programs are frequently used to manage feral pigs (*Sus scrofa*).
- **Biological control or biocontrol** is the development, manipulation, or exploitation of biological agents that can be introduced to reduce target species populations. In 2018, YY male brook trout (*Salvelinus fontinalis*) were introduced into two streams in central Idaho and as of 2024 it appears there are no more female nonnative brook trout in the streams, indicating the likely collapse of this nonnative population of brook trout.
- **Chemical control** is the use of direct chemical application or bait stations to dispatch target species or interrupt breeding.
- **Sterilization** reduces 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.

INVASIVE PLANT MANAGEMENT

SFWMD and other agencies continue to make significant progress toward controlling some invasive plant species on public conservation lands, project lands, and waterways in South Florida (**Figure 7-1**). Ninety-four plant species have been identified for control across the region. These include 77 Category I and 12 Category II invasive species as defined by the Florida Invasive Species Council and five additional priority non-native species. Working with collaborating agencies, SFWMD continues to implement its invasive plant management strategy, which uses integrated pest management to advance maintenance-level control of priority species. The objective of maintenance control is to indefinitely keep the abundance of a targeted species at levels below an impact threshold when complete eradication is not feasible (Panetta and Gooden 2017). Large sections of the Greater Everglades and the marshes of Lake Okeechobee have reached or are nearing maintenance control levels where melaleuca once dominated (Rodgers et al. 2023). However, many regions in the Greater Everglades, including remote sections of the southwestern area of ENP and LNWR 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 invasive plants in these areas are successfully under control.

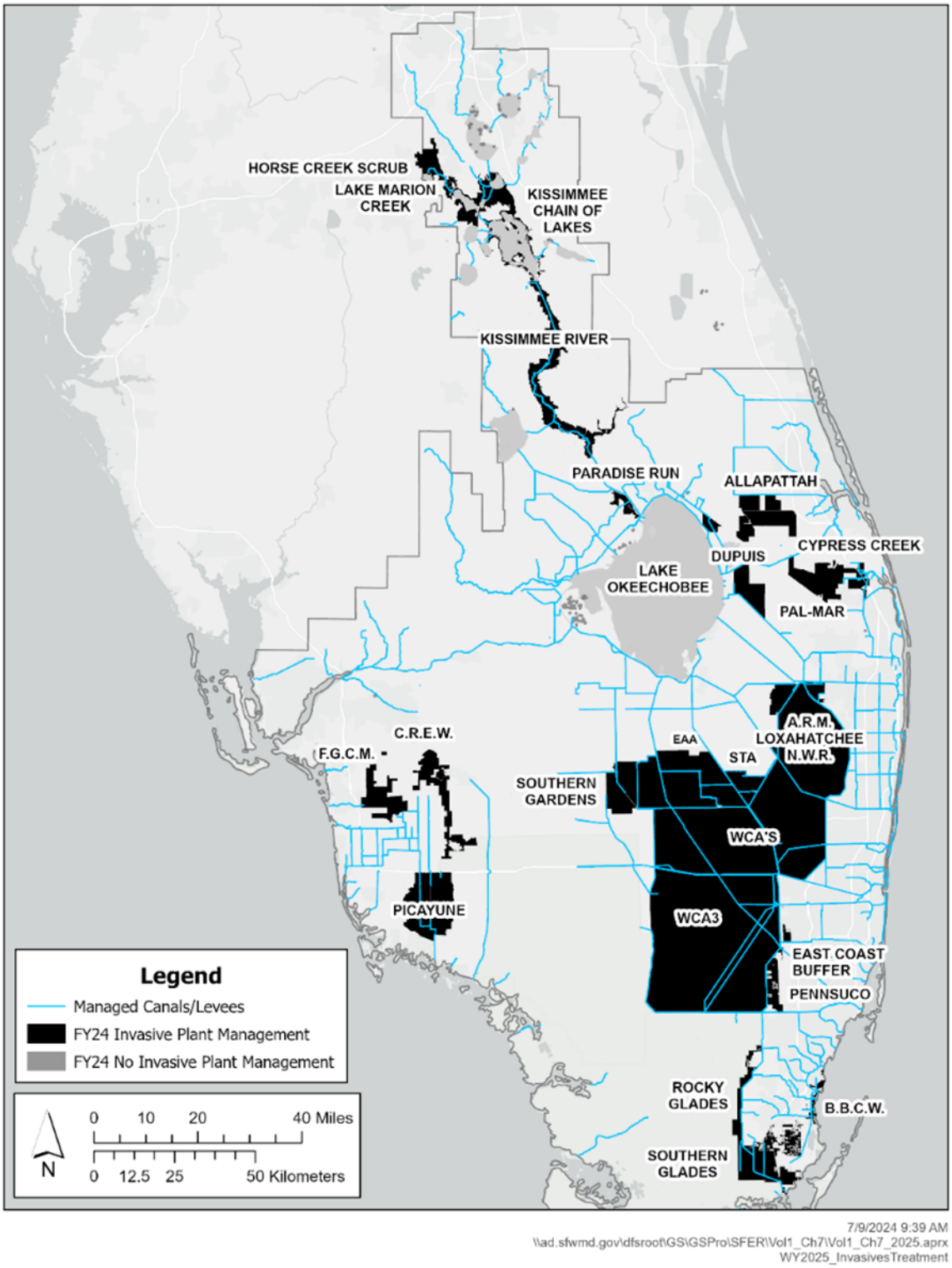


Figure 7-1. SFWMD-managed (or co-managed) lands and canals/levees where invasive plant control is routinely conducted. Black polygons indicate lands where invasive plant control occurred in FY2024. Nearly all canal/levee areas are subject to vegetation management each year, including control of priority invasive plant species. To maintain legibility, not all management areas are labelled. For more detailed information on SFWMD-managed lands and annual land stewardship activities, see Chapter 6B: Land Stewardship Annual Report in Volume II of this report.

SFWMD directs its staff and contractors to control all invasive plant species identified by the Florida Invasive Species Council (FISC) (formerly the Florida Exotic Pest Plant Council) as Category I species (FISC 2023). These species are documented to alter native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with native species. Other non-native plant species that have the potential to disrupt natural communities (e.g., FISC Category II species) or impact restoration infrastructure may also be targeted for control. As part of Everglades restoration and to reduce seed and propagule pressure on neighboring lands, SFWMD continues to expand invasive plant treatment into new areas when feasible. Because initial treatments require follow up control, new work areas must be planned and included in budgets for subsequent fiscal years. Experience has shown vigilant reconnaissance and retreatment 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 (Rayamajhi et al. 2008, Overholt et al. 2009). 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 (Rodgers et al. 2014a). Note SFERTF is compiling expenditure information for participating member agencies. This information can used to create a cross-cut budget for invasive species to increase strategic coordination efforts (SFERTF 2020).

In hydrologically altered, high-nutrient regions of the Everglades system, some native plants can be nuisance species and are actively controlled by land managers. A nuisance plant is defined as an individual or group of individuals of a species that causes management issues or property damage, presents a threat to public safety, or is an annoyance. This term can apply to both native and nonnative species. Carolina willow (*Salix caroliniana*) is expanding rapidly in the Kissimmee River floodplain and in CERP project areas on the eastern boundary of ENP. Prescribed fire is a critical tool for long-term habitat management in both these areas. Carolina willow is not fire susceptible and readily colonizes graminoid marshes, shading out the grasses and sedges that are necessary to carry fire across the landscape. SFWMD is conducting trials to determine the most effective treatment methods and herbicides for controlling Carolina willow while limiting impacts on desirable vegetation. Another native broadleaf plant, Mexican primrose-willow (*Ludwigia octovalvis*), is similarly impacting portions of the southeastern Everglades, particularly in newly disturbed sites. Mexican primrose-willow was one of the first plants to establish in recently constructed CERP components in the Rocky Glades where it has become the dominant species in sections where it was not controlled. It persists in portions of the Frog Pond, Southern Glades, and Biscayne Bay Coastal Wetlands due to its prolific seed production and ability to tolerate fluctuations in water levels. Preliminary observations suggest the plant can be successfully controlled if it is treated immediately when it appears, but once multiple generations of plants have seeded it becomes increasingly difficult to manage the constant succession of new plants. With this knowledge, land managers can anticipate resource needs in new project areas and, if funding allows initiate treatment immediately.

Integrated Pest Management in Florida Natural Areas

Integrated pest management (IPM) is used by land and water managers, farmers, and scientists throughout the world. The guiding principle of IPM is that using a series of control tools designed to work synergistically will yield an optimal strategy for pest control (Prokopy 2003). When used mindfully and deliberately, IPM improves invasive plant management outcomes while reducing herbicide usage and overall costs (Ehler 2006). The tools available for invasive plant management vary depending on the species to be controlled, site conditions, and control objectives (Lake and Minteer 2018).

Implementation of IPM in natural areas (including both upland and aquatic systems) may involve a combination of mechanical, cultural, biological, and chemical management tools (see the *Invasive Plant Control Tools* sub-section above for additional information). It is widely recognized that well-executed IPM strategies result in synergistic improvements in invasive species control, as most available tools are only moderately effective if used on their own. Mechanical, cultural, and biological control tools all require the addition of chemical control to considerably reduce pest plant populations. The use of herbicide allows

land managers to keep pest plant populations at maintenance (the lowest feasible) levels and prevents population explosions. Achieving maintenance levels of invasive plants is important (Panetta and Gooden 2017), particularly in aquatic settings. Uncontrolled aquatic invasive plants inhibit water conveyance and facilitate environmental degradation (Netherland et al. 2005). Control of nuisance aquatic plants is required for SFWMD to fulfill its water quality improvement and flood control missions. Additionally, high densities of aquatic plants contribute to low dissolved oxygen levels and create impenetrable vegetation masses that impede wildlife movement and foraging. Moreover, if aquatic invasive plants expand to large dense populations, subsequent control efforts can lead to extreme fluxes in decaying plant biomass further depleting dissolved oxygen and, in eutrophic waters, may trigger new disturbance regimes favoring blue-green algae blooms (Bicudo et al. 2007).

Numerous herbicides have been approved by the United States Environmental Protection Agency (USEPA) for use in aquatic and natural area settings. These herbicides receive USEPA approval because they require high concentrations (well above approved label maximum usage rates) to be detrimental to fish and invertebrates and they readily breakdown in soil and water through microbial activity and photolysis. SFWMD only uses herbicides approved by USEPA for use in aquatic and natural areas and in strict accordance with the product labels. Twelve of the eighteen herbicides registered for use in Florida waters have a half-life of two weeks or less; some have a half-life of just hours (UF IFAS 2020). Products with the active ingredient glyphosate are some of the most widely used herbicides because of their ability to control multiple weed species, minimal cost, and relatively low environmental toxicity (Solomon and Thompson 2003, Rolando et al. 2017). SFWMD relies on glyphosate as a safe, cost-effective way to treat invasive and nuisance terrestrial plants in natural areas and on levees and rights-of-way. Glyphosate is used for targeted plant control in and along some SFWMD waterways but is a minor component of the aquatics program.

IPM Case Study: Vegetation Control in Canal Systems Using Mechanical Control, Herbicide, and Sterile Grass Carp

SFWMD strives to maintain nuisance aquatic vegetation at the lowest feasible level, i.e., a maintenance control approach, to minimize environmental impact and ensure sustainable water management. This becomes possible by integrating biological, cultural, and mechanical methods alongside judicious use of herbicides. When pest plants become out of control, we can use these methods harmoniously for the best result in regaining maintenance control. In this case study, hydrilla, a submersed aquatic macrophyte invasive to South Florida, grew out of control in the Homestead canal system and become a risk to flood control requiring SFWMD to utilize IPM to take immediate action.

Hydrilla has been measured to grow over 4 meters (m) of total shoots per day in ideal conditions, like the warm and clear waters of Homestead canals (Glomski and Netherland 2012). In Spring 2024, hydrilla was observed growing throughout the water column of over 29 kilometers (km) of canals: an estimated volume of 3 million cubic meters (m^3) of infested water. This substantial biomass slowed the conveyance of water. Frequent fragmentation of the hydrilla further exacerbated the risk of flooding by regularly clogging the intakes of the nearby water management pumps. Specialized mechanical harvesting equipment was deployed for immediate removal of the hydrilla to facilitate water movement.

Two 70-ft aquatic plant harvesters were deployed for over 500 operational hours collecting hydrilla from the canals and disposing the biomass directly on the levee. SFWMD staff were on site throughout the operation to assist with scanning the waterways for the endangered Florida manatee. Harvesting was stopped if a manatee was spotted to ensure minimal disturbance to the animals. In addition to the harvesters, a tow boat dragged a large metal plow on the bottom of the smaller adjacent inflow canals to forcefully remove the hydrilla from the hydrosoil. The uprooted biomass floated downstream where it was collected by the harvesters. Mechanical operations proceeded north until the 29 km of infested canals were all plowed or harvested. The removal of hydrilla initially enhanced water conveyance; however, by that time, hydrilla had already started regrowing in the southern section of the canal. To maintain control of the hydrilla, an herbicide treatment plan was developed.

In late Spring 2024, florpyrauxifen-benzyl (FPB), a synthetic auxin herbicide, was administered in-water to target hydrilla. Prior to treatment, water operations were meticulously coordinated to cease waterflow during the herbicide application. A water grab sample one day before treatment recorded the following values: water temperature at 24.5 degrees Celsius (° C), pH of 7.4, hardness at 192.5 milligram per liter (mg/L), and dissolved oxygen at 2.8 mg/L. A water conditioning agent was added to the tank mixture to mitigate the breakdown of FPB from the slightly alkaline canal water. Four boats were able to carry out the treatment over a two-day period. Soon after treatment, hydrilla became brittle and degraded into fragments, a characteristic symptomology of FPB. One month after treatment, hydrilla was visually undetectable indicating the treatment was effective. Past reports on hydrilla treatments have shown initial success, but hydrilla often reestablishes dominance within three years necessitating similar large-scale management interventions.

To counteract the boom-and-bust cycle typical of hydrilla management, 2,500 triploid grass carp (*Ctenopharyngodon idella*) were released into this canal system in early Summer 2024. Triploid grass carp are sterile herbivorous fish that have been shown to preferentially feed on submersed aquatic vegetation, serving as a biocontrol agent for hydrilla (Sutton et al. 1986). This year's stocking is in addition to the 1,000 triploid grass carp released in early Summer 2023. Incorporating biocontrol into this canal system is anticipated to slow hydrilla growth, leading to lower herbicide use and reduced costs.

The key factor with IPM of hydrilla is careful monitoring of the system to adapt management strategies as environmental conditions and funds change. To keep hydrilla from creating another monospecific contiguous infestation, mechanical harvesting has been incorporated into the annual management plan for this canal system. Additionally, annual herbicide applications will be initiated in the Spring when waterflows tend to be minimal, i.e., conducive for in-water herbicide treatments. Active ingredients will be chosen based on the environmental conditions and the size of the hydrilla population. Over time, less herbicide will be needed as maintenance control is achieved. The final measure in suppression of hydrilla growth in the Homestead canal system is augmented releases of triploid grass carp. Despite being invasive to Florida, hydrilla has become the dominant SAV in the state, filling the water column across extensive areas. This IPM approach provides tools to keep hydrilla populations from becoming a risk to flood control while also reducing its spread into adjacent Homestead waterways.

Biological Control of Invasive Plant Species

Figure 7-2. Brazilian pepper thrips feed on Brazilian pepper leaves and stems (photo by USDA).

Most nonnative plant species arrive in Florida without their co-evolved natural enemies, which facilitates the plants' larger growth, higher reproduction, and rapid spread. As a result, these species may aggressively dominate native plant communities and alter habitats and ecological functions. Classical biological control is a scientific process that reunites these invasive plants with their natural enemies after extensive testing for environmental safety and efficacy. Biological control is a practical management tactic with the potential to not only transform an invasive species into a less aggressive form, but also increase its susceptibility to other control methods such as herbicides for an overall better outcome.

Although several biological control projects have been successful in Florida, this method rarely controls the target completely; rather it complements existing tactics by weakening the target plant and making it less competitive while increasing its susceptibility to herbicides and fire. Developing biological control agents is a long-term process due to the importance of ensuring the environmental safety of prospective agents. Overseas and United States quarantine studies are used to confirm the identity and specificity of an agent, which is then subjected to a rigorous and lengthy review by state and federal regulatory agencies before it can be introduced. Despite

these hurdles, biological control research and implementation has led to the transformation of formerly intractable weeds into less invasive forms.

Brazilian Pepper

Mass rearing and field releases of the Brazilian pepper thrips (*Pseudophilothrips ichini*; (**Figure 7-2**) biological control agent began in May 2019. The thrips is being distributed throughout the Brazilian pepper (*Schinus terebinthifolia*) invaded range and especially within the CERP restoration footprint including impacted areas in and around ENP and BCNP. Within the CERP footprint, over 1.4 million thrips have been released since the project's inception, of which roughly 197,000 were released during FY2024 as of June 2024. These numbers come from the combined efforts of multiple agencies and funding projects. Thrips establishment and feeding damage on the plants has been noted at many of these release sites. In some cases, damage to the Brazilian pepper canopy has been severe, with significant defoliation and secondary infestations of naturalized herbivorous insects such as scale (**Figure 7-3**). In general, the thrips have persisted at up to 60% of survey sites surveyed two months after the last release (Wheeler et al. 2022). There are now at least 30 sites that have thrips detected and have not had a release in over a year. Natural dispersal has also been noted with cases of thrips being found at new sites up to 2 km from the nearest established release site. Moreover, while the thrips primarily feed on growing branch tips, they have been shown to feed on reproductive tissues of the weed when flushing branch tips are scarce, with potential to directly impact Brazilian pepper fruit and flower viability (Nestle et al. 2023).

Figure 7-3. Severely defoliated Brazilian pepper (blue ribbon) 2.5 years after the first release of Brazilian pepper thrips (photo by USDA).

Figure 7-4. Larvae of the melaleuca pea galling midge stimulate pea-shaped gall formation on melaleuca leaves (photos by USDA).

Melaleuca

The melaleuca weevil was introduced in 1997 and established on melaleuca (*Melaleuca quinquenervia*) throughout South Florida. Weevil herbivory reduces reproductive potential as much as 99%, reduces growth rate by more than 80%, and shortens tree height by half (Tipping et al. 2008). Those trees that reach reproductive maturity have smaller flowers containing fewer seeds (Pratt et al. 2005, Rayamajhi et al. 2008). The melaleuca psyllid was released in 2002 and, in conjunction with the weevil, has led to decreases in melaleuca canopy cover over a 16-year period (1997–2013), resulting in a four-fold increase in native plant species diversity at some sites (Rayamajhi et al. 2009, 2019). A five-year field study found melaleuca reinvasion was reduced by 97.8% compared to pre-biocontrol population densities despite a large fire that, in the past, would have promoted dense recruitment of seedlings (Tipping et al. 2012). The melaleuca tip galling midge (*Lophodiplosis trifida*) and the melaleuca pea galling midge (*Lophodiplosis indentata*)

(Diptera: Cecidomyidae) (**Figure 7-4)** are the two newest releases. Both species oviposit on new growth, but *L. trifida* prefers tips and *L. indentata* prefers new leaves. Neonate larvae bore into the growing tips or leaves, stimulating the formation of galls, diverting the tree's resources away from growth and reproduction. When exposed to *L. trifida*, sapling height was reduced by 10%, leaf biomass by 42%, woody biomass by 43%, and root biomass by 30% (Tipping et al. 2016). This agent also works in concert with the other melaleuca biological control agents in suppressing this tree, rendering it less invasive and easier to control using herbicides and fire. Although *L. indentata* was originally discovered alongside *L. trifida* in melaleuca stands in Queensland, Australia, they are observed to differentiate on leaves and shoots, and also spatially: *L. trifida* prefers foliage closer to the ground and *L. indentata* is more frequently found higher in the canopy (Kumaran et al. unpublished data). This feeding specialization will be particularly useful in areas were *O. vitiosa* has difficulty establishing because of hydrology. Melaleuca was recently surveyed and found to have increased its landcover in the Everglades region (Rodgers et al. 2023). This is primarily due to seedling recruitment after fires in BCNP and adjacent areas. Research from Belle Meade and plots within the Raccoon Point Fire footprint indicate these flushes of seedlings are transitory and will precipitously decrease within 60 months of the fire. Research continues in BCNP to investigate if repeated fires can exhaust the seedbank.

Old World Climbing Fern

The brown lygodium moth (*Neomusotima conspurcatalis*), was first released in Florida in 2008 and rapidly established large field populations at release sites (Boughton and Pemberton 2009; **Figure 7-5**). Outbreaks of the moth cause locally heavy damage to Old World climbing fern (*Lygodium microphyllum*), though the moth's population density varies across the landscape in Florida. The lygodium gall mite (*Floracarus perrepae*) induces leaf roll galls on the leaves of Old World climbing fern. It also damages the apical meristems or new growing tips and can reduce vine growth (David and Lake 2020). First released in 2008, mite establishment has been patchy, yet the mite has shown the ability to undergo long distance dispersal and colonize Old World climbing fern populations far from release sites. Monitoring shows that mites are especially abundant in Martin County where > 75% of leaflets in a site can exhibit galls. Furthermore, the mite can quickly colonize Old World climbing fern regrowth following prescribed burns and herbicide applications (David et al. 2020, 2021). Research is underway to determine how to integrate biological control with herbicide applications. In addition to the two established agents, host range testing has been completed at the USDA-ARS quarantine facility in Fort Lauderdale for three additional biocontrol agents: *Lygomusotima stria* (moth), *Neostrombocerus albicomus* (sawfly), and *Callopistria exotica* (moth). The latter two species have already been recommended for release by the Technical Advisory Group for Biological Control of Weeds and are undergoing the Animal and Plant Health Inspection Service (APHIS) regulatory process. The *Lygomusotima* petition is still under review by the advisory group.

Figure 7-5. Damage to Old World climbing fern from the brown lygodium moth (photo by USDA).

Water Hyacinth

Water hyacinth (*Pontederia crassipe*s) is an invasive floating plant that aggressively colonizes freshwater ecosystems in the southeastern and southwestern United States including the Everglades. Three biological control agents of water hyacinth introduced during the 1970s have reduced biomass by more than 50% and seed production by 90%, but additional agents are needed to reduce surface cover. The latest

biocontrol agent, the water hyacinth planthopper (*Megamelus scutellaris*), was released in February 2010 (Tipping et al. 2014b) at that time it was the first new agent released for water hyacinth in 30 years. The species is cold tolerant and can overwinter at least as far north as Gainesville, Florida. Experimental field evaluations of water hyacinth herbivory from the plant hopper and the previously established water hyacinth weevils (*Neochetina* spp.) demonstrate these agents can exert considerable herbivory pressure on the aquatic weed as well as increase the efficacy of herbicidal control. Recently, a multi-year project was established with the South American Biological Control Laboratory to explore the environmental safety and efficacy of the flies in the *Thrypticus* genus, which have characteristics that make them potential agents for water hyacinth. This is part of a multi-year USDA areawide project to develop effective integrated management techniques for water hyacinth in South Florida. This project will also be exploring use of mass-rearing techniques employed by colleagues in South Africa for inundating water hyacinth stands with huge numbers of the *Megamelus* planthopper.

CERP Biocontrol Implementation 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 plants throughout the CERP area. The project included the construction of a mass rearing annex to the existing USDA-ARS biological control facility in Davie, Florida, to mass rear, release, establish, and monitor approved biological control agents for melaleuca and other invasive plants in the CERP area. The final project implementation report and environmental assessment (USACE and SFWMD 2010), the project partnership agreement and cooperative agreement on lands, and the design-build contract were all executed in 2010 with the construction of the mass rearing facility completed in 2013. USDA-ARS, in close coordination with SFWMD and USACE, has begun the operational phase of the project and, to date, has released over 46 million insects and mites (**Figure 7-6**) during more than 3,800 release events for control of four weed species: Old World climbing fern, air potato (*Dioscorea bulbifera*), water hyacinth, and Brazilian pepper. Releases are continuing along with extensive field monitoring and evaluation of the biological control agents. The highly successful projects for water hyacinth and air potato ended in 2021 to focus greater efforts on Old World climbing fern and Brazilian pepper. Most recently releases of the brown lygodium moth have ceased and preparations have begun for releasing the newest melaleuca agent, the leaf-galling fly *Lophodiplosis indentata.*

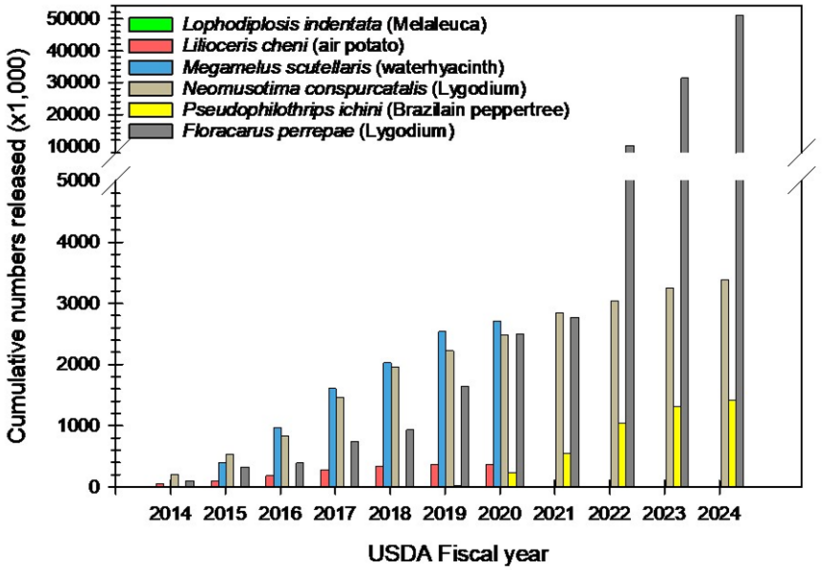


Figure 7-6. Cumulative numbers of biological control agents released between December 2013 and June 2024 within CERP project footprints.

INVASIVE ANIMAL MANAGEMENT

Efforts to develop control tools and management strategies for several priority animal species and to further expand management programs continued in FY2024. Priority species for control included the Burmese python and other giant constrictors, Nile monitor, and Argentine black and white tegu. Despite years of investigation, control tools remain 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. Potential tools for removing reptiles generally include catching, trapping, species-specific toxicants, barriers, detector dogs, introduced predators (Witmer et al. 2007), visual searching, and pheromone attractants. Guzy et al. (202) provides a thorough synthesis of control tools for Burmese pythons.

Regional invasive species biologists associated with ECISMA have developed a conceptual response framework for establishing priority invasive animals in South Florida. Objectives within this framework are classified into three main categories—containment (slow the spread), eradicating incipient populations (remove outliers), and suppression (reduce impact in established areas). Resources to implement this framework remain insufficient, but close collaboration between agencies has allowed for some coordinated efforts. For example, multiple agencies are working together to contain the Argentine black and white tegu, determine its population status, develop monitoring and control tools, and better understand the natural history of this invader in South Florida habitats. A significant step toward a more structured and coordinated framework would be the formation of a regionwide EDRR strike team possibly modeled after the NPS Exotic Plant Management Team's efforts. To date, this strike team has not been formalized; however, FWC regularly receives reports of tegus from the public within and outside of the known established populations and coordinates rapid response when feasible.

There were several ongoing invasive animal initiatives in FY2024 including ongoing monitoring and research efforts for Burmese python, northern African python, Argentine black and white tegu, Nile monitors, spectacled caiman, and numerous invasive freshwater fish species among others.

Everglades Invasive Reptile and Amphibian Monitoring Program

In 2010, UF and SFWMD began collaboration on the Everglades Invasive Reptile and Amphibian Monitoring Program (EIRAMP). In 2020, USACE joined the EIRAMP collaboration, increasing the interagency coordination of this program and expanding the extent of projects that focus on protecting CERP project lands. The purpose of EIRAMP is to monitor priority invasive reptiles and amphibians and their impacts to South Florida. Specifically, the program seeks to (1) determine the status and spread of existing populations and the occurrence of new populations of invasive reptiles and amphibians, (2) provide additional EDRR capability for removal of invasive reptiles and amphibians, and (3) evaluate status and trends of populations in native reptiles, amphibians, and mammals. Surveying for native reptiles, amphibians, and mammals concurrently while conducting surveys for invasive species can provide baseline data that are often key to determine impacts of exotic species on native fauna and ecosystems within state lands and other regional conservation lands.

The EIRAMP monitoring program utilizes a multi-method approach to EDRR, monitoring, and removal with activities detailed annually in a report provided by UF to SFWMD and USACE. A primary component of the EIRAMP involves surveys to detect and remove targeted invasive species on fixed routes along levees and roads within LNWR, BCNP, ENP, Corkscrew Swamp Sanctuary, US-1, Card Sound Road, US-27, Frog Pond Wildlife Management Area (WMA), Everglades and Francis S. Taylor WMA (consisting of the Everglades WCAs), and other areas such as the C-51 Basin and Southern Glades WMA. Visual encounter surveys and amphibian call surveys are conducted to monitor invasive species and their potential prey species. Twenty-one routes have been established since inception of the program and nine are currently active. We conducted a total of 90 surveys on designated routes during the October 2023–June 2024 period.

Additionally, we performed 16 opportunistic surveys when conditions were favorable for detecting nonnative wildlife. We observed and recorded 1,291 animals during surveys. Of these observations, 540 (42%) were species native to Florida, 699 (54%) were nonnative, and 52 (4%) could not be identified due to brief visual encounters. Therefore, 56% of animals identified consisted of nonnative species. We detected 48 native species and 15 nonnative species for a total of 63 species, including 9 nonnative reptiles, 3 nonnative mammals, and 3 nonnative amphibians. Priority nonnative species observed on standard survey routes included 2 Burmese pythons. On opportunistic surveys, opportunistic sightings, and rapid responses we detected 41 additional nonnative reptiles: one veiled chameleon (*Chamaeleo calyptratus*), 12 green iguanas (*Iguana iguana*), 5 Argentine black and white tegus, 9 Burmese pythons, and 14 Peter's rock agamas (*Agama picticauda*).

In FY2023, the most commonly observed (1) nonnative reptiles were brown anoles (*Anolis sagrei*), tropical house geckos (*Hemidactylus mabouia*), and green iguanas; (2) nonnative amphibians were greenhouse frogs (*Eleutherodactylus planirostris*), Cuban treefrogs (*Osteopilus septentrionalis*), and cane toads (*Rhinella marina*); and (3) nonnative mammals were domestic cats (*Felis catus*), domestic cattle (*Bos taurus*), and black rats (*Rattus rattus*). The most observed (1) native amphibians were cricket frogs *(Acris gryllus*), southern toads (*Anaxyrus terrestris*), and green treefrogs (*Hyla cinerea*); (2) native reptiles were cottonmouths (*Agkistrodon conanti*), southern watersnakes (*Nerodia fasciata*), and scarlet snakes (*Cemophora coccinea*); and (3) native mammals were marsh rabbits (*Sylvilagus palustris*), white-tailed deer (*Odocoileus virginianus*), and raccoons (*Procyon lotor*). To date, 209 Burmese pythons have been detected during these visual surveys.

Figure 7-7.
UF biologist with a captured spectacled caiman (photo by UF).

In addition to visual surveys conducted along standard survey routes, EIRAMP provides EDRR capability for invasive reptiles in the Everglades region, including CERP project lands. EDRR surveys and trapping efforts have resulted in removal of 109 Nile monitors, 3,601 Argentine black and white tegus, 601 Oustalet's chameleons (*Furcifer oustaleti*), 1,117 veiled chameleons, 304 spectacled caimans (**Figure 7-7**), 365 Burmese pythons, a giant whiptail lizard (*Aspidoscelis motaguae*), a common water monitor (*Varanus salvator*), a white-throated monitor (*Varanus albigularis*), a Nile crocodile (*Crocodylus niloticus*), a Morelet's crocodile (*Crocodylus moreletii*), 2 boa constrictors (*Boa constrictor*), a rainbow boa (*Epicrates cenchria*), a ball python (*Python regius*), 2 northern African pythons, 2 Peter's rock agamas, 4 brown basilisks (*Basiliscus vittatus*), a leopard gecko (*Eublepharus macularius*), 2 tokay geckos (*Gekko gecko*), a red-footed tortoise (*Chelonoidis carbonarius*), a rhinoceros iguana (*Cyclura cornuta*), 13 green iguanas, and 5 spiny-tailed iguanas (*Ctenosaura similis*). A small group of volunteers managed as part of this program during 2015 to 2017 removed an additional 108 Burmese pythons.

In FY2024, the EIRAMP continued to increase focus on detecting and removing priority species, including adapting established EIRAMP survey routes to address emerging EDRR needs. Future EIRAMP activities will continue to explore and implement additional methods, such as environmental DNA (eDNA) biosurveillance, to increase detection and removal of invasive species.

Python Removal Contractor Program

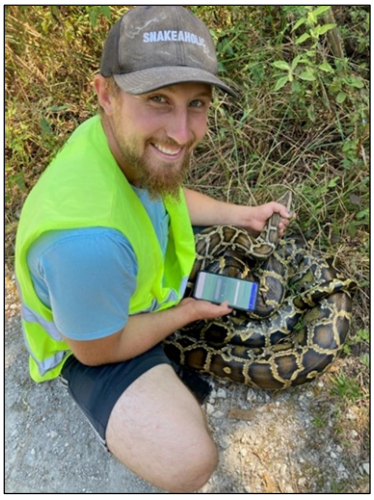


Figure 7-8. SFWMD python removal contractor Kevin Pavlidis with a captured Burmese python (photo by Anthony Flanagan).

In spring 2017, SFWMD and FWC began collaboration to develop independent—but parallel—incentivized python removal programs. Both agencies developed programs to encourage public participation in removing invasive pythons. The new program was built from previous use of volunteers working with SFWMD and UF as a component of EIRAMP, which demonstrated that skilled, motivated python removal experts (**Figure 7-8**) can be an effective means of locating and removing giant constrictors in accessible areas such as levees and canal banks, while reliably collecting data. The objectives of both programs are to deploy experienced python removal experts to specific areas and compensate them for conducting surveys, collecting useful data on search efforts, and removing as many large, nonnative constrictors as possible from public lands.

Both agencies agreed to a multi-tiered compensation structure. Contractors receive $13.00 per hour for time spent in the field surveying for pythons, up to 10 hours daily. Both agencies also compensate contractors at the rate of $18.00 per hour and $30.00 per hour in specific locations on the fringe of the known python range, or in sensitive native habitats, to increase survey effort in areas searched less frequently. For successfully capturing a target species, the contractor receives additional compensation based on the animal's length: $50 for the first four feet and an additional $25 per foot above four feet. SFWMD and FWC also compensate their contractors $200 for each verified, viable python nest found and $50 for a verified picture of a research scout snake.

As of September 30, 2024, SFWMD and FWC program's contractors have conducted a combined 158,989 survey hours, resulting in the removal of 15,273 pythons (**Figure 7-9**), with an average of 10.41 hours of surveying per python caught. The mean body length of pythons removed by SFWMD and FWC contractors is 1.7 m (5.77 feet or ft), with the largest python being 5.72 m (18.75 ft). Currently, there are 100 active contractors between both agency's programs.

FWC and SFWMD have worked collaboratively along with partner agencies to expand their contractor programs. In August 2019, Governor Ron DeSantis directed both agencies to align their respective programs in terms of scope and project area, along with doubling the total number of contractors from 25 per agency to 50, giving a total of 100 paid python removal agents. A 2020 memorandum of agreement between SFWMD, FWC, and NPS authorizes python removal contractors from both programs to survey within ENP, BCNP, and Biscayne National Park. As of July 2022, FWC and SFWMD contractors also have access to four Florida State Parks including Fakahatchee Strand Preserve State Park, Collier-Seminole State Park, Dagny Johnson Key Largo Hammock Botanical State Park, and John Pennekamp Coral Reef State Park and eight National Wildlife Refuges, including LNWR, Crocodile Lake National Wildlife Refuge, Everglades Headwaters National Wildlife Refuge and Conservation Area, Florida Panther National Wildlife Refuge, J.N. "Ding" Darling National Wildlife Refuge, Nathaniel P. Reed Hobe Sound National Wildlife Refuge, National Key Deer Refuge, and Ten Thousand Islands National Wildlife Refuge. As of July 2022, FWC contractors also have access to Rookery Bay National Estuarine Research Reserve.

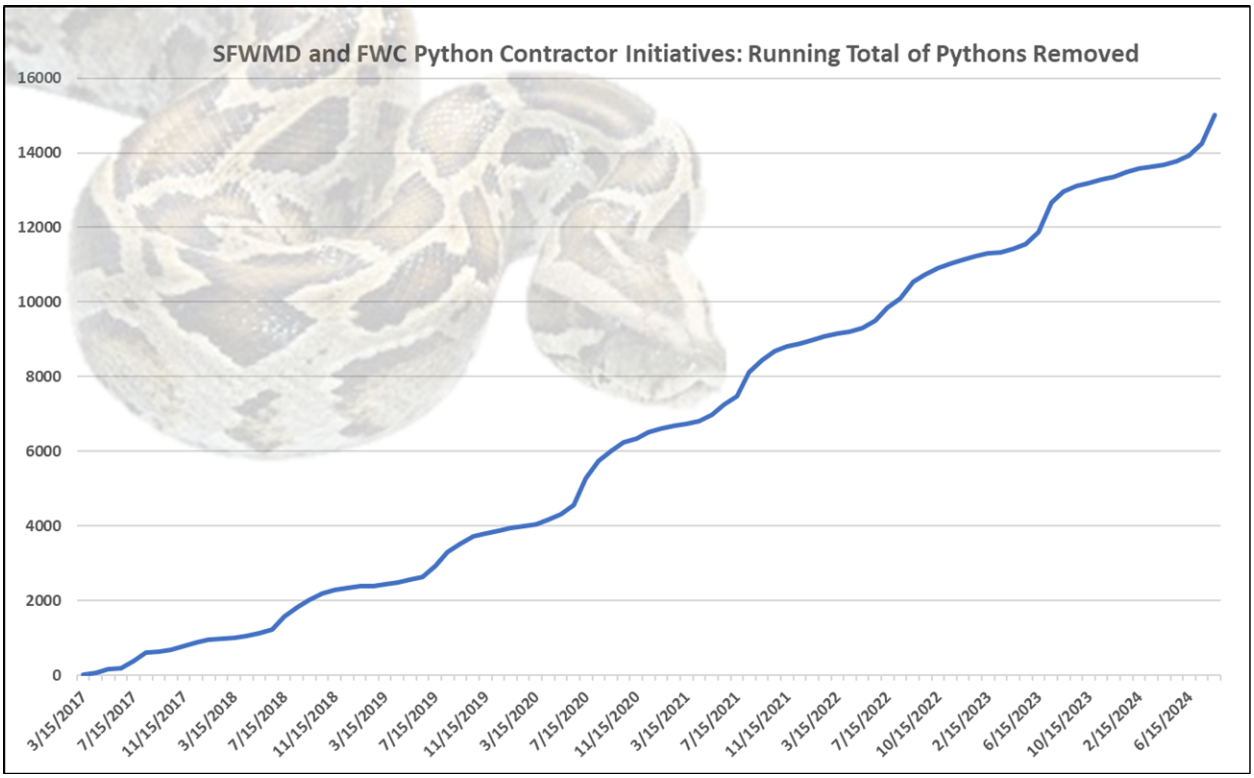


Figure 7-9. Running total of Burmese pythons removed from the Everglades region by SFWMD and FWC python removal contractors between March 25, 2017, and September 30, 2024.

Florida Python Control Plan

The Florida Python Control Plan (FPCP) is a collaborative effort that began in 2019 among 15 federal, state, and local agencies, tribes, and one non-governmental organization. The overarching objective of FPCP is to provide a science-based cohesive resource to be used by land managers, stakeholders, and the public to address pythons on Florida lands.

In September 2021, the FPCP was finalized and signed by FWC, SFWMD, Florida Forest Service, and Florida Department of Environmental Protection. The plan is a living document, focused on adaptive management, guided by science, and revised as new information becomes available. Plan content was driven by in-person workshops and online meetings. As with many environmental issues, FPCP recognizes that multiple strategies working in concert will be the best path forward to protect natural resources from the threat of invasive pythons. The plan is guided by four themes central to effective python control—policy and regulation, control and monitoring, research, and communication. Shortly after the plan was finalized, the FPCP Workgroup was created to implement the plan through continued collaboration and has since had 11 meetings and created two subgroups and a website (flpythoninvasion.org).

Invasive Animal Research and Monitoring Update

An array of research projects related to invasive animals in the Everglades footprint have been undertaken by multiple collaborating agencies and universities. Adaptive management requires integration of monitoring and research as control efforts continue. This section summarizes key research efforts and conclusions to help guide future management of invasive animals.

Burmese python research continues to build upon work completed over the last decade (see Guzy et al. 2023 for a review). Early trials of traps resulted in low python capture rates (Reed et al. 2011) but the

development of a pheromone (or other) attractant may improve the utility of traps. James Madison University, USDA, and NPS are collaborated to test effectiveness of pheromones in luring pythons and their work has shown when male Burmese pythons are presented with a conspecific female scent trail, male snakes consistently follow the female scent trail and exhibit sex-specific behaviors (Richard et al. 2019). However, preliminary assessments of estradiol-implanted radio-telemetered male pythons did not show a significant increase in attractance compared to non-implanted pythons (Guzy et al. 2023). The UF, USDA, and USFWS collaborated on testing a patented large reptile trap specifically designed to avoid capture of non-target species (Gati et al. 2020). While the traps were successful at reducing capture of non-target species, no pythons were captured during the study. However, these traps, particularly when paired with an automated wireless camera network, show promise for reducing resources necessary to trap large invasive reptiles (e.g., Nile monitors) and allow for implementation in remote, hard to access areas.

Pythons in Florida have been radio tracked extensively (Pittman et al. 2014, Hart et al. 2015, Smith et al. 2016, Walters et al. 2016, Bartoszek et al. 2021) to inform management efforts through investigations of spatial ecology and life history, and through scout programs that can increase python detection and removal. Currently, radio telemetry scout research programs for Burmese pythons are active in Southwest Florida, Big Cypress National Preserve, and in Everglades and Francis S. Taylor WMA. In addition to removing pythons, collectively these programs encompass a wide array of habitats in southern Florida and provide key data on python movement, reproduction, behavior, and vital rates, which can inform removal efforts and aid estimates of python abundance. While very high frequency (VHF) transmitters are the standard for collection of spatial data, research by USGS and UF investigated the utility of global positioning system (GPS) telemetry. This technology allows more data collection with less effort but does not work well in closed canopy habitat preferred by pythons (Smith et al. 2018). However, recent advances in technology, as well as assessment of external GIS tag placement, may increase the effectiveness of GPS telemetry, facilitating an increase in data collection while mitigating potential limitations due to habitat and researchers are further assessing the utility of GPS tags. Additionally, use of accelerometer tags in radio tracked pythons may further augment data collection, resulting in fine-scale movement and behavior data (Whitney et al. 2021). Use of drones equipped with radio telemetry tracking software to track Burmese pythons is being investigated by UF in Everglades Francis S. Taylor and may help reduce the high costs associated with tracking pythons to their exact location within a primarily aquatic habitat. Investigating hatchling python movement patterns and life history traits may increase removal efficiency, inform population estimates, and help determine impacts. Studies on size distribution and reproductive phenology provide basic demographic data that may increase the success of python control programs (Currylow et al. 2022). Research on hatchling python movement patterns, conducted by the Conservancy of Southwest Florida estimate a 35.7% hatchling survival rate at six months and very few (2) survivors after three years of tracking (Pittman and Bartoszek 2021), suggesting very high mortality rates among young Burmese pythons in South Florida.

Impacts of Burmese pythons on native wildlife continue to be documented. Previous work on Burmese python diet reveals they are generalist predators (Snow et al. 2007a, Dove et al. 2011) and stable isotope research by USGS and UF indicates pythons consume prey across a broad isotopic niche in saline and freshwater habitats and feed across several trophic levels (B. Smith, USGS/UF, personal communication). Road surveys in the past were useful in providing evidence for dramatic declines in mammal populations as pythons increased their presence (Dorcas et al. 2012) and additional surveys show a predator-prey cycle relationship between pythons and Virginia opossums (*Didelphis virginiana*; F. Mazzotti, UF, unpublished data). Research also shows chronic, direct depredation of marsh rabbits by pythons (McCleery et al. 2015). The effect of python predation on native fauna can result in trophic cascades impacting Florida's ecosystems (Willson 2017). Pythons have been implicated in altering parasite and pathogen dynamics within their invasive range. Studies of Everglades virus have shown that with reduced diversity of mammalian host species due to python predation, the virus has become more prevalent (Hoyer et al. 2017). Pythons have also introduced a nonnative lung parasite to Florida that has spilled over to infect at least 14 species of native snakes (Miller et al. 2018, Metcalf et al. 2019). Native snakes are highly susceptible to

infection, which has facilitated the spread of this parasite to native snakes outside the python's native range (Miller et al. 2020). This parasite can now be found in native snakes as far north as Alachua County, Florida (Walden et al. 2020). Burmese pythons have also been documented to carry a serpentovirus in their invasive Florida range; however, while the virus does not appear to have spread to native snakes, a further examination of the potential for spillover is warranted (Tillis et al. 2022).

Improving detection of Burmese pythons is of critical importance since they are widely established in the region and notoriously difficult to detect. A study by UF and USGS estimated the probability of detecting a Burmese python in the wild to be less than 0.05 (Nafus et al. 2020). Several studies have focused on refining our ability to detect pythons including detector dogs, Irula tribesmen from India, eDNA, mammalian lures, and multispectral cameras. Detector dogs have been proven to successfully locate Burmese pythons, with an initial collaboration among Auburn University, NPS, and SFWMD demonstrating detection of 20 pythons, 19 of which were able to be captured, during searches for free-ranging pythons on federal, state, and tribal lands (Romagosa et al. 2011). Subsequent use of detector dogs worked on Key Largo to find Burmese pythons by scent and dogs were used in the Bird Drive Basin to search for northern African pythons. They found at least one python on Key Largo and many points of interest there and in the Bird Drive Basin. Multiple agencies and organizations, including SFWMD, FWC, USFWS, and the Miccosukee Tribe of Indians of Florida continue exploring detector dogs' utility in python removal. Yet, as dogs can be limited in search duration and efficiency in extreme heat and humidity (Romagosa et al. 2011), the most effective use of detector dogs may be for rapid response efforts and attempts to delineate presence/absence of a target species within a location (i.e., aiding delineation of an invasion front or incipient population). Future studies exploring use of detector dog teams as a control tool for rapid response efforts to detect and remove pythons, as well as other priority invasive species, are warranted to fully understand the utility of detection dogs for invasive species management. A 2021 study conducted by UF and funded by FWC demonstrated live domestic rabbits placed in pens will attract pythons to localized areas, where they remain for extended periods of time with an increased chance for detection (McCampbell et al. 2024). Follow up studies occurred in 2023 through 2024, funded by SFWMD, designed to build on this concept and improve the ability for removals. This strategy may be especially effective in environmentally sensitive areas that are not easily accessible to removal contractors or otherwise under surveyed. A study using eDNA successfully detected Burmese pythons in five sites, including one where pythons were not yet documented (Piaggio et al. 2014). Orzechowski et al. (2019) utilized eDNA to identify the adverse impact of pythons on wading bird breeding aggregations. Recent advancements in eDNA sampling include development of a multiplex digital PCR assay that is capable of simultaneously detecting the presence of Burmese pythons, as well as other large invasive snakes (i.e., northern African pythons, Boa constrictors, and Brazilian rainbow boas), from the same environmental sample (Miller et al. 2024). This can increase efficiency of eDNA surveillance as natural resource managers can monitor for multiple target species within a sample, instead of only testing for one target species per sample, which may reduce costs associated with eDNA sampling.

As visual searching has been one of the most productive methods for finding Burmese pythons, FWC is investigating innovative methods and tools to aid in visual detection. Multispectral cameras capable of detecting Burmese pythons are currently being investigated to potentially increase detection of pythons in the wild (Vaca-Castano et al. 2019, Hewitt et al. 2021). In July 2020, FWC contracted the University of Central Florida (UCF) to create a vehicle mounted near-infrared camera that utilizes artificial intelligence (AI) to improve our ability to detect pythons. The project was completed in June 2022 with two fully developed and field operational cameras delivered to FWC. FWC staff are using the cameras for large constrictor surveys. In March 2023, FWC contracted UCF to take this same infrared technology and test its applicability mounted on unmanned aircraft systems (UAS; drones). Additional methods to increase effectiveness of visual searching have explored use of expert snake hunters of the Irula tribe. Tribe members travelled to Florida and were successful in detecting over two dozen pythons at a rate comparable to local python removal experts (F. Mazzotti, UF, personal communication).

Argentine black and white tegus received extensive attention from researchers during the last five years although they are not as well studied as pythons. Studies have primarily focused on tegu life history and spatial ecology, with an emphasis on their capacity for range expansion. Adverse impacts of tegus on native wildlife, including at-risk species, have been documented. In a study of tegu diet, hatchling gopher tortoises (*Gopherus polyphemus*) were recovered from five tegus (Offner et al. 2021) and tegus have been observed consuming the eggs of an American alligator (*Alligator mississippiensis*) nest (Mazzotti et al. 2014). As omnivorous predators of a diversity of prey taxa, uncontained growth and expansion of tegu populations may be a risk to many native wildlife species. In addition, tegus have been documented as competent hosts of an invasive pentastome (*Raillietiella orientalis*) introduced by Burmese pythons (Miller et al. 2018), indicating tegus may play a role in increased transmission of this parasite (Goetz et al. 2021).

Early radio telemetry work was conducted using VHF transmitters and showed tegus spread readily in altered landscapes such as linear habitats and areas where water does not restrict movement (Klug et al. 2015). GPS tracking and modeling show tegus are most active in warmer temperatures (Mason et al. 2024). This suggests removing them during the hottest months and surveying for them during the hottest parts of the day to maximize removal. Tegus are often in more open habitat than pythons and consequently GPS tags on tegus are generally more successful than those used with pythons (F. Mazzotti, UF, unpublished data). Several agencies trapped tegus extensively and used a wide variety of designs. Using chicken eggs as bait, Tomahawk® and Havahart® traps are the most effective tools for removing tegus, although use of artificial baits are being explored, and drift fences in conjunction with minnow traps successfully capture hatchling tegus (Nestler et al. 2017). The goal of this multi-agency effort is to contain and reduce tegu populations in South Florida. Analysis of data obtained by UF from the 2021 trapping season yielded fewer tegus relative to 2019 supporting temporal consistency of trending decline and corroborating the effectiveness of long-term trapping efforts as a tool for tegu containment. Live trapping is currently being used to manage tegu populations in four Florida counties: St. Lucie, Miami-Dade, Charlotte, and Hillsborough. In addition, researchers are examining the potential for using conspecific chemical cues to increase trap efficacy. Results are promising with both sexes demonstrating the ability to follow the scent trail of a conspecific, with female tegus particularly excelling at this task (Richard et al. 2020). UF continues to evaluate the use of automated AI smart traps designed to selectively capture tegus while eliminating bycatch of non-target species for removal of tegus (M. Miller, UF, unpublished data). A comparison study conducted by UF, Wild Vision Systems, and USDA, of artificial intelligence (AI) smart traps and traditional (i.e., non-smart) traps showed that use of smart traps significantly increased trap efficiency, reduced capture rates of non-target species, and reduced costs to operate traps.

Tegus have demonstrated the ability to withstand climates much cooler than South Florida indicating physiological and behavioral constraints are not likely to limit spread of this invasive lizard throughout the state and to other states with suitable climates within the United States (Jarnevich et al. 2018, Haro et al. 2020, Currylow et al. 2021, Goetz et al. 2021). A study examining the ability of tegus to overwinter in outdoor semi-natural enclosures in Alabama found 9 of 12 tegus were able to withstand winter temperatures and upon necropsy, sperm was found within the testes of males and females displayed previtellogenic or early vitellogenic follicles indicating both sexes were capable of reproduction (Goetz et al. 2021). Recently, established populations of tegus were discovered in two counties in Georgia (Haro et al. 2020) and climate models further support tegus may be capable of successfully establishing beyond South Florida (Jarnevich et al. 2018).

A localized population of Northern African pythons was first detected in 2001 in Miami Dade County. Between 2018 and 2021 captures of Northern African pythons were down to zero. In December 2021 confirmed reports of this species prompted an increase in research and control efforts. In addition to previously mentioned detector dog work, UF utilized surveys of refuges to search for remaining African pythons and estimate detection probability. Because northern African pythons were not detected during those surveys, Cole et al. (2017) estimated detection probability for northern African pythons using Burmese pythons as a surrogate. Detection probability of Burmese pythons was 0.0064 during EIRAMP

surveys on Main Park Road in ENP, 0.00257 on C-110, and 0.0149 for surveys conducted by volunteer python hunters outside ENP. Using these detection probabilities, the minimum number of surveys needed to infer absence with a 95% confidence interval is 467 on Main Park Road and 1,164 on C-110. Increasing the detection probability to 0.0166 drops the number of surveys required to 179.

In December 2021, five Northern African pythons were captured in the Bird Drive Basin by a member of the public. Additional Northern African pythons have been captured since December 2021 and in response to these removals, FWC ramped up efforts to inform the local community about the presence of this species and canvassed nearby residential neighborhoods with outreach information on how to report observations. Initial gut content analysis of these recently captured pythons found remains of raccoon, rat, birds, and an unidentified canid. Two large females were discovered to have developing follicles indicating there could still be reproduction occurring in this area. To date, 49 Northern African pythons have been removed from the Bird Drive Basin since the population was discovered in 2001.

Monitoring and removal of Nile monitors, a large-bodied carnivorous lizard of African origin, continued in 2023 and 2024 by FWC. Habitat assessment was the central research focus and will result in maps to visualize and monitor habitat quality. Scobel et al. (2017) reported trap success of 25.0%, similar to the success of trapping efforts in Cape Coral, Florida, where success averaged 29.2% (K. Hankins, City of Cape Coral, unpublished data). Sample size was too small to assess the best trap design but the highest catch per unit effort (CPUE) in the study was 0.167 monitors per trap day for a Tomahawk S50 trap baited with chicken (Scobel et al. 2017). No Nile monitors were removed by FWC in the last year from Palm Beach County.

Invasive Freshwater Fishes

The spread of invasive fishes may be the most directly linked to water management features and actions of all nonnative species issues in South Florida. Canals, which are unnaturally deep aquatic habitats, are a refuge and a conduit for aquatic invasive species to colonize and persist in Everglades marshes (Harvey et al. 2011). The invasion of nonnative freshwater fishes into ENP coincided spatially and temporally with both the increasing number of reproducing nonnative fish species in Florida and water management actions and infrastructure that increased the connectivity of marshes with canals (Kline et al. 2014). Mayan cichlids (*Mayaheros urophthalmus*) dispersed into the marsh from canals more readily at shallower marsh depths than largemouth bass (*Micropterus salmoides*) with individual cichlids observed moving > 20 km into the marsh from the canal (Parkos and Trexler 2014). Mayan cichlids recolonized the marsh/mangrove ecosystem south of Taylor Slough downstream of nearby canals much more rapidly following the cold weather and drought events in 2010 and 2011 than in mangrove creeks in southern Shark River Slough, more distant from the nearest canals (Rehage et al. 2016). New nonnative species continue to spread into the Everglades. Nile tilapia (*Oreochromis niloticus*), a species that has been spreading throughout Central and South Florida since the mid-2000s (Shafland et al. 2008), has been found in the Everglades STAs (J. Goeke, Florida International University, personal communication), was collected from BCNP in 2017 (USGS Nonindigenous Aquatic Species [NAS] database specimen ID 1396492), and were a new species to ENP in 2019 (Naja et al. 2022). In addition, a credible observation of an individual hornet/zebra tilapia (*Tilapia buttikoferi*) in ENP (Early Detection and Distribution Mapping System [EDDMapS] Record ID 11289274) suggests this species continues to spread west from the locations of first collections in the Tamiami Canal in 2005 (Shafland et al. 2008). The eDNA of the goldline snakehead (*Channa aurolineata*; previously identified as the bullseye snakehead), a prohibited nonnative species in Florida, was detected within the Everglades Protection Area (EPA; Hunter et al. 2019) and a population of these snakeheads is now present upstream of the S-9 structures that pump from the C-11 Canal to the west into the Everglades (K. Gestring, FWC, personal communication). The Midas cichlid (*Amphilophus citrinellus*) continues to be observed in the canals and management areas adjacent to ENP (EDDMapS Record IDs 10510277, 11487510, and 7813826). The Asian swamp eel (*Monopterus albus)* was originally recorded in the CERP footprint in 1998 (NAS Database). It is now firmly established throughout the footprint, and is spreading

rapidly outward, reaching the northern boundaries of the Everglades and beyond. The proximity of these nonnative species to Everglades marshes demonstrates the threat of future invasions and uncertainty for what influence those species may have on Everglades trophic ecology.

Once in the Everglades, nonnative fishes have established populations across various habitats and management areas. Prior to the 2010s, the largest relative abundances of nonnative fish in the Everglades occurred within canals, solution hole habitats of the Rocky Glades, and in the mangrove/marsh/estuarine creek areas of the southern Everglades, however the ridge and slough habitats maintained a relative abundance often much less than < 1% of the total catch in quantitative throw trap samples (Trexler et al. 2000, Kline et al. 2014). Also, in general, ENP tended to have a higher relative abundance of nonnative fish than the WCAs (Trexler et al. 2000). It was thought the vulnerability of many of the nonnative fish to seasonal cold and possibly the occasional drought may have limited their abundance in the sloughs (Trexler et al. 2000). It was because of the traditionally low relative abundance in the quantitative fish density samples from the slough/*Eleocharis* marsh habitats that an arbitrary threshold of 2% of the total catch was considered a "red stoplight" indicator of "substantial deviations from restoration targets, creating severe negative condition that merits action" (Doren et al. 2008). However, in Water Year 2015 (WY2015; May 1, 2014–April 30, 2015) and WY2016, due to a surge in the African jewelfish (*Hemichromis letourneuxi*) population, Shark River Slough exceeded the 2% threshold, and in WY2016 nonnative fish exceeded the 2% threshold in Taylor Slough due to Mayan cichlids and the surge of Asian swamp eels (Brandt et al. 2016). In WY2022, the overall relative abundance of nonnative fish was 2.5% in the CERP's Restoration Coordination and Verification Program's (RECOVER's) Monitoring and Assessment Plan (MAP) aquatic fauna sampling from WCA-1 down through ENP, the highest relative abundance observed over the previous 16 years of the study (**Figure 7-10**) and exceeded thresholds for the first times in WCA-3 in WY2021 and WY2022 (Brandt et al. 2022). Non-native fish relative abundance and spatial spread were higher for WY2018–WY2024 than the baseline WY2005–WY2017 of the RECOVER aquatic fauna data set do to both increases in density and more frequent catches in WCA-3 (N. Dorn from the 2024 System Status Report).

The impact of nonnative fishes in Florida and the Everglades has not often been studied with rigor (Schofield and Loftus 2015), however recent studies have predicted or observed impacts of nonnative fishes in the Everglades. Abundant Mayan cichlid populations appear to reduce the abundance of some small native fish species in southern Taylor Slough mangrove creek and marsh flat habitats likely through predation (Harrison et al. 2013). African jewelfish reduced the abundance of some aquatic invertebrates and a small fish species in mesocosm experiments simulating Everglades marshes (Schofield et al. 2014). Invasive fishes, including African jewelfish, can dominate solution hole habitats of the karst landscape and, in combination with the overdried conditions and extended time isolated in the pools without surface water, results in the Rocky Glades being considered a possible population sink for native marsh fishes (Rehage et al. 2014). Certain small fishes were missing restoration targets from assessment in Shark River Slough when African jewelfish were particularly abundant (Brandt et al. 2016). Jewelfish reduced the density of some small native fishes when they were particularly abundant, but when the jewelfish population declined, the small native fishes began recovery, and those impacts attributable to jewelfish appear to have been smaller and more temporary than the impacts attributed to the Asian swamp eel (Pintar et al. 2023a). Crayfishes and some small fish species known to be vulnerable to predators and to benefit from drying events that knock back predators (e.g., Dorn and Cook 2015) have almost disappeared from long-term monitoring plots after Asian swamp eels spread from adjacent canals, established throughout Taylor Slough, and attained high abundance. The Asian swamp eel's ability to persist through drying events may break the typical hydrological control drying causes by reducing the abundance of all other large fishes in Everglades marshes (Pintar et al. 2023b). Maintaining the consistency of long-term monitoring programs will be very important to assess the potential influence of Asian swamp eels now that the species has recently spread throughout much of WCA-3 and ENP (Pintar et al. 2023a, 2024).

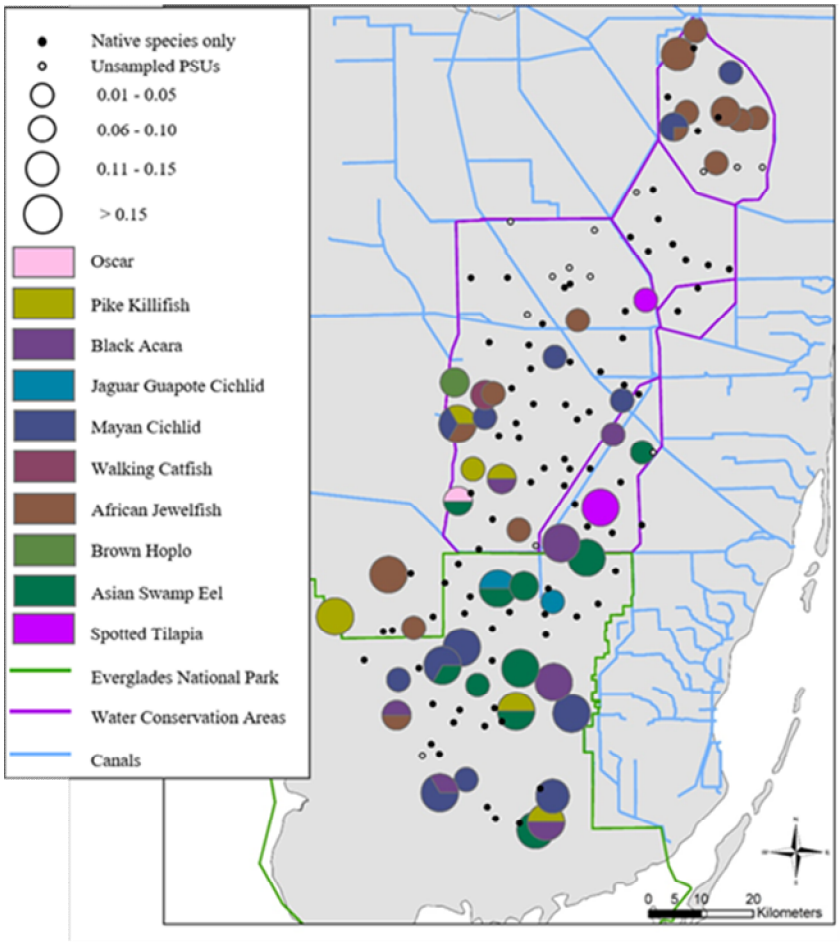


Figure 7-10. Nonnative fish proportions and composition from the CERP MAP throw trap data in WY2022. The overall percentage nonnative for the Everglades was 2.5%. Figure is reprinted from Brandt et al. 2022.

Agency staff use natural waters surveys to proactively determine the distribution and abundance of established species and, if a new species is detected, to implement management strategies to eradicate or minimize potential negative impacts. FWC staff are conducting electrofishing surveys and removing invasive fish—primarily tilapia (*Oreochromis* sp.) and sailfin catfish (*Pterygoplichthys* sp.)—from selected natural water bodies (**Figure 7-11**). FWC used experimental gillnets to remove tilapia from several springs in Central Florida with little success. Based off their results, they developed a custom gillnet with a single mesh opening and heavier lead line with plans to do removal surveys during the winter months when fish use the springs as a thermal refuge.

Figure 7-11. FWC fisheries biologists using experimental gillnets and electrofishing to remove tilapia from Silver Glen Springs in Central Florida (photo by FWC).

Species Profile: Sailfin Catfish

Figure 7-12. Sailfin catfish (photo by FWC).

FWC contracted with UF to generate bioprofiles and complete Aquatic Species Invasiveness Screening Kit (AS-ISK) risk screens for 4 species of sailfin catfish (*Pterygoplichthys anisitsi*, *P. disjunctivus*, *P. multiradiatus*, and *P. pardalis*) (**Figure 7-12**) with native ranges in the Orinoco and Amazon River basins, or rivers in Paraguay. These species are large-bodied, heavily armored fish commonly referred to as sailfin catfish due to an elongated dorsal fin. Florida and the international aquaculture industry trade *Pterygoplichthys* catfishes and collectively this group of fish (16 species) is within the top five species by trade volume annually. Aquarists use them to clean algae from their tanks and to eat surplus fish food. Florida is a major producer of these species with an estimated production and sale of > 25 million individuals per year. Due in part to their popularity, catfish in *Pterygoplichthys* are one of the most widely introduced fishes with established populations in many tropical and subtropical regions of the world. They cause a variety of negative ecological impacts over their introduced range including competition for food, spawning burrows, and habitat alteration. Habitat alteration, either by burrowing activities, alteration of nutrient cycling, or destruction of aquatic macrophytes, is most likely to cause ecological harm to Florida. The AS-ISK analyses yielded scores for the four *Pterygoplichthys* species similar to other high-risk species that represent a hazard to Florida (e.g., lionfish [*Pterois* spp.]). FWC will use this information to inform future management recommendations for these species.

Species Profile: Asian Swamp Eel

Figure 7-13. Asian swamp eel (photo by USACE).

The Asian swamp eel (*Monopterus albus*), an aquatic invasive species native to Asia, was recorded within the CERP footprint as early as 1998 (**Figure 7-13**). It is thought to have been introduced by way of aquarium release or from live fresh fish market releases. It is morphologically similar to several native Florida species, like the American eel (*Anguilla rostrata*) and several salamander species. Asian swamp eels are typically found in slow moving, fresh bodies of water, burrowing into soft sediments or rocky crevasses (Shafland et al. 2010). Despite being a mostly freshwater species, they have been found to be tolerant to dry environments as well as saline environments up to a salinity of16 (Schofield and Nico 2009). They are a nocturnal species which feed on many Florida native fishes, including eastern mosquitofish (*Gambusia holbrooki*), bluegill (*Lepomis macrochirus*), largemouth bass and more (Shafland et al. 2010). According to a 26 year data set in the Everglades, it was found that Asian swamp eels have reduced the population of native crayfishes (*Procambarus alleni* and *P. fallax*) by 99% (Pintar et al. 2023b). Furthermore, several fish species populations have been reduced by over 50% (golden topminnow [*Fundulus chrysotus*] and eastern mosquitofish) and others have been reduced by more than 90% (flagfish [*Jordanella floridae*], marsh killifish [*Fundulus confluentus*]) (Pintar et al. 2023b). Furthermore, in a study on both wild-caught and imported *Monopterus*, the occurrence of internal parasites in wild-caught Asian swamp eels was found to be nearly 100%, making their potential as a vector for disease very high (Nico et al. 2011). The Asian swamp eel was originally thought to be a single species, but further study has shown some genotypic distinctions, which indicates they may have originated from several locations throughout Asia (Collins et al. 2002). If this species persists and continues its spread throughout

Florida, the potential for ecological harm only grows larger. The maps below show its spread from 1998 to 2023 (**Figure 7-14**).

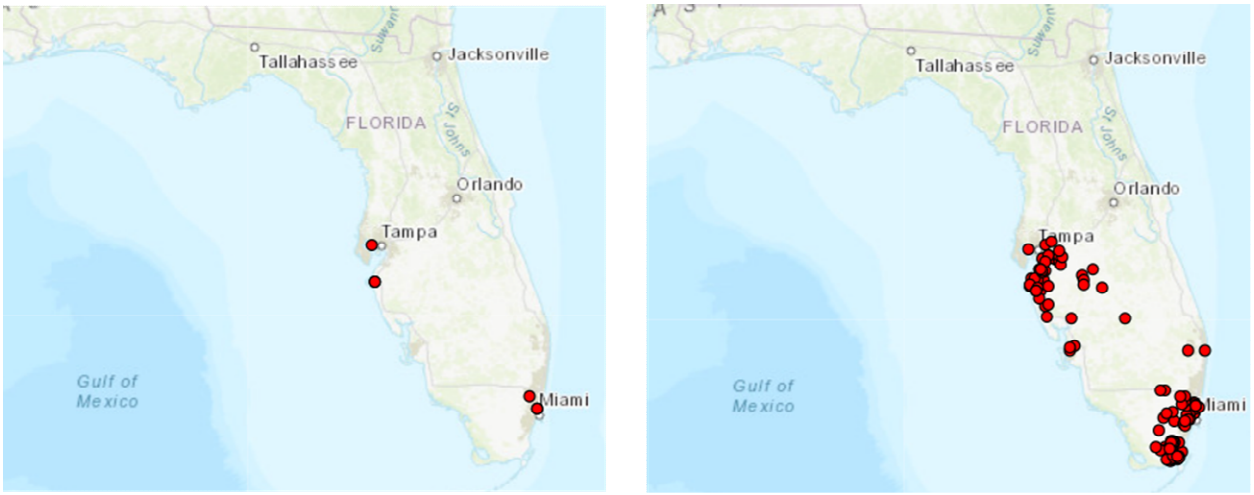


Figure 7-14. Maps of Florida displaying Asian swamp eel sightings in a pre-CERP environment in 1998 (left panel) and 2023 (right panel).

Priorities Moving Forward

As management of invasive animals in the Everglades restoration footprint continues, gaps in knowledge are increasingly filled. But important questions and the need for critical resources remain. Identifying and prioritizing future needs are important steps to move forward effectively and increase our likelihood of managing invasive fauna successfully. This section outlines future priorities.

The most consistent and important resource identified by most invasive species management experts is a steady and substantial source of dedicated funding. Resources for invasive animal research and management are much less substantial than funding for invasive plant work. Identifying a source capable of delivering sufficient and sustainable resources, developing a pathway to acquire them, and successfully executing that plan are vital to the success of managing invasive fauna.

Preventing introduction of new species or of existing species in new locations is the easiest and most cost-effective method of keeping the landscape free of nonnative species. Outreach, education, and risk assessment are important tools to achieve prevention. These tools are beginning to gain momentum in management efforts and the value of these programs should be reinforced. Creating regulations and patterns of responsible ownership to limit the introduction and spread of many nonnative species has occurred after species have been introduced but would be more effective if set in place proactively to prevent future introductions.

EDRR is the next best tool after prevention. Successful EDRR efforts have prevented the establishment and/or spread of several species such as sacred ibis (*Threskiornis aethiopicus*), Nile crocodiles, Asian water monitor (*Varanus salvator*), red swamp crayfish (*Procambarus clarkii*), and one population of panther chameleons (*Furcifer pardalis*). Maintaining a readily available response team with expertise across taxa is critical to success in extirpating a nonnative species quickly after its introduction.

Burmese pythons remain a priority species due to their ability to impact native wildlife. Increasing detection of this cryptic predator is a high priority. Many avenues exist to pursue this goal. Work will continue with detector dogs, eDNA, and artificial intelligence, in addition to pheromone and mammalian lures. Currently, technologies such as sophisticated cameras capable of scanning wavelengths outside human visible spectrum have been developed and continue to be tested. Analyses of ideal conditions for

python detection are nearly complete but should continue to be refined as data collection continues. Most control tools used for Burmese pythons also apply to Northern African python eradication efforts. While this species' population is thought to be extremely limited geographically in South Florida, it should remain a key focus of invasive animal specialists. Scout snakes, captured snakes that are radio-tagged and released back into the wild to find conspecifics, may be an effective tool for northern African pythons and should be deployed if possible. Continued monitoring of pythons will help in evaluation of control efforts.

Control of Argentine black and white tegus should continue, and current declines are encouraging in suggesting that removal efforts may impact the population in local areas. Additional research on diet, body condition, and phenology of tegus is underway and will continue to shed light on the species, potentially leading us to weaknesses to exploit in removal efforts.

While Nile monitors are relatively confined geographically, they are another species needing aggressive control efforts. Exploratory surveys and public outreach may provide important information on undiscovered metapopulations. Researchers and managers likely have an incomplete picture of where they occur and how they use the areas in which we already know they occur. Currently, a GPS telemetry study is ongoing to determine how monitors are using the landscape in Cape Coral. Nile monitor diet and body condition research is currently underway.

Several species have emerged as candidates for increased control measures. Spectacled caimans are sparsely distributed throughout the landscape of South Florida. Several agencies (FWC, SFWMD, and USACE), and UF have ramped up removal programs to extirpate local populations or even eradicate the species entirely from Florida, and at present, maximum control of this species is thought to be achieved (Godfrey et al. 2023). Green iguanas cause economic damage through crop damage, aircraft strikes on runways, and structure damage (Falcón et al. 2013). For these reasons, FWC, UF, and SFWMD have begun pilot programs to test iguana control methods from the Florida Keys through Palm Beach County.

INTERAGENCY COORDINATION

This section provides updates on key interagency coordination activities pertaining to invasive species in South Florida during FY2024. To be successful, regional management of invasive species requires strategic integration of a broad spectrum of control measures across multiple jurisdictions. As such, numerous groups and agencies are necessarily involved with invasive species management in Florida. More information on agency roles and responsibilities pertaining to invasive species in Florida is available online at http://www.eli.org/sites/default/files/eli-pubs/fillingthegaps.pdf (Environmental Law Institute 2004).

Florida Invasive Species Council

Recognizing the need to standardize terminology (Iannone et al. 2021), the Florida Exotic Pest Plant Council (FLEPPC) formally changed its name to the Florida Invasive Species Council (FISC) in 2022. As with FLEPPC, FISC's primary mission is to reduce the impacts of invasive plants in Florida through the exchange of scientific, educational, and technical information. The organization accomplishes this by hosting an annual symposium, compiling an invasive plant species list every two years (FISC 2023), and developing invasive species management plans and outreach materials. In addition to its name change, FISC formerly merged with the Florida Invasive Species Partnership (FISP) in 2023. FISP was a collaborative effort between local, state, and federal agencies, as well as non-governmental organizations, to connect private and public landowners with professional expertise and assistance programs. FISP played an important role in helping coordinate cooperative invasive species management areas (CISMAs) at the state level. With the organizational merger, FISC formally established a CISMA committee, which will provide similar functions as FISP. Finally, following the trend of other invasive species coordinating groups, FISC has integrated invasive animals into its mission.

Cooperative Invasive Species Management Areas

Florida has a long history of invasive species organizational cooperation including FISC, Noxious Exotic Weed Task Team, Florida Invasive Animal Task Team, and Invasive Species Working Group. At more local levels, land managers and invasive species scientists have informally coordinated across the fence line for many years. These regional groups 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 2011). To date, there are 16 CISMAs in Florida covering roughly 98% of the state (**Figure 7-15**). Of these 16 CISMAs, seven occur either wholly or partially within the CERP footprint. Additional information on the Florida Invasive Species Partnership and the ongoing cooperative efforts throughout Florida is available online at https://www.floridainvasives.org.

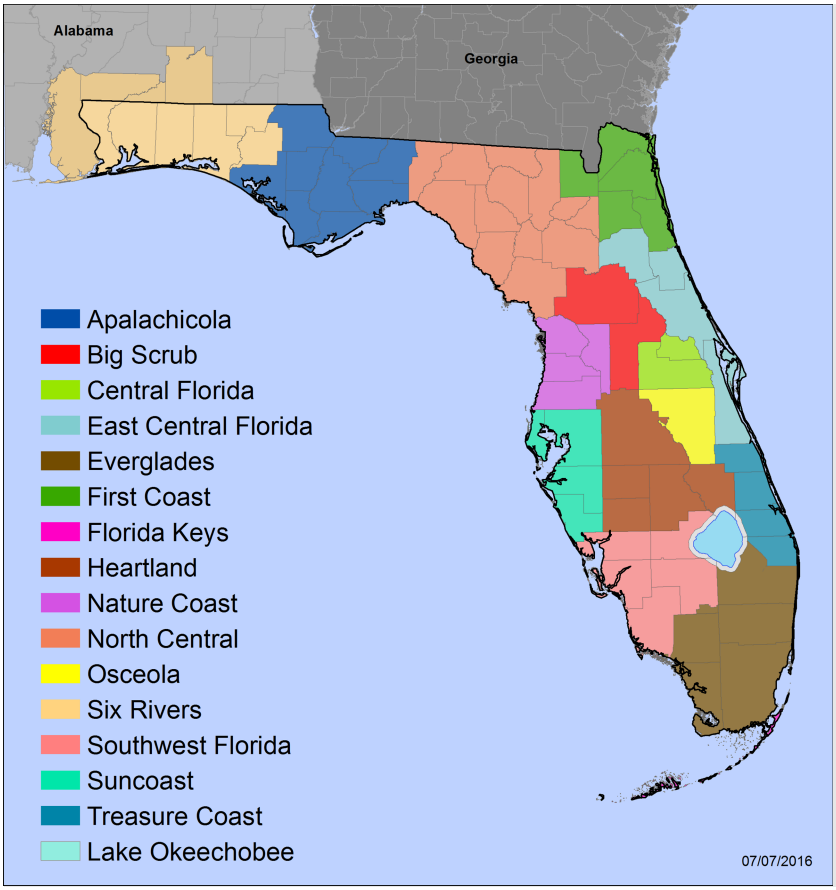


Figure 7-15. Locations of Florida's CISMAs.
(Note: this map was produced by the Center for Invasive Species and Ecosystem Health at the University of Georgia.)

Everglades CISMA

The Everglades Forever Act of 1994 directed SFWMD to coordinate invasive species management between public agencies with jurisdiction in the EPA. To formalize this coordination, invasive species scientists and Everglades land managers formed the Everglades Cooperative Invasive Species Management Area (ECISMA) in 2006 to improve cooperation and information exchange related to invasive species

management. The ECISMA partnership was formalized in 2008 (renewed in 2023) with a memorandum of understanding (MOU) among SFWMD, 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 ECISMA consists of 18 cooperators and partners, spanning the full spectrum of jurisdictions, including tribal, federal, state, local, and nongovernmental conservation organizations. The geographic extent of ECISMA includes all state and federal lands within the EPA and Everglades Agricultural Area (EAA), Miccosukee and Seminole lands, and Broward, Palm Beach, and Miami-Dade counties. ECISMA has achieved much progress toward improved coordination and cooperation among those engaged in invasive species management in the Everglades. These accomplishments include development of regional monitoring programs, completion of numerous rapid response initiatives, and enhanced coordination of management and research activities. During FY2024, partner agencies continued quarterly coordination meetings to share progress and challenges. In addition, ECISMA partners participated in ongoing rapid response workdays to eradicate invasive black mangrove (*Lumnitzera racemosa*) from mangroves adjacent to Fairchild Tropical Botanic Gardens in Miami-Dade County. ECISMA partners also organized several invasive species workdays focused on outreach and small-scale invasive plant removal. Workdays were held at Galaxy Scrub and Delray Oaks natural areas in Palm Beach County. A northern African python removal survey was also conducted during National Invasive Species Awareness Week. ECISMA partners also held invasive species training events targeting technicians and other field workers who spend time in the Everglades. These are the strategic "eyes on the ground" personnel who are most likely to observe these animals in the field. ECISMA also hosted its annual Everglades Invasive Species Summit on June 25 and 26, 2024. This two-day meeting provided a forum for exchanging updates on invasive species management activities, new research, and outreach efforts as well as planning workshops to organize future collaborations and projects. More information about ECISMA is available online at http://www.evergladescisma.org/.

Treasure Coast CISMA

The Treasure Coast CISMA (TC-CISMA) is a regional partnership established in 2007 to cooperatively address the threats of invasive plants and animals. The 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 as well as non-governmental organizations. Current active participants include SFWMD, USFWS, FWC, Florida Park Service, Martin County, The Nature Conservancy, Treasure Coast Resource Conservation and Development Council, Natural Resources Conservation Service, Palm Beach County Environmental Resources Management, UF's Institute of Food and Agricultural Sciences (IFAS), St. Lucie County, Indian River Country, Aquatic Vegetation Control Inc., Habitat Specialists Inc., and The Florida Native Plant Society.

In 2024, TC-CISMA hosted an annual planning meeting where the previous year's activities were reviewed, and new projects and events were proposed. In addition to the annual meeting, sub-committee meetings for private lands, cooperative workdays, and EDRR species were held throughout the year. The Treasure Coast CISMA has largely been focused on outreach and community-driven workdays. The group engaged in five local outreach events geared towards educating the public about issues with invasive flora and fauna in natural and suburban areas, in addition to the planning and participation of six workdays which involved actively surveying for and removing invasive species within the region. TC-CISMA and partners hosted two workshops offering continued education units to participants with Restricted Use Pesticide licenses, one covering common invasives within the CISMA and one discussing management and identification of the invasive *Scleria* species within the CISMA. The CISMA also gave a presentation to the Treasure Coast chapter of the Florida Association of Environmental Professionals. Providing opportunities for managers and citizen scientists to learn how to identify and manage invasive species that are less well known can aid in preventing their spread and distribution across the landscape. More information about TC-CISMA is available online at http://www.floridainvasives.org/treasure/ [floridainvasives.org].

Southwest Florida CISMA

The Southwest Florida CISMA (SWCISMA), founded in 2008, is a partnership between the Florida Forest Service, FWC, Florida Park Service, USFWS, Lee County, Conservation Collier, Audubon of Florida, Conservancy of Southwest Florida, Naples Zoo, and others. The boundary of this CISMA encompasses five counties: Collier, Lee, Charlotte, Hendry, and Glades. Both the Weed Wrangle and Invasive Fish Roundup, two seminal events for the CISMA, garnered much attendance. These events in conjunction with the annual SWCISMA Invasive Species Symposium engage members in invasive species removal efforts and local research and management efforts. CISMA members learn to identify and treat a variety of invasive plant species and put their knowledge to work at Weed Wrangle events and Invasive Fish Roundups. Fish Roundups, hosted by Bass Pro Shops, incentivizes participant anglers to target nonnative and/or invasive fish for removal with the chance of earning prizes for their catch. CISMA members were able to educate and engage with not only the participants but also the public attracted to the events and those that watched the local news coverage.

Other CISMAs

In addition to ECISMA, TC-CISMA, and SWCISMA, there are four other CISMAs either wholly or partially within the footprint of the Greater Everglades ecosystem: Florida Keys Invasive Species Task Force, Heartland CISMA, Osceola County CISMA, and Central Florida CISMA. These CISMAs have also recognized many successes that have benefitted the Everglades ecosystem by furthering the concept of a landscape-level approach to invasive species management.

Lake Okeechobee Aquatic Plant Management Interagency Task Force

Invasive plant management on Lake Okeechobee is coordinated according to policy contained in the *Corps of Engineers Letter of Operating Procedures for Aquatic Plant Management on Lake Okeechobee* (USACE 1989) which was adopted by the involved agencies: USACE, SFWMD, Florida Department of Natural Resources, now Florida Department of Environmental Protection (FDEP), and FWC. Representatives from partner agencies in the group have conducted semi-monthly helicopter flights since 1987 to estimate the lake's coverage of water lettuce and water hyacinth, and now fly every month. At bi-monthly meetings, interagency representatives present ongoing and planned invasive plant management projects for review. The group considers all aspects of the project including presence of endangered species, conservation of quality fish and wildlife habitat, flood control, and navigation. Public stakeholders and nongovernmental organizations are encouraged to attend and provide input. In recent years, greater emphasis has been put on integrated management of floating aquatic plants incorporated within the lake. More information about this task force is available online at https://www.floridainvasives.org/okeechobee.

Kissimmee River and Greater Kissimmee Chain of Lakes Watershed Coordination

Invasive plant treatment priorities on the Kissimmee River and Greater Kissimmee Chain of Lakes Watershed are planned at interagency meetings, though these groups do not have a formal agreement such as the *Corps of Engineers Letter of Operating Procedures for Aquatic Plant Management on Lake Okeechobee* (USACE 1989). Funding from the Florida Aquatic Plant Management Trust Fund and the Land Acquisition Trust Fund, administered by FWC, is used for much of the aquatic plant management in these waters. The primary lakes within the Kissimmee Chain of Lakes are given high state priority for large-scale aquatic plant management treatments, particularly for hydrilla, water lettuce, water hyacinth, Cuban bulrush (*Cyperus blepharoleptos*), and creeping water primrose (*Ludwigia* spp.). The primary lakes are large (1,620–13,800 hectares [ha]) and interconnected with flood protection canals, which are navigable with boat locks along the system.

Invasive plant management on the Kissimmee River includes the river channel and floodplain and is strategically implemented to align with restoration efforts. With the completion of construction for the Kissimmee River Restoration Project, invasive plant management activities have mostly been focused within the restoration project footprint, in areas where high quality habitat exists or in areas where restoration is expected to have the greatest impact. The highest priority species for management in the river and floodplain include Old World climbing fern, Brazilian pepper, and a suite of invasive grasses. Effective control methods and management strategies are known for the two former species and managers are working with researchers to investigate efficient and sustainable options for controlling invasive grasses in the river and floodplain.

South Florida Ecosystem Restoration Task Force

Authorized by the United States Congress in the Water Resources Development Act (WRDA) of 1996, the South Florida Ecosystem Restoration Task Force (SFERTF) brings together federal, state, Tribal, and local agencies involved in restoring and protecting America's Everglades. The critical role of the intergovernmental SFERTF is to facilitate the coordination of the numerous conservation and restoration efforts being planned and implemented. It also provides a forum for the participating agencies to share information about their restoration projects, resolve conflicts, and report on progress. SFERTF is chaired by the Secretary of the United States Department of the Interior or their appointed designee. It is staffed and supported in the accomplishment of its mission and duties by the United States Department of the Interior's Office of Everglades Restoration Initiatives (OERI).

SFERTF recognizes the significant threat invasive species pose to the goals and objectives of ecosystem restoration programs in South Florida. To address this, the Invasive Exotic Species Strategic Action Framework began in 2013. The initial framework was completed in 2015 (SFERTF 2015) and helped to improve invasive species coordination and boost the effectiveness of existing programs. The framework was updated in 2020 (SFERTF 2020) and includes a set of complimentary resources, which can be found online at https://www.evergladesrestoration.gov/invasive-species-strategic-action-framework.

In 2020, section 528 of WRDA 1996 was amended to add specific duties to SFERTF's mission related to invasive species. WRDA 2020 directs SFERTF to develop a priority list of invasive species that significantly impact the structure and function of ecological communities, native species, or habitats within the South Florida ecosystem. SFERTF member agencies are directed to manage those species through coordination and collaboration, develop innovative strategies and tools, guide applied research, and facilitate improved management, control, eradication, and prevention efforts. SFERTF, its Working Group, Science Coordination Group, and the Office of Everglades Restoration Initiatives, have established an Invasive Species Team of experts to help implement the SFERTF's WRDA 2020 duties.

An initial list of priority species was developed for those species not yet within the South Florida Ecosystem and of highest concern for prevention. This effort identified 19 species as high priority prevention species. This initial list and associated recommended actions were presented to SFERTF at their June 1, 2023, meeting. The recommended actions include regulation, outreach, and response planning if prevention efforts are not successful. To help communicate the priority species and recommendations, a summary document was prepared and is available at:
https://www.evergladesrestoration.gov/invasive-species-strategic-action-framework.

Ongoing work by the Invasive Species Team includes developing an invasive species prioritization tool and assessing needs and gaps for early detection monitoring. Currently, efforts are underway through an effort led by UF and USGS to develop a web-based prioritization tool for species all along The Invasion Curve (see **Figure 7-16** in the *Invasive Species Status Updates* section). The web-based prioritization tool is intended to provide a repeatable, science-based method of evaluating risk of invasive species to the South Florida ecosystem. A workshop process for the tool's development, sponsored by USGS and the Center for Environmental Studies at Florida Atlantic University, is designed to be inclusive and scientifically based,

incorporating expert option from the Invasive Species Team and input from managers, technical taxonomic experts, and stakeholders. The first of two workshops was conducted in April 2024; the second was held in September 2024. Currently, the draft web-based tool is undergoing testing by taxonomic experts. The team is also conducting an inventory of invasive species detection programs and tools currently being utilized by agencies and Tribes. This inventory will help identify any gaps or needs with the goal of optimizing the detection of incipient populations of invasive species.

INVASIVE SPECIES STATUS UPDATES

This section provides a summary of invasive species that threaten the success of SFWMD's mission. Regional invasive species scientists and land managers have adopted The Invasion Curve (**Figure 7-16**) as an organizing graphic to communicate the status, impacts, and management strategies for biological invaders. The curve depicts, at a glance, the ability to combat invasive species in terms of time, resources, and likelihood of eradication or containment. The left-hand side of the invasion curve represents the best chance for long-term success. Since eradication of widely established invasive species is rarely achieved, a long-term commitment to controlling established species is required to protect vulnerable natural resources. Long-term suppression of established species is challenging and costly. Thus, early detection and control of new invasive species results in lower overall environmental impact and economic cost along with a higher likelihood for eradication.

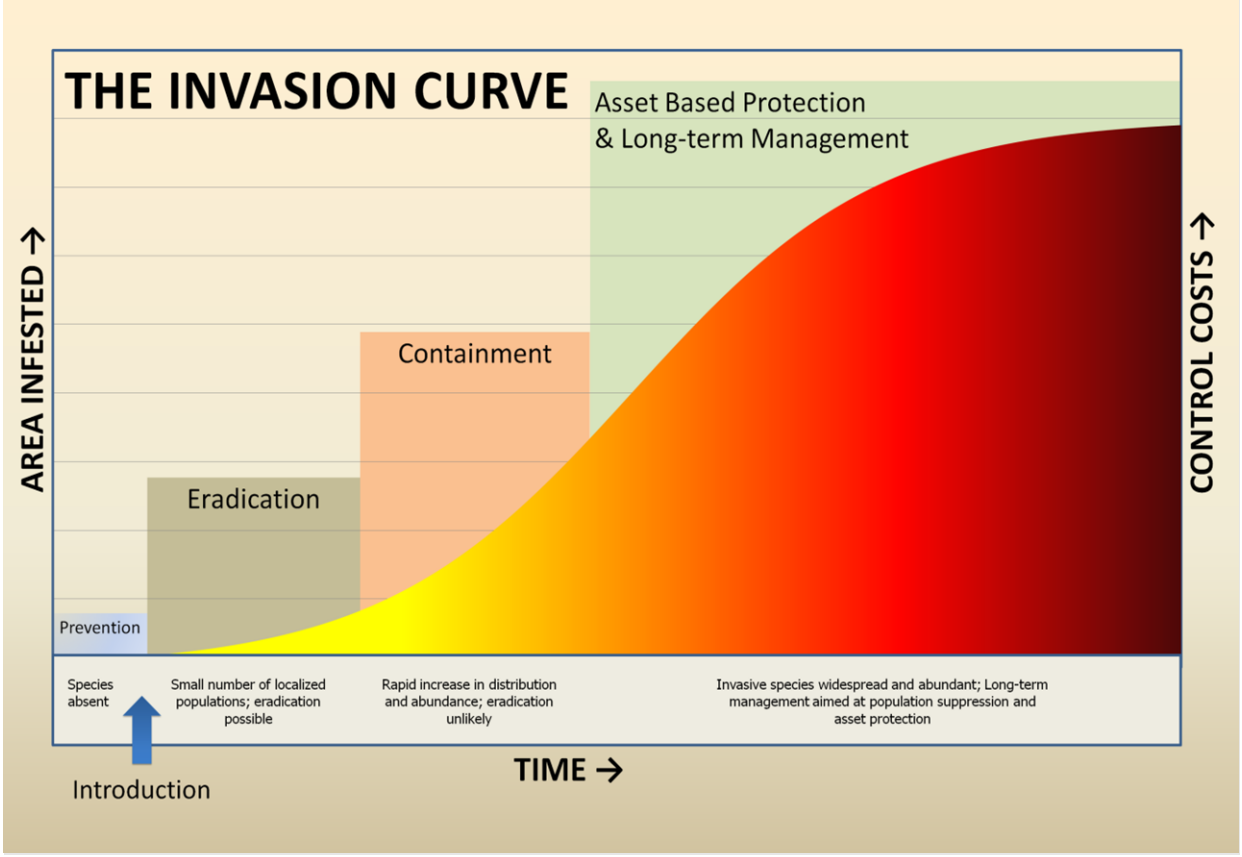


Figure 7-16. The Invasion Curve (Rodgers 2010) depicts four major categories of management actions that may be taken as the invasion progresses from initial establishment to widespread dominance on the landscape.

In this section, each of the priority species is summarized in a one-page synopsis that highlights key management issues and provides general distribution information. Species are presented in three sections following principles of The Invasion Curve. The three sections group species according to the management strategies for long-term suppression or containment/eradication. Species managed by regional land managers for long-term suppression typically have wide distribution ranges and are assumed to be beyond regional containment or eradication. Species targeted for containment or eradication generally have regionally limited or highly localized distributions and are thought to have the potential for containment or eradication due to limited distributions and/or sufficient control tools and resources. A third group includes nonnative species considered highly invasive in the South Florida ecosystem but are not actively managed due to insufficient control tools or management resources. These species may be the focus of monitoring and research on ecosystem and species level impacts. Omitting specific mention of other invasive species in the following priority summaries does not imply 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. In addition, numerous nonnative freshwater fishes with known or suspected impacts to native fauna are not included in this report. Ongoing monitoring and research regarding many of these fish species is beginning to elucidate the scope of the problem.

For each one-page synopsis, county distribution maps are provided. Plant species distribution is determined by presence of a species in each county. Animal distribution is based on establishment of a species, which is determined by the presence of all sexes and age classes, or other evidence of breeding. Distribution data were compiled from a variety of resources including herbarium records and documented and verified sightings by citizen scientists, and in only a few cases are data used from systematic, statewide monitoring efforts. As such, these maps should be viewed as provisional and only intended to give general instruction on species' distribution. Primary data sources for the distribution maps and the module occurrence table found in Appendix 7-1 of the *2014 South Florida Environmental Report – Volume I* (Rodgers and Black 2014) include EDDMapS, ECISMA, FWC Florida's Nonnative Species, USGS Nonindigenous Aquatic Species, and the University of South Florida Atlas of Florida Vascular Plants. More photographs and general information about these and other invasive species can be found at the following websites:

- Early Detection and Distribution Mapping System (EDDMapS) – www.eddmaps.org/distribution/
- ECISMA – www.evergladescisma.org/
- FWC Florida's Nonnative Fish and Wildlife – myfwc.com/wildlifehabitats/nonnatives/
- USGS Nonindigenous Aquatic Species – nas.er.usgs.gov/
- University of South Florida Atlas of Florida Vascular Plants – https://florida.plantatlas.usf.edu/
- UF IFAS Center for Aquatic and Invasive Plants – https://plants.ifas.ufl.edu/

Additionally, each species synopsis includes an indicator-based stoplight table that gauges the status of the species in each of SFWMD's land management regions, as well as Lake Okeechobee, Florida Bay, and the Florida Keys. These regions closely align with the CERP RECOVER modules but are more inclusive of all conservation and project lands within SFWMD's boundary. The stoplight table technique was established through coordination among the Science Coordination Group, Noxious Exotic Weed Task Team, and Florida Invasive Animal Task Team of the SFERTF (Doren et al. 2009). Like its application in previous reports, the indicator table assesses each species by region per the following questions: (1) How many hectares within the module does this species occur in? (2) Is the distribution 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?

A brief explanation of stoplight indicators provided for each priority species in the following species summaries is as follows:

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 localized but expected to spread if sufficient resources or actions are not provided.

Green – Situation is under control and has remained under control for several years or in some cases, is not yet present.

SPECIES MANAGED FOR LONG-TERM SUPPRESSION

Fourteen established plant species were selected by invasive species biologists from SFWMD and partner agencies for long-term suppression based on potential and current implications to SFWMD's infrastructure and ecological concerns (**Table 7-1**). The three established invasive animal species presented in this section are in close alignment with the species identified by regional invasive species experts as priorities for long-term suppression and have active management programs in place. These species are generally presented with a "SFWMD-centric" justification for listing, and priority plant species may differ for other agencies depending on regional factors and agency priorities and goals.

Table 7-1. Priority species currently managed within the South Florida ecosystem for long-term suppression and/or asset protection (e.g., endangered species), ranked by taxonomic group and then alphabetically by common name.

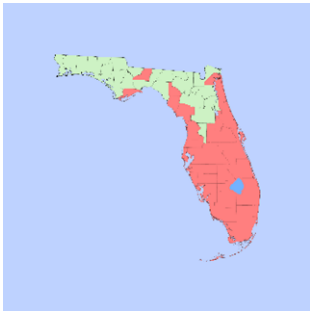
Plants	
Australian pine (*Casuarina* spp.)	Old World climbing fern (*Lygodium microphyllum*)
Brazilian pepper (*Schinus terebinthifolia*)	Shoebutton ardisia (*Ardisia elliptica*)
Cogongrass (*Imperata cylindrica*)	Torpedograss (*Panicum repens*)
Downy rose myrtle (*Rhodomyrtus tomentosa)*	Water hyacinth (*Pontederia crassipes*)
Dwarf rotala (*Rotala rotundifolia*)	Water lettuce (*Pistia stratiotes*)
Hydrilla (*Hydrilla verticillata*)	Water primroses (*Ludwigia* spp.)
Melaleuca (*Melaleuca quinquenervia*)	Wright's Nutrush (*Scleria lacustris*)
Mammals	**Reptiles**
Feral hog (*Sus scrofa*)	Burmese python (*Python molurus bivittatus*)
	Green iguana (*Iguana iguana*)

Australian Pine (*Casuarina* spp.)

SUMMARY: Three invasive species in Florida are collectively referred to as Australian pine: *Casuarina equisetifolia*, *C. glauca*, and *C. cunninghamiana*. Australian pine is a large, fast-growing tree that readily colonizes coastal and inland habitats (Morton 1980). Mature plants produce thick litter mats containing plant growth inhibiting compounds (**Figure 7-17**; Batish et al. 2001), making the plant particularly destructive to native plant communities. Australian pine can interfere with sea turtle and American crocodile (*Crocodylus acutus*) nesting (Klukas 1969), and small mammal populations are lower in habitats dominated by this invader (Mazzotti et al. 1981).

Figure 7-17. Australian pines form dense litter mats that inhibit understory native species (photo by UF).

KEY MANAGEMENT ISSUES



Distribution: Australian pine is present throughout South Florida, especially in coastal counties. It often occurs in stands on small tracts of private land, along rights-of-way, and in windbreaks on agricultural land. Control efforts in natural areas have largely been successful, but recruitment is inevitable in areas adjacent to mature stands, necessitating perpetual maintenance control. Australian pine is now under maintenance control throughout most of the Everglades restoration area, with only a few significant infestation areas remaining in the South Dade wetlands and eastern ENP.

Control Tools: Herbicide control methods are well established for this species although access to remote infestations makes control challenging. Mechanical removal is often used to remove trees when access by heavy equipment is feasible. There are no biological control agents approved for *Casuarina* spp. in Florida.

Monitoring: Agencies monitor for this species in high priority public lands regionwide. Monitoring is conducted within the Greater Everglades and on most SFWMD-owned lands.

Interagency Coordination: Agency-sponsored control efforts are ongoing and gaining public support through education. However, local opposition to control efforts, especially on beaches, can sometimes complicate efforts.

Regulatory Tools: *Casuarina* species are designated as Florida Prohibited Aquatic Plants. *C. equisetifolia* and *C. glauca* are designated as Florida Noxious Weeds. Florida law allows plantings of male *C. cunninghamiana* for windbreaks in commercial citrus groves in some counties.

Critical Needs: State and local restrictions on planting and maintaining Australian pine. Numerous potential biological control agents have been identified but support for research into their development and implementation is needed.

2024 Status of Australian Pine by Management Region

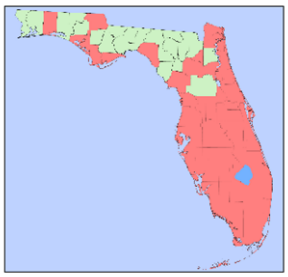
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Brazilian Pepper (*Schinus terebinthifolia*)

SUMMARY: Brazilian pepper (**Figure 7-18**) is a fast-growing tree that rapidly invades disturbed areas then expands into adjacent natural areas. Brazilian pepper reduces native plant and animal diversity (Campello and Marsaioli 1974, Morton 1978, Curnutt 1989) and alters fire regimes (Stevens and Beckage 2009). The invasiveness of this plant is partly explained by hybrid vigor. Florida's Brazilian pepper originated from multiple genetic strains (Mukherjee et al. 2012). The Florida hybrids have greater fitness relative to their progenitors (Geiger et al. 2011).

Figure 7-18. Brazilian pepper produces large quantities of viable seeds (photo by NPS).

KEY MANAGEMENT ISSUES



Distribution: Brazilian pepper is the most widespread and abundant invasive species within SFWMD boundaries. The plant invades most natural communities from mangrove forests to freshwater swamps, even scrub habitat, and can become dominant in all these areas if left unmanaged. It also remains abundant on rights-of-way and private lands, facilitating constant reestablishment on conservation lands. It occupies an estimated 30,379 ha within the Everglades restoration area, primarily in southwestern ENP (Rodgers et al. 2014b).

Control Tools: Managers typically use chemical, mechanical, and cultural controls. UF and SFWMD scientists are developing new treatment techniques that result in lower volumes of herbicide required to control this species. One biological control agent that targets Brazilian pepper was approved in 2019; another is in development. With Brazilian pepper dominating so many hectares of private lands, biological control agents are an important tool we can use to reduce the reintroduction of seed to maintained natural areas.

Monitoring: Agencies monitor for this species in high priority public lands regionwide. Monitoring is conducted within the Greater Everglades and on all SFWMD-owned lands.

Interagency Coordination: ECISMA partners coordinate control efforts on adjacent lands in the Everglades. Although there is some coordination by local agencies and partner groups, increased coordination between major landholders is needed.

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

Critical Needs: Development and implementation of statewide private lands initiatives is needed to reduce propagule pressure on conservation lands.

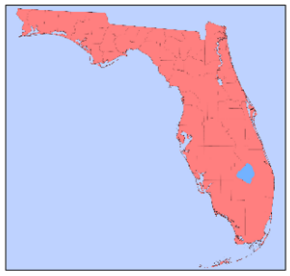
2024 Status of Brazilian Pepper by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Cogongrass (*Imperata cylindrica*)

SUMMARY: Cogongrass (**Figure 7-19**) is among the worst invasive plants globally (Holm et al. 1977). Originally from Southeast Asia, Australia, and East Africa, this fast-growing grass was widely planted for forage in the 1900s and is now documented in every county in Florida. Cogongrass invades numerous habitats where it displaces plant communities and alters ecosystem processes, such as fire regimes (Lippincott 2000) and biogeochemical cycling (Daneshgar and Jose 2009, Holly et al. 2009). Experimental evidence supports concerns that ornamental cultivars may hybridize with invasive biotypes of cogongrass resulting in increased cold tolerance and range expansion (MacDonald 2009).

Figure 7-19. Cogongrass aggressively invades disturbed soils and pine flatwoods (photo by SFWMD).



KEY MANAGEMENT ISSUES

Distribution: Cogongrass is documented in natural areas throughout Florida. Within SFWMD boundaries, cogongrass is most prevalent in the Kissimmee and Caloosahatchee watersheds, but in recent years it has spread in the Lake Okeechobee marsh, BCNP, Dupuis Management Area, and East Coast Buffer Lands. The plant is expanding throughout SFWMD along levees where it is easily spread by mowers.

Control Tools: Herbicide can be effective in reducing cogongrass abundance when applied multiple times a year (Minogue et al. 2012). Successful control may require an integration of approaches including repeated herbicide applications, prescribed fire, mechanical controls, and native revegetation (Sellers et al. 2018). The grass-specific herbicide, fluazifop-P-butyl, may provide selective control of cogongrass allowing for accelerated native plant recovery (Hinkson et al. 2024). Two potential biological control candidates have been identified and were brought to the United States to observe their veracity at the USDA-ARS Invasive Plant Research Lab in Fort Lauderdale, Florida (Gazdick et al. 2024).

Monitoring: Agencies monitor for this species in high priority public lands regionwide.

Interagency Coordination: Interagency inspectors continue to monitor the plant and recommend control areas. SFWMD works to reduce the spread of this species when working with contractors, maintaining levees, roads, and other infrastructure with heavy equipment or mowers through outreach, coordination, and decontamination practices.

Regulatory Tools: Cogongrass is designated as both a federal and Florida noxious weed and is a FISC Category 1 species.

Critical Needs: Development of biological control agents would improve regional control of this species. Regulatory pressure is needed to encourage increased control efforts on rights-of-way where this species is commonly spread.

2024 Status of Cogongrass by Management Region

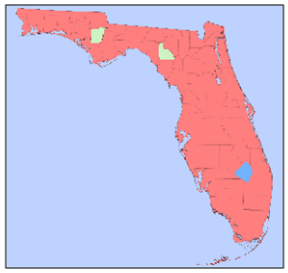
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Water Primroses (*Ludwigia* spp.)

SUMMARY: Numerous invasive aquatic *Ludwigia* species native to South and Central America have become widely established in Florida. These species include *L. grandiflora*, *L. hexapetala* (**Figure 7-20**), *L. peruviana*, and *L. peploides*. DNA analysis is often the only method to identify some of these species and the taxonomy remains unclear. *L. grandiflora* is often used as a "catch all" species name for plants in the creeping water primrose complex. Creeping water primrose initially spread horizontally across the water surface, easily overtaking other plants. When mature, emergent plants grow up to two meters tall, and dense rhizome mats fill the water column (Jacono 2014). In the Kissimmee River Watershed, creeping water primrose overwhelms populations of emergent native plants. Allelopathic effects further contribute to the plant's invasiveness (Dandelot et al. 2008).

Figure 7-20. Monotypic stands of *Ludwigia hexapetala* dominate large areas of the Kissimmee River floodplain (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Accurate distribution of creeping water primrose is difficult to determine because of large gaps in reporting, possibly due to confusion in identification. It is reported from the St. John's River to Lake Okeechobee and is documented in other Florida waters including the Blackwater River State Forest and the Blue Cypress Conservation Area (EDDMapS 2021).

Control Tools: Herbicide can be effective for early prostrate creeping water primrose but it is less effective on dense, emergent populations. SFWMD uses triclopyr or a combination of carfentrazone and imazamox to manage mature stands with limited success. USDA-ARS is evaluating South American insects for biocontrol potential but the number of native *Ludwigia* species in Florida make this development unlikely.

Monitoring: While there is no comprehensive monitoring program for this species, the Florida Fish and Wildlife Research Institute performs annual long-term monitoring point intercept sampling of aquatic vegetation in select water bodies throughout the state.

Interagency Coordination: The Florida Aquatic Plant Management and Land Acquisition trust funds, as administered by FWC, fund control of these species in waters designated as Waters of the State. Interagency plant managers working on the Kissimmee and Alligator Chains of Lakes, Kissimmee River and Lake Okeechobee allocate available funding towards managing this species through a coordinated effort.

Regulatory Tools: There are no regulatory tools in place for this species.

Critical Needs: State-wide documentation and reporting of population location, status, and control methods for dense populations are lacking for this complex. Continued funding and effort are essential to maintain pressure on new and previously treated creeping water primrose populations.

2024 Status of Creeping Water Primroses by Management Region

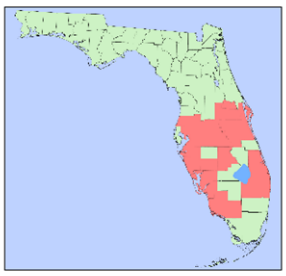
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Downy Rose Myrtle (*Rhodomyrtus tomentosa*)

SUMMARY: Downy rose myrtle is an ornamental shrub of Asian origin. Introduced to Florida in the late 1800s, the plant now occurs in natural areas throughout South and Central Florida. This fast-growing shrub spreads into pine flatwoods and drained cypress strands, even in the absence of disturbance, and can form dense thickets that crowd out native vegetation (**Figure 7-21**). Downy rose myrtle recovers quickly from fire. Successful control of downy rose myrtle with herbicides is being accomplished where adequate resources are available. The high cost per hectare to clear advanced invasions demonstrates the value of detecting and eliminating downy rose myrtle before it dominates a natural area.

Figure 7-21. Downy rose myrtle displaces understory plant communities in pine flatwoods (photo by USDA-ARS).

KEY MANAGEMENT ISSUES



Distribution: Downy rose myrtle occurs throughout Central and South Florida.

Control Tools: This species is difficult to control and can often require multiple treatments to enter the maintenance phase of management. Glyphosate and imazapyr can be effective as a foliar treatment but are nonselective and can impact native plants and inhibit revegetation. Cut and stump treatments of triclopyr are effective but to ensure good coverage, these can be time and labor intensive in dense infestations. Plants are often multi-stemmed or are found clumped together as separate plants sprouting from scat piles. Every stem is required to be cut and have herbicide applied for effective control. Multiple candidate biological control agents have been evaluated and rejected as not specific to the weed.

Monitoring: Because downy rose myrtle is difficult to detect from the air, monitoring is currently limited to observations by land managers.

Interagency Coordination: TC-CISMA makes this species a priority for regional coordination.

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

Critical Needs: Statewide private lands initiatives to reduce propagule pressure on conservation lands; plans to guide regional, integrated management; and monitoring to support early detection are needed.

2024 Status of Downy Rose Myrtle by Management Region

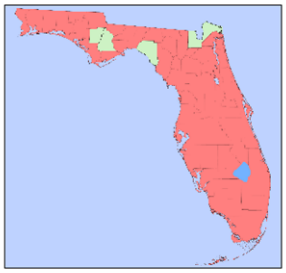
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Hydrilla (*Hydrilla verticillata*)

SUMMARY: Hydrilla is a rooted submerged plant that often forms dense mats through the water column, competitively excluding native aquatic plant communities (**Figure 7-22**). It is native to the Old World and Indo-Pacific and was likely first introduced to Florida in the 1950s as an aquarium plant. By the 1990s, hydrilla was widely distributed in the state, occupying more than 56,000 ha of public lakes and rivers. Hydrilla is now the dominant submerged plant in Florida, forming large infestations that can obstruct flood control structures and hinder navigation with over 21,000 ha treated in 2023. Hydrilla also supports the growth of a cyanobacterial epiphyte, *Aetokthonos hydrillicola*, which produces an avian toxin affecting herbivorous waterbirds and their avian predators (e.g., coots [*Fulica americana*] and bald eagles [*Haliaeetus leucocephalus*]; Wilde 2005, 2014, Martin 2015).

Figure 7-22. Dense hydrilla mats aggressively overtake native aquatic vegetation (photo by USDA).

KEY MANAGEMENT ISSUES



Distribution: Hydrilla is found in all types of Florida freshwater bodies. It has often dominated much of the Kissimmee Chain of Lakes. Hydrilla has been in Lake Okeechobee for over 20 years but has not been a consistent problem.

Control Tools: Herbicide is the primary control tool for hydrilla. Fluoridone was highly effective on this species until it developed resistance after widespread, repeated use. Agencies involved in hydrilla management often rely on an integrated approach to reduce herbicide usage and the likelihood of new resistance development. Tools available include several aquatic herbicides, mechanical harvesting, and grass carp. Four biological control agents have been released against hydrilla, with the leaf-mining fly *Hydrellia pakistanae* and the stem-boring weevil *Bagous hydrelliae* established in South Florida ecosystems. Unfortunately, the beetle remains rare in the landscape. The fly's impacts, although occasionally impressive, are largely ephemeral and unpredictable.

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

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

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

Critical Needs: Continued research on effective systemic herbicides and foreign exploration to locate potential biological control agents in China and Korea are needed. In addition, integrated management with frequent monitoring and retreatments is needed for long-term control.

2024 Status of Hydrilla by Management Region

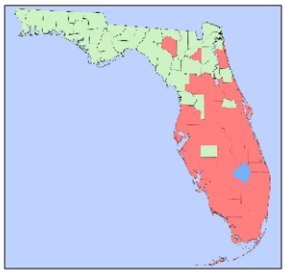
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Melaleuca (*Melaleuca quinquenervia*)

SUMMARY: Before organized state and federal invasive plant control operations were initiated in 1990, melaleuca (**Figure 7-23**) was widely distributed throughout the WCAs, ENP, BCNP, Lake Okeechobee, and LNWR. Overall, agency efforts to control melaleuca are succeeding in containing and reducing its footprint. However, 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).

Figure 7-23. Melaleuca converts diverse marsh habitat to single species melaleuca swamps (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Dense infestations of melaleuca have been systematically cleared from Lake Okeechobee, WCA-2, WCA-3, and Holey Land and Rotenberger WMAs and these areas are now considered under maintenance control. Significant infestations remain in LNWR and many west coast properties.

Control Tools: Herbicidal, mechanical, physical, and biological controls are all used as part of an **i**ntegrated management technique that has resulted in the maintenance control over large areas in public lands. Three biological control agents are now established and have demonstrated they reduce flower and seed production and biomass (Tipping et al. 2008, 2016). A fourth insect was approved in 2022 and has been released into natural areas infested with melaleuca where populations will be monitored to ensure successful establishment and spread.

Monitoring: Agencies monitor for this species in high priority public lands regionwide. Monitoring is conducted within the Greater Everglades and on all SFWMD-owned lands (see the *Invasive Plant Management* subsection for more information).

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

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

Critical Needs: Private land initiatives are needed to reduce remaining infestations near conservation lands. Consistent funding is important to ensure the current level of control does not reverse due to irregular treatment, wildfires, or seed rain from neighboring untreated land.

2024 Status of Melaleuca by Management Region

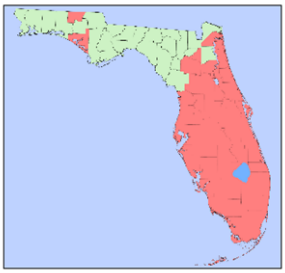
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 (**Figure 7-24**). Without active control measures, this species could potentially overtake most of South Florida's mesic and hydric forested plant communities (Lott et al. 2003, Volin et al. 2004).

Figure 7-24. Old World climbing fern overtaking a cypress swamp (photo by USDA-ARS).

KEY MANAGEMENT ISSUES



Distribution: Old World climbing fern dominates many tree islands, strand swamps, pine flatwoods, and other forested wetlands throughout South and Central Florida. First collected in Martin County, this species continues to expand its range northward. Dense infestations are particularly widespread in LNWR and the Kissimmee River region.

Control Tools: Herbicides are used to control Old World climbing fern, but rapid reestablishment makes chemical control costly and unlikely to succeed alone. Recent herbicide evaluations confirm that triclopyr is a suitable alternative to glyphosate in wetland ecosystems (Glueckert et al. 2023). Biological control is a critical component to effective long-term management of this plant. Three agents have been released in Florida; two have established—the brown lygodium moth and lygodium gall mite. The USDA-ARS continues to mass-rear and release the gall mite. Three additional agents are in the regulatory pipeline for approval. Prescribed fire can provide effective short-term reductions in biomass and regrowth (Richards et al. 2020) and may encourage establishment of biological controls (David et al. 2020), though care should be taken given documented impacts to native plant canopies from fire laddering on Old World climbing fern (Hutchinson et al. 2006).

Monitoring: Agencies monitor for this species in high priority public lands regionwide. Aerial mapping is conducted on a 5-year cycle within the Greater Everglades.

Interagency Coordination: An interagency management plan (FLEPPC 2006) was developed for this species and agencies are coordinating management efforts. Research investigating new herbicides, biological controls, and integrated pest management strategies for this species is ongoing.

Regulatory Tools: Old World climbing fern is a Federal Noxious Weed and Florida Noxious Weed.

Critical Needs: Greater understanding of the natural history of Old World climbing fern may improve development of management strategies. Successes in biological control efforts, ground-based monitoring programs, and private lands initiatives to reduce propagule pressure on conservation lands are also needed.

2024 Status of Old World Climbing Fern by Management Region

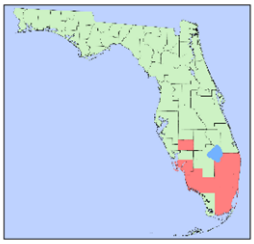
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Dwarf Rotala (*Rotala rotundifolia*)

Figure 7-25. Dwarf rotala growing in a canal (photo by SFWMD).

SUMMARY: Dwarf rotala (**Figure 7-25**) is a submersed aquatic plant native to India and Southeast Asia. It was introduced into Florida's natural waters as a disposed aquarium plant. Dwarf rotala was first collected in Florida in 1996 in Broward County and can now be found in Lee, Collier, Palm Beach, Broward, and Miami-Dade counties in Florida and Tuscaloosa County, Alabama (UF IFAS 2021/ EDDMapS). It is unique in its ability to grow fully submersed, emerged, and terrestrially. Dwarf rotala roots at the nodes and grows year-round in Florida, which contributes to its invasive nature. Furthermore, this species can reproduce from seeds and fragmentation. The branching growth habit of dwarf rotala leads to the creation of thick clumps that can block waterways and inhibit water movement and navigation.

KEY MANAGEMENT ISSUES



Distribution: Dwarf rotala primarily inhabits South Florida canal systems and is particularly troublesome in the Broward, Miami-Dade, and Collier counties' canal systems. A small population exists in the canal systems surrounding the J.W. Corbett WMA in Palm Beach County. Rotala is commonly found in canals south of Southern boulevard in Palm Beach County.

Control Tools: Control of dwarf rotala has been achieved using surface applications of glyphosate and imazamox or submersed applications of fluridone; however, fluridone is not a practical treatment method in many of the canal systems where water moves constantly. Bispyribac has also been shown to provide control when used as a foliar spray, but this method requires populations of emergent rotala (Della Torre et al. 2017). ProcellaCOR (florpyrauxifen-benxyl) has shown promising results at low rates to provide long-term control of this species even a short exposure time (Gettys et al. 2021). Additionally, dwarf rotala is routinely mechanically removed from canal systems, but this method does not provide long-term control and may promote new populations from regrowth of fragmented stems.

Monitoring: There is no comprehensive monitoring program for this species, but involved agencies share information regarding established and new populations. SFWMD routinely monitors and treats its canals for large populations of this and other submersed and emerged aquatic weeds.

Interagency Coordination: More interagency coordination is needed to regulate the spread of this species.

Regulatory Tools: There is no regulatory status for this species, however it is listed as a Category II species by FISC.

Critical Needs: Continued development of chemical control methods and biological control feasibility studies are needed. Given its increasing spread in Florida water bodies and continued sale as an aquarium plant, this species should be considered for additional risk assessments.

2024 Status of Dwarf Rotala by Management Region

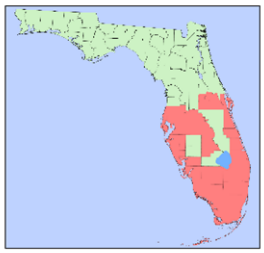
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Shoebutton Ardisia (*Ardisia elliptica*)

SUMMARY: Shoebutton ardisia (**Figure 7-26**) was imported from southeast Asia as an ornamental shrub in the early 1900s (Gordon and Thomas 1997). This species has since invaded certain South Florida natural areas where it will form dense monospecific stands, resulting in the displacement of native plants (Potter et al. 2023). There is a tendency for reinvasion by shoebutton ardisia or other invasive nonnative plants following removal of dense thickets of this species (Pascarella and Horvitz 1999). Early infestations may go unnoticed due to this species' physical similarity to the common native marlberry (*A. escallonioides*).

Figure 7-26. Shoebutton ardisia seedlings often create dense carpets in the mangrove understory (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Ardisia is established in natural areas throughout South and Central Florida, particularly in forested wetlands and riparian corridors (Koop 2003).

Control Tools: Light infestations can be hand pulled or treated with triclopyr amine through a cut stump application (Siso and Burzycki 2004). This approach is costly in denser infestations and is typically only employed in sensitive wetland habitats where other removal methods are not feasible. Applying triclopyr acid or ester as a basal application can be more cost effective for lighter infestations. However, the most efficient approach for dense infestations is mechanical shredding followed by a foliar herbicide application of a low rate triclopyr product. Follow up treatments are required to control plants germinating from the seedbank (Pascarella and Horvitz 1999). There are currently no biological controls or feasibility studies for potential agents for this species.

Monitoring: Shoebutton ardisia is difficult to detect from aerial reconnaissance. Monitoring is currently limited to ground-based observations by land managers.

Interagency Coordination: While there is no regionwide strategic coordination for this species, biologists from SFWMD, Miami-Dade County, and ENP are working closely to address major infestations in the Southern Glades and Biscayne Bay regions.

Regulatory Tools: Shoebutton ardisia is listed as a Florida Noxious Weed and a FISC Category 1 species.

Critical Needs: A comprehensive feasibility study on the potential for biological control is needed. Increased funding to remove dense infestations in the eastern Everglades, improved revegetation methods after shoebutton ardisia removal, and more efficient means of monitoring to identify new populations are also needed.

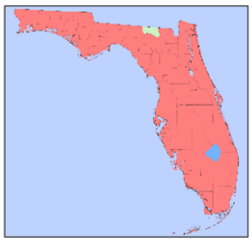
2024 Status of Shoebutton Ardisia by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Torpedograss (*Panicum repens*)

SUMMARY: Torpedograss, a perennial rhizomatous grass native to parts of Africa and Eurasia, was introduced to Florida for cattle forage during the early 1900s (Sperry et al. 2023). By 1992, it was reported in over 70% of the state's public water ways (MacDonald et al. 2008). Robust, partitioned rhizomes enable this plant to recover from fire, drought, herbicide application, frost, and mechanical disturbance, which in turn allows the plant to form dense, homogenous mats that can outcompete native plants (Langeland et al. 1998). Although seed originating from Florida has shown to have very low viability, torpedograss readily spreads vegetatively to new sites (Khamare et al. 2021). Torpedograss represents a significant management challenge in restoration projects where it aggressively invades and hampers native plant colonization and survival.

Figure 7-27. Imazapyr bare-soil treatments of torpedograss at Abiaki Prairie Restoration site in Hendry County (photo by SFWMD).



KEY MANAGEMENT ISSUES

Distribution: Torpedograss is ubiquitous in South Florida, occurring within disturbed wetlands, ditches, and sandy upland sites. In areas such as Lake Okeechobee, where active torpedograss management is taking place, populations have been reduced. However, many areas where this species is managed struggle with the plant's ability to adapt to a variety of environmental conditions (Davidson et al. 2011).

Control Tools: Torpedograss is one of the most difficult weeds for land managers in South Florida to control. Mowing and grazing can marginally impact torpedograss, while disking and fire can increase its abundance if not utilized in concert with additional management tools (Khamare et al. 2021). Repeated herbicide treatments is currently the best method for long-term control. In mixed vegetative communities selective gramicides such as fluazifop-p-butyl and sethoxydim have proven effective (Enloe and Netherland 2017). When selectivity is not a concern, non-selective herbicides such as imazapyr and glyphosate have been shown to reduce rhizome biomass (Enloe et al. 2020) (**Figure 7-27**). Treatment before site inundation appears to increase control efficacy (Toth 2007). An effort is underway to initiate a biological control program for this weed.

Monitoring: Torpedograss monitoring on Lake Okeechobee, begun in the 1980s by SFWMD and FWC, demonstrates that control efforts here have been successful, though populations remain.

Regulatory Tools: There are no federal or state prohibitions for this species, however, torpedograss is listed as a FISC Category I species.

Critical Needs: Strategies proven successful in reducing torpedograss rhizomes differ significantly from other weed management strategies. Because of this, proper education, including a comprehensive understanding of torpedograss biology, is needed for land managers who manage this species.

2024 Status of Torpedograss by Management Region

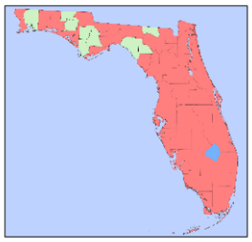
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Water Lettuce (*Pistia stratiotes*)

SUMMARY: Water lettuce is a floating aquatic plant of uncertain origin but is now found throughout the tropics and subtropics. 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% viable (Dray and Center 1989). Water lettuce was reported by William Bartram in 1765 as forming dense mats on the St. Johns River. These mats continue to occur, clogging waterways and water management structures (**Figure 7-28**).

Figure 7-28. Water lettuce clogging a canal in Palm Beach County (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Water lettuce inhabits all water body types in South Florida. Herbicide control efforts have suppressed water lettuce populations in many canal systems. However, most large lakes continue to harbor significant populations requiring frequent control. Aquatic vegetation barriers installed in many canal systems have prevented the clogging of water management and subsequent release of water lettuce into downstream water bodies. Routine maintenance for control of this plant is required, as it reproduces rapidly by vegetative offshoots formed on short, brittle stolons resulting in an exponential growth pattern.

Control Tools: Water lettuce is readily controlled by herbicides, but rapid reestablishment of this species in some water bodies necessitates frequent retreatments. Two biocontrol agents, the South American weevil *Neohydronomous affinis* and the Thai moth *Spodoptera pectinicornis* were released in Florida to suppress water lettuce. The moth failed to persist and despite encouraging early success on Lake Okeechobee, the weevil has become ephemeral in the field. Mechanical harvesting for water lettuce can be practical when it forms a dense mat and is not mixed with native vegetation.

Monitoring: FWC monitors water lettuce in all public waters and SFWMD routinely monitors its canals for large populations. Interagency aerial surveys are conducted monthly to document floating plant coverage on Lake Okeechobee.

Interagency Coordination: 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: Development of additional biological controls is needed.

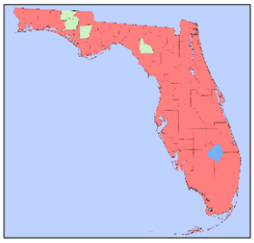
2024 Status of Water Lettuce by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Water hyacinth (*Pontederia crassipes*)

SUMMARY: Water hyacinth (**Figure 7-29**), a floating plant native to tropical South America, was brought to Florida in 1884. After introduction, it quickly blocked navigation on the St. Johns River. Vegetative reproduction occurs rapidly during all but the coolest months. New plants are also produced from seed, which germinate copiously on exposed moist soils (Perez et al. 2011). Low nutrient needs and wide tolerance for water conditions enable its persistence and spread throughout Florida water bodies.

Figure 7-29. Dense floating mat of water hyacinth (photo by USACE).



KEY MANAGEMENT ISSUES

Distribution: Water hyacinth can inhabit all freshwater bodies in South Florida. Herbicide treatments have virtually eliminated it from many major canal systems. However, most large lakes continue to harbor significant populations requiring frequent control.

Control Tools: Water hyacinth is readily controlled by herbicides, but rapid reestablishment of this species in some water bodies necessitates frequent monitoring and retreatments. In the Kissimmee Chain of Lakes and Lake Okeechobee, populations increase in abundance and distribution when treatments are suspended to accommodate Everglade snail kite (*Rostrhamus sociabilis*) nesting. When treatments resume, expanded populations are much costlier to control. The newly labeled auxin herbicide, ProcellaCOR (florpyrauxifen-benxyl) has shown effective control of water hyacinth at low rates (Mudge et al. 2021). USDA has released and established four water hyacinth biocontrol insects in Florida, including two weevils of the genus *Neochetina*. These agents reduce biomass by up to 58% and flower production by up to 97% in mesocosm studies (Tipping et al. 2014a) but do not reduce surface coverage enough to meet management standards. Herbivory by these agents makes the plant more susceptible to herbicides. In 2010, a new water hyacinth-feeding insect, *Megamelus scutellaris,* was released in Florida. This planthopper is now established in Florida and can be more readily integrated with herbicides than the previously released agents (Goode et al. 2020). Augmented releases of these biocontrol agents can also be effective.

Monitoring: FWC monitors water hyacinth in all Florida public waters. SFWMD routinely monitors and treats its canals for large populations of this and other floating aquatic weeds. Interagency flights are conducted monthly over Lake Okeechobee to quantify the coverage of floating aquatic plants.

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.

2024 Status of Water Hyacinth by Management Region

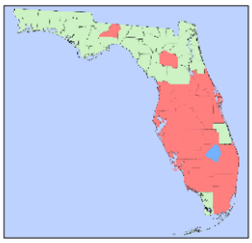
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

West Indian Marsh Grass (*Hymenachne amplexicaulis*)

SUMMARY: West Indian marsh grass is native to Central and South America and the West Indies. It was first collected in North America in 1957 (Bair 1957) but began expanding in Florida natural areas in the 1990s (Langeland et al. 2008). This robust grass grows in freshwater marshes where it often forms large, dense monospecific stands and displaces native marsh species. The plant is well adapted to disturbed habitats and fluctuating water levels (Kibbler and Bahnisch 1999) and appears to spread during seasonal flooding and via surface water ditches (Bouchard et al. 2020).

Figure 7-30. Dense stand of West Indian marsh grass on the Kissimmee River floodplain (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: West Indian marsh grass is documented in 27 Florida counties, primarily in Central and South Florida. It is common in the Kissimmee Chain of Lakes region and has invaded large areas of the Kissimmee River floodplain (**Figure 7-30**) as restoration efforts increased hydroperiods (Toth 2017, Koebel et al. 2020). This species is the target of ongoing containment efforts within the ECISMA footprint as its spread into the Greater Everglades region could negatively impact open water slough habitats.

Control Tools: Herbicides are the primary control tools currently available for control of this species. Glyphosate and imazapyr control West Indian marsh grass but non-target impacts to native plants are a challenge with these broad-spectrum herbicides. Experimental field trials suggest that West Indian marsh grass abundance can be reduced, while increasing native plant diversity, using the grass-specific herbicides sethoxydim and fluazifop-P-butyl (Quincy and Enloe 2020). However, the high monetary cost is prohibitive, considering the limited evidence of successful long-term control. SFWMD scientists have initiated field trials to determine how to best manage this species in the restored portion of the Kissimmee River. The nonnative heteropteran insect, *Ischnodemus variegatus*, was first reported in Florida in 2000 feeding on West Indian marsh grass (Halbert 2000). Subsequent investigations on potential host-specificity indicate that *I. variegatus* preferentially feeds on West Indian marsh grass (Diaz et al. 2009) though population-level effects of this insect on West Indian marsh grass are not fully understood.

Monitoring: Interagency partners continue to monitor the plant and recommend priority control areas.

Interagency Coordination: While there is no regionwide strategic coordination for this species, ECISMA partners are actively monitoring for new infestations within the Everglades region.

Regulatory Tools: There are no federal or state prohibitions for this species, however, West Indian marsh grass is listed as a FISC Category I invasive species.

Critical Needs: Integrated pest management and additional herbicide research is needed.

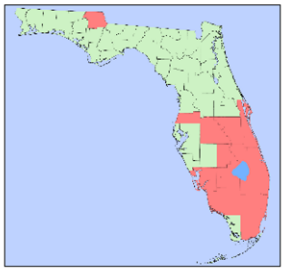
2024 Status of West Indian Marsh Grass by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Wright's Nutrush (*Scleria lacustris*)

SUMMARY: Wright's nutrush is a robust annual, aquatic sedge, considered native throughout the Caribbean, northern South America, originating in parts of Africa (Jacono 2001). The first Florida record is from 1988, but large populations were not documented until 2001. Wright's nutrush prefers open sunny habitats with reduced competition from taller shading trees and shrubs and is typically found invading seasonally dry wetlands but once established, can tolerate occasional drought or prolonged flooding due to its persistent seedbank (Jacono et al. 2011). Sawgrass and graminoid marshes, cypress strands, and floodplain basins are all vulnerable to invasion by Wright's nutrush, where it readily outcompetes the native graminoid species (**Figure 7-31**).

Figure 7-31. Dense stand of Wright's nutrush (photo by SFWMD).



KEY MANAGEMENT ISSUES

Distribution: Established populations vary annually in size and density, depending on water levels and durations. To date, Wright's nutrush has been documented in many South and Central Florida counties and has expanded into southern Broward and Miami-Dade counties, where managers are prioritizing monitoring and controlling of this species when it is encountered.

Control Tools: This plant is readily controlled by a variety of herbicides. Diquat is an effective contact herbicide for this species and imazamox provides an effective and selective method of control. Clipping seed heads and treating plants can also be effective in areas with small populations but this is not feasible across multiple acres. Land managers often find treatment timing and the intensive monitoring effort necessary for effective management challenging. When treatment occurs too early in the season, late flowering plants are missed and if seeds are clipped from early seeding plants, they will flower again. Late season treatments risk allowing viable seeds to enter the system. Annual treatments are necessary to control the persistent seed bank.

Monitoring: Land managers survey for this species each spring when water levels begin to rise, and the sedge is actively growing. Interagency surveys have identified new locations of Wright's nutrush in WCA-3A.

Interagency Coordination: There is no formal rapid response plan or region-wide containment strategy, but informal treatment coordination and information sharing occurs among partners.

Regulatory Tools: Wright's nutrush is not a regulated or prohibited species but it is listed as a FISC Category I species.

Critical Needs: Expanded surveys and control efforts for Wright's nutrush including private lands, particularly in the Kissimmee Chain of Lakes region and in the Lake Okeechobee marsh.

2024 Status of Wright's Nutrush by Management Region

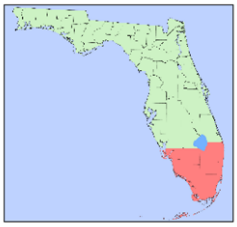
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Burmese Python (*Python molurus bivittatus*)

Figure 7-32. Detection of Burmese pythons is primarily along levees and roads (photo by UF).

SUMMARY: The Burmese python (**Figure 7-32**) is widely established in the southern Everglades (Snow et al. 2007b) and increased sightings in the central Everglades indicate it is spreading. This large constrictor is a top predator known to prey upon more than 60 native Florida species and is implicated in substantial mammal declines in ENP (Dorcas et al. 2012, McCleery et al. 2015). Control of this species is a top priority among agencies. See the *Invasive Animal Management* subsection above for more detailed updates on monitoring and removal efforts.

KEY MANAGEMENT ISSUES



Distribution: The Burmese python is found south of Lake Okeechobee to the east and west coasts and into the Upper Florida Keys, with the core of the python population occurring throughout the southern Everglades.

Control Tools: Control options for this species are limited, primarily due to very low detectability (Nafus et al. 2020). Potential controls include visual searching, traps, detection dogs, scout snakes, pheromone attractants, and multispectral or near infrared camera imaging. Research and development for these and other tools is ongoing or in the early stages of development. Python contractor programs are ongoing with SFWMD and FWC, but an NPS volunteer program was suspended because of COVID-19. Collectively, these programs have removed over 15,272 pythons between 2017 and October 2024. Statewide, more than 17,000 Burmese pythons have been removed as of August 2022 (FWC, unpublished data).

Monitoring: A regional python monitoring network continues to develop and expand in South Florida. Pythons are regularly reported by members of the public to the 888-IVE-GOT1 hotline and EDDMapS reporting website (https://www.eddmaps.org/) and IveGot1 smartphone app. UF conducts monitoring surveys as a major component of EIRAMP.

Interagency Coordination: FWC and partner organizations completed an interagency python control strategy (*Florida Python Control Plan*; FWC et al. 2021) to align management goals and leverage resources among partners. SFWMD and FWC python contractor programs are closely aligned with the cooperation of NPS, USFWS, and FDEP. Additionally, USGS has headed up coordination of the python synthesis, a document detailing python life history, research, and control efforts in South Florida (Guzy et al. 2023).

Regulatory Tools: The State of Florida lists the Burmese python as a Prohibited Species, which prevents public ownership. A federal ban on importation and interstate trade was instated in January 2012 but subsequently lifted in 2017.

Critical Needs: Critical needs include the development of technologies to improve detection in the field, research into methods to improve population estimates, and protection of vulnerable resources such as bird rookeries.

2024 Status of the Burmese Python by Management Region

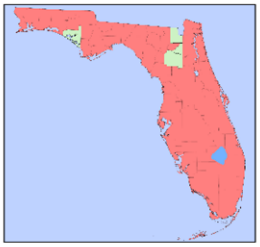
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Feral Hog (*Sus scrofa*)

SUMMARY: Feral hogs (**Figure 7-33**) have existed on the Florida landscape since their introduction by Spanish explorers four centuries ago. Feral hogs consume a variety of vegetation, invertebrates, insects, reptiles, frogs, bird eggs, rodents, small mammals, and carrion (Laycock 1966, Baber and Coblentz 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 damage plant communities and may facilitate establishment of invasive plant species (Belden and Pelton 1975, Duever et al. 1986). Feral hog damage to rangeland pasture is estimated to result in at least $2 million in losses to Florida cattle production (Bankovich et al. 2016). Plans are to document these impacts more fully in future work (Wisely 2016). $1.5 billion is conservatively estimated as the annual United States costs of feral swine damage (Mississippi State University Extension Service 2014).

Figure 7-33. A pair of feral hogs at Lake Okeechobee (photo by FWC).

KEY MANAGEMENT ISSUES



Distribution: Wild hogs are reported in all 67 Florida counties. Within SFWMD boundaries, feral hog populations are particularly high in the counties immediately north and west of Lake Okeechobee, and in the Big Cypress and East Coast regions.

Control Tools: Hunting, trapping, and exclusion may be used to control feral hogs. SFWMD has improved contract procedures for hog control. Hog removal contracts are no cost; the incentive is that the permittee keeps the hogs. No toxicants are approved for use on wild hogs in Florida at this time.

Monitoring: There is no regional, coordinated monitoring program for wild hogs. Monitoring is limited to efforts associated with removal programs.

Interagency Coordination: The Florida Feral Hog Working Group was established in 2018 to better coordinate feral hog policy, research, outreach, control, hunting and other stakeholder services between agency/non-governmental organization (NGO) partners to best serve Florida stakeholders and natural resource management.

Regulatory Tools: Hunting regulations could be modified to better control hog populations.

Critical Needs: Development of target specific toxicants or contraceptives and initiatives for control on private lands.

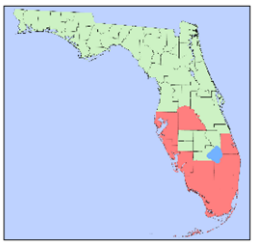
2024 Status of Feral Hogs by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Green Iguana (*Iguana iguana*)

Figure 7-34. Adult male green iguana (photo by Ed Metzger)

SUMMARY: The green iguana (**Figure 7-34**) is a large, predominantly herbivorous lizard native to South and Central America and some Caribbean islands. The species was introduced to Florida through the pet trade in the 1960s (King and Krakauer 1966) and is now firmly established in human-modified habitats throughout South Florida. Although they occupy some natural areas where they consume native vegetation and displace native animals such as burrowing owls (*Athene cunicularia*), green iguanas are primarily a threat to SFWMD infrastructure. Their high burrow densities along canals and near water control structures are likely to accelerate erosion and, in severe cases, could compromise levee integrity during high flow events. Green iguanas directly impact stakeholders as a pest species because they destroy ornamental vegetation and deface property with feces, which may contain *Salmonella* bacteria. The green iguana is increasingly becoming a priority taxon due to apparently exponential population growth from Key West to Pinellas County.



KEY MANAGEMENT ISSUES

Distribution: Escaped or released captive green iguanas have been reported throughout Florida, but the distribution of breeding populations is limited to Central and South Florida. The species is found along human-modified waterways and on the periphery of natural areas. Anecdotal reports suggest iguana abundance is increasing but may decrease after an extreme cold weather event.

Control Tools: Manual removal, firearms, and trapping are all effective control tools, and many iguana control companies are in operation.

Monitoring: The UF EIRAMP program monitors green iguanas throughout the Greater Everglades. They have conducted removal/monitoring in certain urban areas, but most metropolitan monitoring is through reports from the public.

Interagency Coordination: SFWMD has funded EIRAMP monitoring and removal since 2011, as well as special projects focused on levee damage assessments. FWC contracted UF and independent contractors for iguana management and encourages the public to remove iguanas whenever possible. Green iguanas are a priority species for management in ecologically sensitive systems or where infrastructure is threatened.

Regulatory Tools: In April 2021, FWC listed green iguanas as a Prohibited Species under Chapter 68-5 of the Florida Administrative Code, which restricts pet ownership and commercial sales with some limited exceptions.

Critical Needs: Research on the economic impacts of green iguanas is needed, as is a greater understanding of the ecology of this species in Florida and an evaluation of the effectiveness and long-term impacts of removal efforts on the population.

2024 Status of Green Iguana by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

SPECIES MANAGED FOR CONTAINMENT OR ERADICATION

Four invasive plant species were identified as priorities for regional containment or eradication by invasive species biologists from SFWMD and partner agencies (**Table 7-2**). Two graminoid species—tropical American watergrass and tropical nutrush—are well established in the northern reaches of SFWMD. Land managers are working to contain the spread of these species and prevent further expansion in the southern reaches of the Everglades and elsewhere. The eight established invasive animal species presented in this section are also targeted for containment or eradication (**Table 7-2**). Species with numerous population cores, such as the Nile monitor, are actively managed for regional containment while others with still limited geographic distributions (e.g., northern African python) remain candidates for eradication from Florida.

Table 7-2. Priority species currently managed within the South Florida ecosystem for geographic containment or eradication, ranked by taxonomic group and then alphabetically by common name.

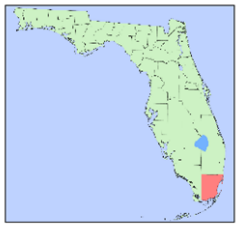
Plants	Reptiles
Asian black mangrove (*Lumnitzera racemosa*)	Argentine black and white tegu (*Salvator merianae*)
Mile-a-minute (*Mikania micrantha*)	Chameleons (*Furcifer oustaleti*/ and *Chamaeleo calyptratus*)
Tropical American watergrass (*Luziola subintegra*)	Nile monitor (*Varanus niloticus*)
Tropical nutrush (*Scleria microcarpa*)	Northern African python (*Python sebae*)
	Spectacled caiman (*Caiman crocodilus*)
Mollusks	**Mammals**
Giant African land snail (*Lissachatina fulica*)	Gambian pouched rat (*Cricetomys gambianus*)

Asian Black Mangrove or Lumnitzera (*Lumnitzera racemosa*)

SUMMARY: Lumnitzera, the Asian black mangrove (also known as kripa; **Figure 7-35**), is native to Asia and Australia but escaped cultivation from Fairchild Tropical Botanic Garden in Miami-Dade County. The plant was discovered to be rapidly proliferating in neighboring Matheson Hammock Preserve in 2009. Lumnitzera aggressively out-competes native mangrove species. The full effects of a major invasion of this species on Florida mangrove swamp diversity and function are difficult to predict. Given the important contributions of mangroves to marine productivity and South Florida's economy, Everglades CISMA and Fairchild Tropical Botanic Garden launched a rapid response effort almost immediately after the invasion was detected.

Figure 7-35. Asian black mangrove (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Lumnitzera is known to occur in Florida only in and around Fairchild Tropical Botanic Garden in Miami-Dade County.

Control Tools: This plant is readily controlled by herbicides and hand pulling, but rapid reestablishment of this species from the seedbank has required repeated treatments. Unlike most other mangrove species, lumnitzera does establish a true seedbank. Several cooperative interagency workdays eliminated many of the invading plants early on and later funding from FWC allowed for more aggressive treatments using vegetation management contractors. The number of plants removed annually from the 8-ha area continues to decline and are almost entirely seedlings and saplings, indicating that the seed bank is diminishing. However, after 14 years of annual removal efforts, new lumnitzera saplings continue to be found in the area.

Monitoring: Biologists at Fairchild Tropical Botanic Gardens with the support of Everglades CISMA collaborators conduct annual monitoring for this species.

Interagency Coordination: In the absence of a formalized, regional rapid response program, the 14-year eradication effort led by ECISMA is a model for grassroots coordination between agency resource managers. Cooperative annual workdays continue the efforts to pull seedlings and survey outlying areas for new plants. In FY2024, Fairchild Tropical Botanic Gardens and ECISMA coordinated three interagency workdays.

Regulatory Tools: There are no federal or state prohibitions for this species, however, lumnitzera is listed as a FISC Category I invasive species.

Critical Needs: Continued annual efforts to monitor and remove remaining established plants. State and federal agencies should review this species for future importation restrictions.

2024 Status of Asian Black Mangrove or Lumnitzera by Management Region

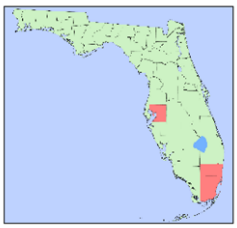
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Mile-a-minute (*Mikania micrantha*)

SUMMARY: Mile-a-minute (**Figure 7-36**) is a federally listed noxious weed first documented in South Florida in 2008. This South American vine has turned into a serious weed where it was introduced in Asia, Australia, and Africa (Holm et al. 1977, Zhang et al. 2004). Research shows that mile-a-minute invasion changes soil nutrients, microbial community composition, and metabolic function in subtropical forests, creating more favorable growth conditions for the vine, potentially forming a positive feedback invasion process (Zhao et al. 2023). Upon discovery of this species near Homestead, an aggressive eradication effort began immediately. Controlling the plant is challenging, in part due to infestations on private lands (Dozier 2012), although the threat of FDACS quarantine is an incentive for nursery owners to eliminate the plant. Eradication from Florida seems unlikely, but containment and suppression remain a priority to prevent it from colonizing large natural areas like the South Dade Wetlands and ENP.

Figure 7-36. Mile-a-minute can quickly smother and kill trees and shrubs (photo by FDACS Division of Plant Industry).

KEY MANAGEMENT ISSUES



Distribution: Apart from a single site discovered in 2014 in Broward County that appears to have been eradicated, mile-a-minute's distribution appears to be limited to the Homestead area in Miami-Dade County. Occurrences and densities vary, from single plants, to much larger infestations that create problems in disturbed portions of hardwood hammocks. Canopy openings in tropical hardwood hammocks from Hurricanes create favorable conditions for the weed.

Control Tools: This plant is readily controlled by herbicides. After several years of treatment, it appears many population cores of the plant may be eradicated but annual maintenance work on county properties continues to be necessary and limited monitoring access and treatment on private land hinders control efforts. The growth rate of mile-a-minute can be decreased using a rust fungus (*Puccinia spegazzinii*) as a biological control agent (Zhang et al. 2023).

Monitoring: Biologists at Miami-Dade County with the support of ECISMA collaborators conduct periodic monitoring for this species.

Interagency Coordination: Coordination is limited to ad hoc rapid response efforts conducted by Everglades CISMA.

Regulatory Tools: Mile-a-minute is designated a Federal Noxious Weed.

Critical Needs: Continued annual efforts to monitor and remove remaining established plants, particularly on private lands and outreach to and education of Florida nurseries that may spread this species are needed.

2024 Status of Mile-a-minute by Management Region

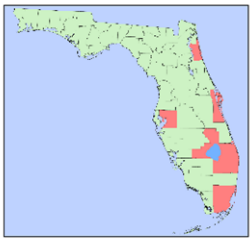
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Tropical American Watergrass (*Luziola subintegra*)

SUMMARY: Tropical American watergrass (**Figure 7-37**) was first discovered in North America in 2007 in Lake Okeechobee (Kunzer and Bodle 2008). This perennial South American grass grows floating or emergent with prostrate creeping culms that form dense mats. UF researchers found plants annually produce hundreds of fertile seeds that remain viable for long periods. Plants decline in winter; new spring and summer growth occurs from seed and surviving rhizomes. Managers aim to treat the plants before the onset of fall flowering.

Figure 7-37. Dense monospecific stands of tropical American watergrass (photo by USACE).

KEY MANAGEMENT ISSUES



Distribution: In the western Lake Okeechobee marsh, *L. subintegra* has spread well beyond its initial establishment area, although it remains mostly contained within the lake's levee system. An incipient population accidentally transported on equipment from Lake Okeechobee to Miami-Dade County was successfully eradicated. A second population is documented near the St. Johns River in Brevard County (EDDMapS 2021) and individuals or small patches are managed when observed in the Caloosahatchee River.

Control Tools: Herbicides are the only control tool currently available. Commonly used herbicides to control *L. subintegra* include glyphosate and imazypr. Contact herbicides, e.g., diqaut and flumioxazin, have been known to fragment *L. subintegra* furthering its spread. There is currently no research on biological control development because tropical American watergrass is in the rice tribe (Oryzeae) and the discovery of a species-specific parasitoid is unlikely.

Monitoring: Interagency inspectors continue to monitor the plant and recommend control areas. Treatment funding is available from the Florida Invasive Species Management Trust Fund.

Interagency Coordination: Within the Lake Okeechobee Watershed, large property owners have been contacted to look out for the plant. Also, the Sanibel-Captiva Conservation Foundation was asked to look for the plant in their role as Caloosahatchee River Riverkeeper.

Regulatory Tools: Tropical American watergrass is not a federal or Florida Noxious Weed, but it is an FISC Category I species.

Critical Needs: Additional herbicide research and funding for monitoring and rapid response efforts are needed. Trials with several newly labeled aquatic herbicides, separately and in combinations, may provide more control options and prevent development of herbicide resistance to commonly used herbicides.

2024 Status of Tropical American Watergrass by Management Region

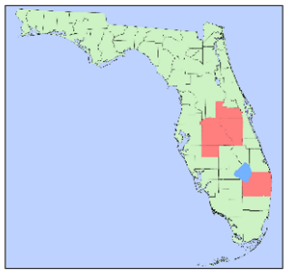
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Tropical Nutrush (*Scleria microcarpa*)

SUMMARY: Tropical nutrush is perennial sedge with a neotropical distribution. This species was first identified in 2016 shortly after it established dense stands in the understory of swamps bordering several lakes in the Kissimmee Chain of Lakes (**Figure 7-38**). This species prefers dappled or indirect light and is typically found in the understory of bald cypress (*Taxodium distichum*) forests where it thrives. Tropical nutrush outcompetes and displaces native plant populations and is the target of ongoing containment monitoring and control efforts within several CISMAs in the central and southern regions of SFWMD as its spread into the Greater Everglades region could negatively impact forested wetlands and swamps.

Figure 7-38. Tropical nutrush under cypress canopy (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: To date, tropical nutrush has been documented in Polk, Orange, Osceola, Highlands, Hardee, and Palm Beach counties and is most abundant in Polk and Osceola counties. Expansion of this species through the Greater Everglades Watershed is evident as new populations are being discovered downstream in the Kissimmee River Floodplain. Continued expansion to the Southern region of the Everglades is a concern because suitable habitats are at risk of becoming invaded by this species including BCNP and ENP.

Control Tools: Recent unpublished studies suggest glyphosate and imazamox provide effective control of this species. Additional trials determined herbicide is most effective for this species when applied under dry conditions (Onisko 2020). Although consecutive treatments reduce tropical nutrush density, seed production may still occur. Increased treatment frequency is being investigated as it may be needed for achieving maintenance control.

Monitoring: This species must be detected from the ground since it thrives under canopy. Heartland, Treasure Coast, and Osceola CISMAs have provided outreach to engage land managers in the region in detection, reporting, and management of this species.

Interagency Coordination: Heartland-CISMA makes this species a priority for regional reporting coordination. UF IFAS' Assessment of Nonnative Plants in Florida's Natural Areas website (https://assessment.ifas.ufl.edu/) concluded this species to be invasive in Central Florida. The Treasure Coast CISMA lists this species as an EDRR priority.

Regulatory Tools: Tropical nutrush is not a regulated or prohibited species but it is listed as a FISC Category I species.

Critical Needs: Expanded surveys for tropical nutrush including private lands and information about treatment intervals are needed.

2024 Status of Tropical Nutrush by Management Region

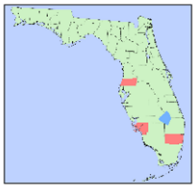
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Giant African Land Snail (*Lissachatina fulica*)

Figure 7-39. The giant African land snail is a host of the rat lungworm (photo by FDACS).

SUMMARY: The giant African land snail is known to eat a great variety of vegetation, including crop plants, horticultural plants, and environmentally valuable plants. This species has invaded other places outside its native range in Africa, often causing substantial damage. It is an intermediate host of the rat lungworm (*Angiostrongylus cantonensis*), which can infect humans and cause meningitis (Cowie 2013). A previous infestation of this snail occurred in Miami in 1966. The Florida state eradication effort took 10 years at a cost of $1 million (USDA 2020). The State of Florida has requested federal resources to help control outbreaks in currently affected counties.

KEY MANAGEMENT ISSUES



Distribution: A population of the giant African land snail (**Figure 7-39**) was discovered in 2011 in an area of Miami (FDACS 2020). An intensive EDRR campaign resulted in a declaration that the Giant African land snail was eradicated from Florida in September 2021. However, additional populations have been observed in Pasco County (2022) and Broward County (2023), triggering a renewed effort by state and federal agencies to eradicate this population (USDA 2024).

Control Tools: Eradication is challenging and requires public support and education. Hand collection (wearing gloves) and snail toxicants containing metaldehyde are used (FDACS 2013). There are indications that control efforts are having an effect, as fewer large snails are being seen. Local extinctions of the snail have been observed in many population cores (Roda et al. 2016).

Monitoring: An aggressive federal and state cooperative program is now under way to eliminate the existing population. The eradication program proposes using detector dogs, visual inspections, and traps to monitor for the snail.

Interagency Coordination: The USDA-FDACS eradication program is a model for collaborative rapid response efforts.

Regulatory Tools: USDA APHIS established quarantine areas in Broward, Lee and Pasco counties.

Critical Needs: Continued annual efforts to monitor and remove remaining populations, particularly on private lands, are needed.

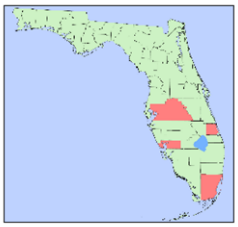
2024 Status of Giant African Land Snail by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Argentine Black and White Tegu (*Salvator merianae*)

SUMMARY: The Argentine black and white tegu (**Figure 7-40**) is a large, omnivorous lizard that is known to eat eggs. In its native range, it prefers open grassy areas and nests in burrows (Winck and Cechin 2008). This species may impact Everglades restoration by increasing predation on threatened and endangered species, including the American crocodile and the Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) (Kevin Enge, FWC, unpublished data) and ecologically important species such as the American alligator (Mazzotti et al. 2014). Eradication from Florida is now considered unlikely. Interagency efforts resulted in the removal more than 13,000 of this species state-wide since 2012 (FWC, UF, and NPS unpublished data)

Figure 7-40. Argentine black and white tegu (photo by FWC).



KEY MANAGEMENT ISSUES

Distribution: Four breeding populations are known in Florida—Hillsborough County (Enge et al. 2006), southern Miami-Dade County (Pernas et al. 2012), and emerging populations in Charlotte (Quinn et al. 2022) and St. Lucie counties (Sarah Funck, FWC, personal communication), which likely resulted from releases by pet breeders (Hardin 2007). Monitoring results suggest the South Florida population is expanding. However, long-term trapping efforts within the core of the tegu's range in Miami-Dade County have proven effective with a decline in local tegu abundance observed over time in this area (UF, unpublished data). Statistical assessment of trapping data collected from multiple sites in South Florida corroborate systematic trapping efforts, particularly with a high density of traps and a low rate of immigration, can significantly reduce tegu populations (Udell et al. 2022).

Control Tools: Trapping with baited traps and/or drift fences and removal by firearms may be effective control tools. Automated AI smart traps designed to capture tegus are being examined by UF to increase detection and removal of tegus while reducing resources needed to operate trap lines. As of October1, 2024, over 811 traps have been deployed by FWC, SFWMD, NPS, UF, and FPL for FY2024 (number to be provided for the final draft).

Monitoring: Interagency collaborators have conducted regional monitoring for tegus in Miami-Dade County since 2011. This collaborative monitoring continues.

Interagency Coordination: There is interagency monitoring and trapping coordination for tegus. However, funding is needed for expanded removal efforts if containment is to be achieved.

Regulatory Tools: As of April 29, 2021, tegus (genera *Salvator* and *Tupinambis*) are listed as Prohibited species per Chapter 68-5, Florida Administrative Code. The Prohibited species regulatory classification does not allow for these species to be kept as pets or for commercial sales with some limited exceptions.

Critical Needs: Needs include research on severity of impacts; utilizing a model to predict optimal trapping regimes; and federal and other states' regulations to restrict possession of this species.

2024 Status of the Argentine Black and White Tegu by Management Region

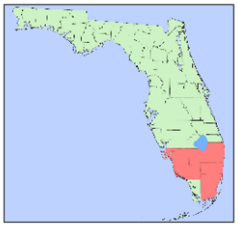
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Chameleons (*Furcifer oustaleti* and *Chamaeleo calyptratus*)

SUMMARY: The Oustalet's chameleon (*Furcifer oustaleti*) is a large chameleon native to a variety of habitats in Madagascar (D'Cruze et al. 2007). In Florida, their diet includes moth larvae, other insects, snails, and brown anoles (Krysko et al. 2012). The veiled chameleon (*Chamaeleo calyptratus*; **Figure 7-41**) naturally occurs in mountain and coastal regions of the Arabian Peninsula. The veiled chameleon is also known to utilize a wide range of habitats. Florida populations of both species are suspected to have been established through intentional releases by reptile enthusiasts. While chameleons are not particularly vagile, intentional introduction by humans must be considered when assessing their potential for reaching natural areas. Eradication of newly established populations is justified because of their unknown ecological impacts and high likelihood of eradication success.

Figure 7-41. A veiled chameleon (photo by UF).

KEY MANAGEMENT ISSUES



Distribution: A population of Oustalet's chameleon was discovered in Miami-Dade County in early 2010 (Gillette et al. 2010). This species does not appear to be spreading without human assistance, but surveys stopped in 2017 and subsequent survey effort is needed to assess this population. Breeding populations of veiled chameleon are now documented in Broward, Collier, Hendry, Lee (northwest estuaries), Miami-Dade (including populations near ENP), and Palm Beach counties (Metzger and Ginoza 2021). In addition, reports of veiled chameleons are common from Buckingham, Alva, Cape Coral, Marco Island, and Lutz, Florida.

Control Tools: Nighttime searches using flashlights and telescopic poles are generally the best way to detect and remove chameleons.

Monitoring: An interagency team, led by FWC, began a rapid assessment monitoring project in July 2011 for Oustalet's chameleons. Between July 2011 and July 2017, biologists removed 601 Oustalet's chameleons from a 49-ha site (Mike Rochford, UF, personal communications). Beginning December 2020, efforts lead by UF, SFWMD, and USACE began to eradicate a population of veiled chameleons in Palm Beach County, Florida. A total of 1,117 chameleons were removed from Palm Beach County during December 2020 to April 2023.

Interagency Coordination: FWC and partnering agencies coordinate response efforts for these species but efforts to implement controls are constrained by limited resources and few control tools.

Regulatory Tools: There are no federal or state prohibitions for these species. However, chameleons used for public exhibition or commercial sales requires authorization from FWC.

Critical Needs: Research on ecological and economic impacts of chameleons, as well as the life history of chameleons in Florida, are needed. An outreach strategy to discourage hobbyists from releasing chameleons is critical to preventing their dispersal throughout Florida.

2024 Status of Chameleons by Management Region

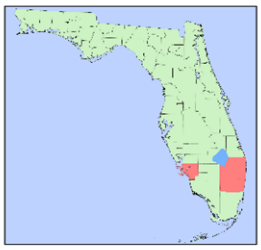
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Nile Monitor (*Varanus niloticus*)

SUMMARY: The Nile monitor (**Figure 7-42**) is a large predatory lizard known for its intelligence and adaptability (Bennett 1998). It is a generalist feeder (Losos and Greene 1988) that commonly preys on crocodile eggs and hatchlings in Africa (Lenz 2004). The impact of Nile monitors on Florida fauna is unclear but their potential to impact native species through competition and predation is high (Enge et al. 2004). This species threatens many endangered species (Meshaka 2006, Hardin 2007). Diet studies found 94% of Nile monitors had food in their gastrointestinal tracts with insects, snails, and reptiles most consumed.

Figure 7-42. Nile monitors grow to 1.5 meters in length (photo by UF).

KEY MANAGEMENT ISSUES



Distribution: Established populations are documented in Lee (Enge et al. 2004), and central Palm Beach (Eckles et al. 2017) counties. Numerous sightings have also been reported in Broward County near WCA-3B, and in Miami-Dade County on and around the Homestead Air Reserve Base.

Control Tools: Snares, traps, and firearm hunting are the only available control tools for this species. City of Cape Coral and FWC biologists respond to citizen reports in Lee County and FWC and UF conduct regular removal surveys in Palm Beach County. The total number of Nile monitors that have been removed from Palm Beach County and Lee County are 135 and over 639, respectively. In July 2019, one Nile monitor was removed on SFWMD land in Hendry County at the Caloosahatchee River (C-43) West Basin Storage Reservoir Project site and may have been an emigrant from the Lee County population.

Monitoring: FWC and UF are currently monitoring, and when possible, removing Nile monitors in Palm Beach County. Based on FWC data, the number of Nile monitors in Palm Beach County appears to be declining. Between 2010 and 2018, the number of Nile monitors removed per year averaged nearly 15. Between 2018 and 2024, that number dropped to less than 3 per year. Nile monitors continue to be observed on game cameras, but canal bank vegetation removal, road construction, and boat-based iguana hunters have likely contributed to fewer observations and subsequently, fewer removal efforts during boat surveys.

Interagency Coordination: Higher-level coordination was moved forward by a Nile monitor workshop organized by FWS in May 2016. A formal interagency control program is needed.

Regulatory Tools: On April 29, 2021, the Nile monitor was listed as a Prohibited Reptile by the State of Florida. Federal regulations are needed to further curtail releases of this invasive species.

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

2024 Status of the Nile Monitor by Management Region

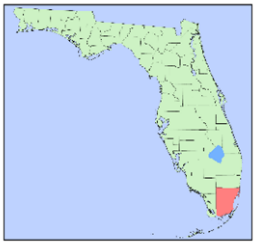
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Northern African Python (*Python sebae*)

SUMMARY: Since 2001, over 46 northern African pythons (**Figure 7-43**) have been removed from Miami-Dade County (McKayla Spencer, FWC, personal communication). This giant constrictor shares many natural history traits with the Burmese python and is considered a high risk for establishment and expansion throughout South Florida (Reed and Rodda 2009). SFWMD, the Miccosukee Tribe of Indians, and Miami-Dade County, the primary landowners within the Bird Drive Basin, are working with FWC to address this threat.

Figure 7-43.
The northern African python (photo by UF).

KEY MANAGEMENT ISSUES



Distribution: The northern African python is thought to occur within a 100-square kilometer area centered around the Bird Drive Basin in western Miami-Dade County, immediately east of ENP. However, extensive surveys in adjacent areas are needed to fully understand the distribution of this species. FWC continues to work with private landowners in the area to be given permission to access their land for surveys and removal. One private landowners' permission was obtained, and one was removed off those lands in February 2023.

Control Tools: Control options for this species are limited, primarily due to low detectability. Potential controls include visual searching, traps, detection dogs, scout snakes, sentinel prey, and pheromone attractants. eDNA surveys may improve detection and delineate the species' distribution. Additionally, as northern African pythons are thought to be dispersed in a relatively small area, control through habitat modification (i.e., chemical, fire, or mechanical) may be a viable option.

Monitoring: FWC and partnering agencies continue surveys in the Bird Drive Basin. A northern African python was photographed by a private citizen in 2017. Soon after, another individual was found and removed by SFWMD staff. Irula tribesmen searched the area in 2017 but did not find additional animals. Detector dogs did not locate snakes but did find points of interest. In December 2021, a citizen removed five northern African pythons from the Bird Drive Basin. FWC and partners responded by canvassing the adjacent residential neighborhood and continue to conduct additional surveys.

Interagency Coordination: There is excellent interagency coordination for this species but efforts to implement controls are constrained by limited resources and few control tools.

Regulatory Tools: The northern African python is listed as a Prohibited species per Chapter 68-5, Florida Administrative Code. In 2017, a federal court ruled USFWS could not ban interstate trade for this species.

Critical Needs: Critical needs include development of detection technologies, more funding for eDNA monitoring and enhanced removal programs (i.e., scout snakes or prey, detection dogs, habitat modification to reduce refugia, and increased understanding of movement patterns).

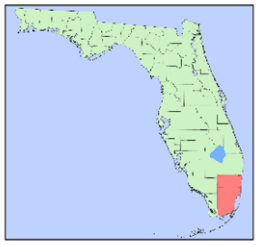
2024 Status of Northern African Python by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Spectacled Caiman (*Caiman crocodilus*)

SUMMARY: Spectacled caiman (**Figure 7-44**) from the exotic pet trade were first reported in canals at the Homestead Air Reserve Base as early as 1960 (Ellis 1980). Native to Central and South America, this secretive crocodilian can reach up to 2.4 meters total length. In Florida, spectacled caiman primarily occupies ditches, canals, and disturbed wetlands but are occasionally found in undisturbed marshes. This crocodilian feeds primarily on fish, mammals, waterbirds, and snails in its native range (Thorbjarnarson 1993). Breeding populations are documented in localized areas of Miami-Dade and Broward counties. Recent genetic analysis indicates introductions from at least two different South American regions (Parks et al. 2023)

Figure 7-44. A spectacled caiman (photo by UF).



KEY MANAGEMENT ISSUES

Distribution: Currently, the spectacled caiman's range includes parts of Miami-Dade and Monroe counties with most records located in Homestead, Florida City, along US-41 (including the northern part of ENP), and along Loop Road in BCNP. Spectacled caimans have been observed and captured in western Broward County, as well as single individuals in Palm Beach, Desoto, and Lee counties suggesting the original population may have spread northward or other introductions have occurred. A small population of caiman was recently discovered within the footprint of the Biscayne Bay Coastal Wetlands Complex. Increased freshwater flow may encourage that population to expand into Biscayne National Park, and changes to flow in the canal may lead to a similar expansion into ENP. Determining the extent that immigration or additional releases of caiman are occurring is key to assessing the potential for maximum containment of this species.

Control Tools: Spectacled caimans are controlled primarily by visual searching and removal. This is done by trained experts to ensure native crocodilians are not harmed. Efforts by FWC, SFWMD, USACE, and UF have resulted in the removal of approximately 300 caimans since 2011.

Monitoring: UF is currently in collaboration with SFWMD, USACE, and USFWS in efforts to remove caiman. Caiman observations have continually declined in all survey areas despite an increase in survey effort in 2017. Results of removal efforts suggest maximum control of caiman within survey areas indicating extirpation may be possible (Godfrey et al. 2023).

Interagency Coordination: There is excellent interagency coordination for this species but efforts to implement controls are constrained by limited resources.

Regulatory Tools: Spectacled caiman are regulated as Class II Wildlife by FWC, requiring a permit for public exhibition, sale, or personal possession.

Critical Needs: Continued efforts to monitor and remove remaining populations should continue. An understanding of the extent of potential immigration and additional release of caiman are needed.

2024 Status of Spectacled Caiman by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Gambian Pouched Rat (*Cricetomys gambianus*)

SUMMARY: The Gambian pouched rat is a large, omnivorous rodent of African origin (**Figure 7-45**). Once popular in the pet trade, the United States Center for Disease Control banned their importation in 2003 because they are a carrier of monkey pox. Prior to this ban, numerous Gambian rats escaped captivity in the Florida Keys (Grassy Key) and established a reproducing population. This species is considered likely to invade the Florida mainland and is viewed as a significant threat to endangered rodents and other fauna, agriculture, and human health (Engeman et al. 2006). These concerns prompted rapid response measures in 2005, which appeared to have been successful. In 2009, FWC biologists cautiously declared the population was eradicated while continuing periodic monitoring for the rodent. Then in 2011, the Gambian pouched rat was again reported on Grassy Key. USDA and FWC biologists reinitiated trapping efforts in early 2011 and removed 31 rats to date. The last removal and sighting occurred in 2012. Though unconfirmed, in August 2017, a picture surfaced of an American crocodile with what could be a Gambian pouched rat in its mouth.

Figure 7-45. Gambian pouched rats continue to occur in the Florida Keys despite years of trapping (photo by USDA).

KEY MANAGEMENT ISSUES

Distribution: The Gambian pouched rat has historically occurred in the Florida Keys, with breeding confirmed on Grassy Key. There is no contemporary evidence that the population has persisted but biologists remain vigilant for any credible reports.

Control Tools: Toxicant baits were effectively used to control most the population (Engeman et al. 2007). Control efforts for remaining animals involve baited traps.

Interagency Coordination: USDA, FWC, and the Florida Keys Invasive Exotic Task Force coordinate closely on early detection and rapid response efforts for this species.

Regulatory Tools: The United States Center for Disease Control banned the importation of the Gambian pouched rat in 2003. The Gambian pouched rat is listed as a Prohibited species by the State of Florida.

Critical Needs: Continued efforts to monitor and remove remaining populations should continue.

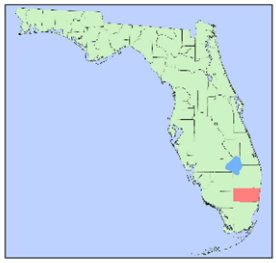
2024 Status of Gambian Pouched Rat by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Conehead Termite (*Nasutitermes corniger*)

SUMMARY: Conehead termites were first discovered in Dania Beach, Florida in 2001 (**Figure 7-46**). While control efforts were conducted previously, an official eradication program was established by FDACS in 2012. The termites, which are native to South America, Central America, and much of the Caribbean islands, have been shown to thrive in South Florida but have been kept mostly contained to a small region of Broward County by the eradication program's efforts.

Figure 7-46. Photo of conehead termite nest and inset of termite (photo by FDACS).



KEY MANAGEMENT ISSUES

Distribution: Documented spread of this species since arrival has included four cities and urban environments in Broward County. Most of the previously identified populations have been eliminated and include residential, commercial, and natural landscapes. Currently known active populations are restricted to approximately 10 acres of land near the Ft. Lauderdale/Hollywood International Airport, which include a mangrove wetland and canal edge tree habitat.

Control Tools: Control of this species is conducted with detailed visual surveys to locate all active nest sites and colonies. Treatment of a termite colony includes physical destruction of the nest and chemical termiticides. Proximity to surface water of many current populations limits chemical treatment capabilities. In some cases, nesting habitat, such as dead trees or debris piles, are removed and treated with termiticide or fumigation.

Monitoring: FDACS Conehead Termite Eradication Program conducts all current monitoring. However, outreach efforts to the general public, land managers, and local biologists extends surveillance as much as possible.

Interagency Coordination: The program is managed by FDACS but is often assisted by Broward County and/or other local biologists via volunteer workdays and events coordinated through the ECISMA network.

Regulatory Tools: Conehead termites and all *Nasutitermes sp*. are on the USDA's Regulated Plant Pest List.

Critical Needs: Additional funding to support survey efforts, treatments, and removal of nesting and foraging habitat would greatly improve overall eradication success.

2024 Status of Conehead Termite by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

ESTABLISHED INVASIVE SPECIES WITHOUT CONTROL PROGRAMS

The final group of invasive species are well established in the Everglades ecosystem and are known or presumed to exert significant negative impacts on Florida ecosystems or native species populations but are not currently the focus of active management (**Table 7-3**). Common reasons for the limited management of these species are inadequate control tools, limited resources for project implementation, and/or limited risk assessment information. Most of these species are the focus of ongoing monitoring and research to better understand their impacts to the South Florida environment or to develop control tools. While there are many other species that may warrant inclusion in this section, particularly freshwater fishes, the included species represent some of the most concerning organisms for South Florida.

Table 7-3. Priority species not currently managed within the South Florida ecosystem for geographic containment, ranked by taxonomic group and then alphabetically by common name.

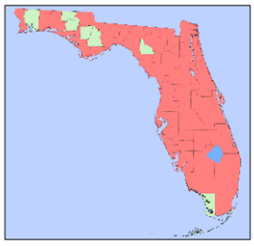
Mollusks & Planarians	**Birds**
Island apple snail (*Pomacea maculata*)	Grey-headed swamphen (*Porphyrio porphyrio*)
New Guinea flatworm (*Platydemus manokwari*)	
Insects	**Amphibians**
Laurel wilt, vectored by an ambrosia beetle (*Raffaelea lauricola*, *Xyleborus glabratus*)	Cuban treefrog (Osteopilus septentrionalis)
Mexican bromeliad weevil (*Metamasius callizona*)	
Fishes	**Reptiles**
Asian swamp eel (*Monopterus albus*)	Black Spiny-tailed Iguana (*Ctenosaura similis*)

Island Applesnail (*Pomacea maculata*)

SUMMARY: The island applesnail (**Figure 7-47**) is a large (up to 10 centimeters) South American freshwater mollusk now established in Florida. It was introduced through intentional releases from aquaria and as a food crop. Likely impacts include destruction of native vegetation, competition with native fauna, and disease transmission. The island applesnail may out compete the native applesnail, *P. paludosa*, the primary food of the endangered Everglade snail kite. Juvenile kites have difficulty handling larger island applesnails and experience lower net daily energy balances when feeding on them (Cattau et al. 2010). Also, a recently described cyanobacterium (*Aetokthonos hydrillicola*) found in the Kissimmee Chain of Lakes is associated with a lethal neurologic disease, avian vacuolar myelinopathy, which affects avifauna in the southeastern United States (Wilde et al. 2005). Research confirms island applesnail bioaccumulation of a neurotoxin produced by *A. hydrillicola* and 100% development of avian vacuolar myelinopathy in laboratory birds fed affected snails (Dodd et al. 2016), suggesting a significant risk to the snail kite and other avifauna.

Figure 7-47. The island applesnail (photo by FWC).

KEY MANAGEMENT ISSUES



Distribution: The island applesnail has been reported widely throughout Florida (Rawlings et al. 2007). It is found in most freshwater systems. Monitoring by ENP and the Miccosukee Tribe of Florida indicate this species' abundance is increasing in many canals near or within the Everglades. Initial studies conducted by researchers at the UF to determine impacts to native vegetation by applesnails suggested applesnails were feeding on and damaging Kissimmee grass *(Paspalidium geminatum)*, an important native aquatic grass (Haller et al. 2017)

Control Tools: No control tools exist with applicability in large natural areas. State and federal agencies should dedicate resources to develop control strategies.

Monitoring: State and federal monitoring programs are either limited to small geographic areas or participatory monitoring through outreach.

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.

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

2024 Status of Island Applesnail by Management Region

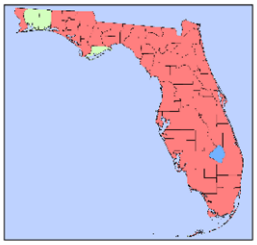
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Laurel Wilt (*Raffaelea lauricola*)

Figure 7-48. Dying red bay trees in a mixed hardwood forest (photo by UF).

SUMMARY: Laurel wilt (**Figure 7-48**) is a lethal fungal disease of red bay (*Persea borbonia*) and other members of the Laurel family (Lauraceae). The disease is caused by the fungus (*Raffaelea lauricola*) introduced into trees by the wood-boring redbay ambrosia beetle (*Xyleborus glabratus*) (Fraedrich et al. 2008). This Asian beetle was introduced into the United States via infested wood used for shipping crates with Taiwanese origin (Harrington et al. 2011, Dreaden et al. 2019). Once infected, susceptible trees rapidly succumb to the pathogen and die. The disease also impacts other members of the Lauraceae family (Hanula et al. 2009) including swamp bay (*P. palustris*), an important species of many Everglades plant communities. Since its introduction into the United States, the fungus is now vectored by several native and nonnative ambrosia beetles (Carrillo et al. 2014)

KEY MANAGEMENT ISSUES



Distribution: Laurel wilt disease is now found in every county in Florida (Ward and Riggins 2023). Since the 2010 detection of the redbay ambrosia beetle in Miami-Dade County, laurel wilt has spread across the central Everglades region (Rodgers et al. 2014) and is now throughout the Greater Everglades. Laurel wilt is also widespread throughout SFWMD's East Coast land management region and the Kissimmee River Basin.

Control Tools: There is currently no feasible method for controlling this pest or associated disease in natural areas. 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). Research to identify ambriosa beetle repellents for use in agrosystems is showing promising results (Cloonan et al. 2023)

Monitoring: State and federal agencies are monitoring the spread of laurel wilt disease through the Cooperative Agricultural Pest Survey Program. Recent monitoring studies suggest variability of red bay survivorship, with higher sapling survival and growth in proximity to mature survivors, suggesting disease tolerance in some individuals (Eicholtz et al. 2024). There is little research under way to assess ecological impacts of laurel wilt disease.

Interagency Coordination: Due to lack of feasible control strategies in natural areas there's interagency support for research into effective management options.

Regulatory Tools: The redbay ambrosia beetle is considered a plant pest.

Critical Needs: Critical research areas needed include (1) continued evaluation of *Persea* resistance, (2) *Persea* seed/germplasm conservation efforts, (3) potential chemical or biological control tools, (4) discovery of chemical attractants for *X. glabratus*, and (5) impacts on native flora, ecological processes, and native fauna such as the Palamedes swallowtail butterfly (*Papilio palamedes*).

2024 Status of Laurel Wilt by Management Region

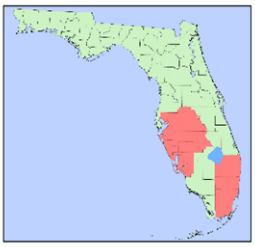
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
		not applicable				not applicable	

Asian Swamp Eel (*Monopterus albus*)

SUMMARY: Asian swamp eels (**Figure 7-49**) are versatile animals, capable of living in a broad spectrum of hydrology and salinity. They can travel over flooded land when necessary and burrow into mud to survive periods of drought. Populations in Florida likely originated as escapes or deliberate releases. The eels are generalist predators, but it is their ability to survive periods of drought that make this species unique to the large fishes of the Everglades. Since first documented in the Everglades in 2007, the species attained high abundance throughout Taylor Slough and subsequently, species known to be vulnerable to fish predators virtually disappeared from the wetlands (Pintar et al 2023a&b).

Figure 7-49. Asian swamp eel (photo by NPS).

KEY MANAGEMENT ISSUES



Distribution: During the late 1990s, three reproducing populations of Asian swamp eel were discovered in Florida (north Miami canals, Homestead, Tampa; Fuller et al. 1999; L.G. Nico, USGS, personal communication). The species was first collected in ENP and more recently has been collected throughout much of WCA-3 (Pintar et al 2023a,b) and appear to be spreading more widely across Florida (Pintar et al 2024). Recent sampling near Orlando in Orange County indicates swamp eels have a widespread distribution in Central Florida. A new species of swamp eel, *Amphipnous cuchia*, (mud eel) was recently discovered in Lake Underhill in Orange County. While currently not documented in the wild in South Florida, it is occurrence in live food markets in Florida suggest a possible vector for introduction into new areas.

Control Tools: Given the abundance and wide distribution of swamp eels in Florida's canals, eradication is probably impossible.

Monitoring: Existing long-term monitoring programs have proven invaluable to track the spread of Asian swamp eels and assess their influence in the Everglades (e.g. Pintar et al. 2023a,b). FWC monitors Asian swamp eel numbers in select urban canals through routine electrofishing sampling.

Interagency Coordination: No significant interagency coordination presently aims to manage this species. However, an interagency Swamp Eel Summit hosted by USACE will provide a venue to exchange information on swamp eel distribution and spread, brainstorm and evaluate control methods, and coordinate efforts between agencies with the goal of mitigating the ecological and economic impacts of swamp eels. The USACE funded literature review is currently in progress.

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

Critical Needs: Maintaining long-term quantitative monitoring to evaluate distribution and impacts; research to determine potential species' impacts and spread; research and development of control techniques; and increased collaboration with CERP planners to integrate prevention measures.

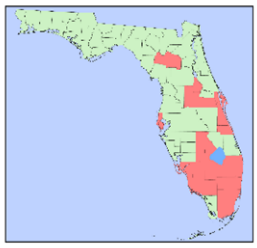
2024 Status of Asian Swamp Eel by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Grey-headed Swamphen (*Porphyrio porphyrio*)

SUMMARY: The grey-headed swamphen (**Figure 7-50**) is a rail native to Australia, Europe, Africa, and Asia. Its introduction was likely due to escapes from the Miami Zoo and private aviculturists in Broward County. This invasive rail feeds on shoots and reeds, invertebrates, small mollusks, fish, snakes, and waterfowl eggs and young (Pranty et al. 2000). Highly aggressive and territorial, the grey-headed swamphen could impact native waterbirds through competition, destruction of habitat, and direct predation. 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 monitoring (Hardin et al. 2011) and preventing spread or establishment in new areas through EDRR.

Figure 7-50. The grey-headed swamphen (photo by SFWMD).



KEY MANAGEMENT ISSUES

Distribution: The original Florida grey-headed swamphen population is believed to have established in Pembroke Pines in 1996 (Hardin et al. 2011). Grey-headed swamphens are established in the WCAs, Lake Okeechobee, and in all Everglades STAs and continue to expand into wetlands to the north and west.

Control Tools: Previous efforts to remove birds by hunting did not significantly deplete the population (Hardin et al. 2011). No other control tools are currently developed for this species. There are currently no control efforts in place within known established areas, but FWC coordinates rapid response to sightings in new areas to prevent spread and establishment of new populations.

Monitoring: Agencies rely on reports from the public and agency personnel to track the spread of this species.

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 this species and eradication is no longer considered feasible. FWC staff have removed over 3,000 grey-headed swamphens to date, mostly from Lake Okeechobee, STAs, and WCA-2B (Johnson and McGarrity 2009, Hardin et al. 2011). Florida Atlantic University scientists studied habitat use and diets of grey-headed swamphens to assess impacts this species may have on the Greater Everglades ecosystem (Callaghan and Gawlik 2016)

Regulatory Tools: There are currently no regulations that prohibit import or possession of this species in Florida. Regulations to restrict possession of this species would help avoid new releases.

Critical Needs: Additional monitoring to assess population expansion; additional information on impacts of this species on native species; and regulations to restrict possession of this species are needed.

2024 Status of Grey-headed Swamphen by Management Region

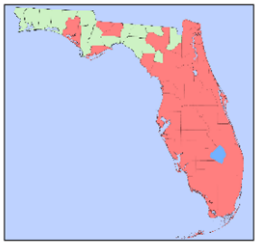
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Cuban Treefrog (*Osteopilus septentrionalis*)

SUMMARY: The Cuban treefrog (**Figure 7-51**) is native to Cuba, the Cayman Islands, and the Bahamas. It was first reported in Florida in the 1920s and was likely transported in cargo or ornamental plant shipments. Cuban treefrogs consume a variety of invertebrates and native treefrog species (Maskell et al. 2003). Native green (*Hyla cinerea*) and squirrel (*Hyla squirella*) tree frogs are less likely to be found when Cuban treefrogs are present (Waddle et al. 2010), and when Cuban treefrogs are removed from an area, the abundance of native treefrogs increases (Rice et al. 2011). Recent work has shown snakes that consume Cuban tree frogs endure a cost to fitness as Cuban tree frogs contain a noxious chemical that can hinder growth and exert energetic costs for digestion in snakes consuming this species relative to native tree frogs (Goetz et al. 2018). Additionally, Cuban treefrog populations in Florida are hosts to rat lungworm, a parasitic nematode capable of infecting humans and animals with a deadly disease (Chase et al. 2022). Given the Cuban treefrog's wide distribution and habitat tolerances, mounting evidence of direct impacts to native species, and the lack of management programs, the status of this species is red in all management regions.

Figure 7-51. The Cuban treefrog is now widely dispersed throughout Florida (photo by UF).

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, mangrove forests, and swamps. In urban and suburban settings, they are most 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 2017).

Control Tools: There are currently no agency-sponsored, coordinated control efforts for the Cuban treefrog in South Florida. Polyvinyl chloride (PVC) pipes are frequently used by many treefrog species and Cuban treefrogs may be detected and removed by using them.

Monitoring: SFWMD and UF continue to monitor Cuban treefrogs and other priority invasive animals in the Everglades via EIRAMP. This species is found on all survey routes and are the second most frequently encountered invasive amphibian. In addition, UF maintains a small monitoring and outreach program, but state and federal agencies need to assist with coordinating a statewide program.

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 on the severity of impacts and development of control techniques are needed.

2024 Status of the Cuban Treefrog by Management Region

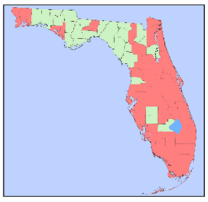
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

New Guinea Flatworms (*Platydemus manokwari*)

SUMMARY: The New Guinea flatworm (NGF; *Platydemus manokwari*) belongs to the Phylum Platyhelminthes, specifically to the subgroup of land planarians (family Geoplanidae) (**Figure 7-52**). This species is a predator of snails, slugs, insects, annelids, and other invertebrate prey, occasionally also being scavengers. Its main prey consists of different species of snails, including tree snails. The impact of this species on endemic tree snails in Pacific Islands is severe, making this animal one of the 100 worst invasive species in the world (Global Invasive Species Database 2023), and this impact is now negatively affecting the native tree snail community in South Florida. Floridian native tree snail species such as *Liguus fasciatus* and *Orthalicus floridensis* are readily consumed by this species. Its presence in tropical hardwood hammocks in the Miami Rock Ridge in southeast Florida is negatively affecting populations of these unique Floridian tree snails (Lopez et al. in review).

Figure 7-52. New Guinea flatworm (Photo by Lawrence Lopez).

KEY MANAGEMENT ISSUES



Distribution: From North Florida to the Florida Keys, the NGF has been observed in a number Florida cities as well as non-urban areas. It is found in yards, gardens, nurseries, parks, and tropical hardwood hammock habitat. Its distribution appears to be determined by the availability of humid environments and its expansion into wilderness areas, such as into BCNP and ENP appears to be happening gradually. Cold and dry environments may be acting as deterrents to its geographic spread.

Control Tools: No control tools are currently approved for NGF. Testing of control measures are necessary to mitigate their population growth and spread. Killing of the NGF by using hot water (43 to 50 degrees Celsius) could be used to treat potted plants that could carry this species.

Monitoring: Monitoring is essential in understanding the population and seasonal dynamics of this species. FWC (Florida Keys) and FDEP (Dagny Johnson and John Pennekamp state parks) monitor this species with the use of ground boards. Also, Florida International University (FIU) researchers have found this species follows annual seasonal cycles, being more common during the wet or rainy season and less common during the dry season. Monitoring activities need to be implemented across Florida.

Interagency Coordination: FWC and NPS have committed grant funding to the study of the NGF and their impact on tree snails. Results from research conducted by FIU have found that this flatworm species has established populations in tropical hardwood hammocks in the Miami Rock Ridge area and is causing ecological problems especially on native tree snail communities (Lopez et al. in review).

Regulatory Tools: Currently, there are no regulatory tools to control NGF. Regulations should be applied to the plant trade, which could prove helpful to limit the spread of this species into new areas in Florida.

Critical Needs: This species needs further research in terms of its invasive biology and experimentation for the ways by which populations of this species could be controlled. The impact of the NGF to native species of tree snails has been observed by FIU researchers (Lopez et al. in review), prompting the need to implement control measures for this invasive species.

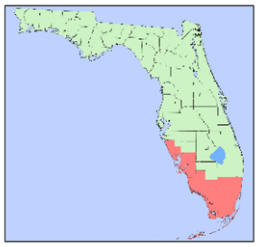
2024 Status of New Guinea Flatworm by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Black Spiny-tailed Iguana (*Ctenosaura similis*)

SUMMARY: The Black Spiny-tailed Iguana (**Figure 7-53**) is native Mexico and Central America and was first reported in Florida in 1979. Black spiny-tailed iguana's generalist diet includes vegetation as well as variety of invertebrate and vertebrate species, including Gopher tortoises (Fitch and Hackforth-Jones 1983, Avery et al. 2009). Like the green iguana, it has adapted to human-altered habitats throughout South Florida. They are known to burrow into earthy and rocky banks, rock crevices, and man-made structures, which raises concerns for impacts to SFWMD infrastructure. The increasing spread of black spiny-tailed iguana's across South Florida emphasizes the necessity to develop and implement management strategies, potentially in tandem with green iguana management.

Figure 7-53. Black spiny-tailed iguana (photo by Jenna Cole).



KEY MANAGEMENT ISSUES

Distribution: Black spiny-tailed iguanas inhabit mostly human-modified habitats throughout most of South Florida. They are most frequently sighted in urban areas around homes and buildings and can be seen along human-modified waterways. They also occur in agricultural settings where they can take advantage of ornamental plants nurseries and crops (Fitch and Henderson 1978, Krysko et al. 2003, Avery et al. 2014).

Control Tools: There are currently no agency-sponsored, coordinated control efforts for black spiny-tailed iguanas in South Florida. Removal options include manual removal, firearms, and trapping. There are iguana control companies in operation who will also remove black spiny-tailed iguanas**.**

Monitoring: The UF EIRAMP program monitors black spiny-tailed iguanas throughout the Greater Everglades. Most metropolitan monitoring is through reports from the public.

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 on the severity of economic and ecological impacts and development of management plan is needed.

2024 Status of the Black Spiny-tailed Iguana by Management Region

Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

FUTURE NEEDS IN MANAGEMENT AND CONTROL

The elements of a comprehensive management program for some invasive plant species—legislation, coordination, planning, research, education, training, and funding—have been in place in Florida for many years. Most plants identified in this chapter as priority species are being managed on public lands by local, state, or federal agencies. This is not true for many invasive animal species, though significant strides have been made in this area in recent years. The threat of invasive animals has become an important ecological and restoration issue for many agencies in Florida. Meaningful legislation to significantly limit establishment of new nonnative species, continued funding for control programs, and coordination at all levels are needed for a comprehensive invasive animal management program for Florida. The Florida Melaleuca Control Plan (Laroche 1999), Invasive Exotic Species Strategic Action Framework (SFERTF 2020), and the Florida Python Control Plan (FWC et al. 2021) are all excellent examples of the coordination required to effectively address invasive species in the restoration footprint. The number of invasive species 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 invasive organisms in South Florida, scientists are obliged to factor these species and their impacts into restoration planning and models. Continued research is needed to understand the distribution, biology, and impacts of these invasive organisms. Controlling and managing invasive organisms in an all-taxa approach is a relatively new concept, even among ecologists, but it is emerging as an important field of science given global trade and insufficient regulatory controls. 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 nonnative 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 nonnative plant and animal species are needed before their introduction.

Species like the Argentine black and white tegu in the Everglades and Gambian pouched rat in the Florida Keys illustrate the need for agencies to act quickly to contain and attempt to eradicate animals that have the potential to become widespread and difficult to control. While definitive research is lacking to support the immediate management of many 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 "toolbox" for nonnative 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 (Springborn et al. 2011).

The use of an EDRR program increases the likelihood invasions will be controlled while the species is still localized, and population levels are so low 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. Implementing an EDRR program is typically much less expensive than a long-term 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. Prompt cooperative action has been successful to eliminate or locally contain emerging populations of sacred ibis and the invasive mangrove species *Lumnitzera racemosa*. These EDRR efforts may have prevented widespread ecological harm by these new invaders and

saved significant public resources required to manage more widespread invasions. Biological risk assessments are being developed to enable agencies to determine which species are most likely to become problems (Gordon et al. 2006, Simons and De Poorter 2009, Springborn et al. 2011). 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 CISMAs and the SFERTF are attempting to initiate additional EDRR efforts.

An overarching theme in this chapter is describing the alarming extent and impacts of some invasive species and stating the need for increased coordination and control. While these observations are valid, control efforts against certain invasive species have proven successful and demonstrate 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 SFWMD-led melaleuca management program has been implemented for over 20 years and the plant is now under maintenance control on Lake Okeechobee and in most of the Greater Everglades. The success of this 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.

For the invasive species already widely established, long-term commitments to integrated control programs are the only feasible means of containing and reversing impacts. Effective management of other 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, like that used for the management of melaleuca, if Everglades restoration is to be successful. Further, many biological invasions are likely to be permanent and may easily reestablish dominance if maintenance and control management is not sustained. For this reason, policymakers, regulators, scientists, and land managers should focus on preventing importation of potentially invasive species through improved regulatory programs and regional monitoring programs.

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