Chapter 7: Status of Invasive Species

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HIGHLIGHTS

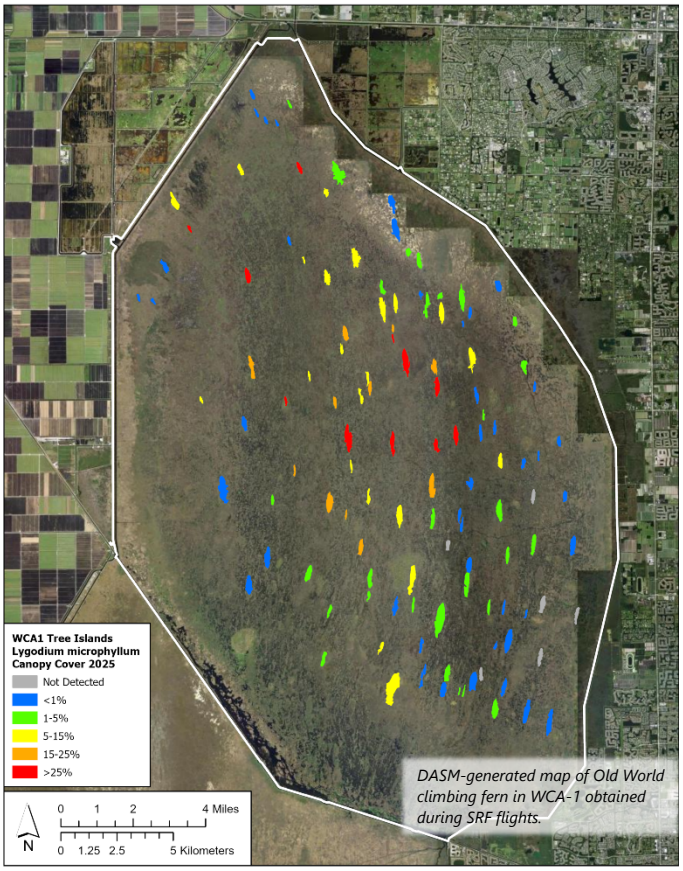
Quite a few accomplishments related to invasive species were made just prior to or during Fiscal Year 2025 (October 1, 2024–September 30, 2025). Several are highlighted here.

INVASIVE PLANT MANAGEMENT OF WCA-1 TREE ISLANDS

The most prolific and damaging invasive plant species within Water Conservation Area (WCA) 1 are melaleuca and Old World climbing fern. Progress was made towards Old World climbing fern control on tree islands of WCA-1. Monitoring (see next section) reveals promising trends in reducing the level of infestation on vulnerable tree islands. There have been significant reductions in heavy infestations and sustained control following initial treatments. In addition, dense melaleuca is also trending down on many tree islands.

INVASIVE PLANT MONITORING OF WCA-1

the South Florida Water Management District (SFWMD) has established a monitoring protocol to assess invasive plant species across geographically large areas within WCA-1 in a timely and cost-effective manner. Systematic reconnaissance flights (SRF) are conducted utilizing digital aerial sketch mapping (DASM) to determine distribution and abundance of priorty species. The monitoring program is allowing for informed decision making on control efforts.



DASM-generated map of Old World climbing fern in WCA-1 obtained during SRF flights.

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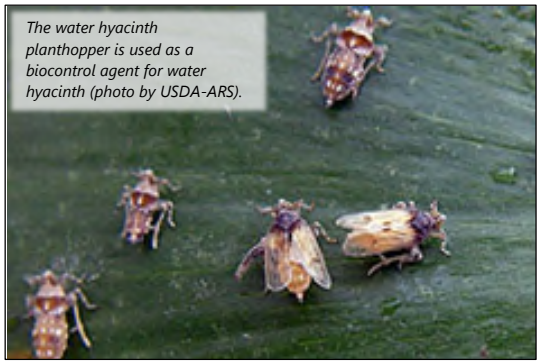
INUNDATIVE RELEASES OF BIOCONTROL AGENTS OF WATER HYACINTH



The water hyacinth planthopper is used as a biocontrol agent for water hyacinth (photo by USDA-ARS).

Typically, the use of biocontrol agents involve one initial mass release to encourage establishment, after which time agents are left to reproduce in the field without frequent additional releases. This can be effective but, in many cases, and particularly for invasive aquatic plants, plant growth rates are high and achieving maintenance control through biological control can be challenging. To counteract this challenge, inundative releases of insects can be conducted to create a strong top-down force, but this requires the production of large numbers of insects to be released frequently. To achieve maintenance control of water hyacinth populations, mass rearing and inundative releases of the water hyacinth planthopper were conducted at a site near Indiantown, Florida. Water hyacinth coverage in the nearby Allapattah area was reduced from 95% water body coverage in July 2024 to less than 5% water body coverage in January 2025. There is now the potential for decreased herbicides in areas populated by this and other water hyacinth biocontrol agents.

PICAYUNE STRAND INVASIVE FISH PROJECT

The United States Army Corps of Engineers (USACE) in partnership with the Florida Fish and Wildlife Conservation Commission (FWC) surveyed fish for biodiversity in each canal system within the Picayune Strand Restoration Project footprint in spring 2025. An overwhelming majority of fish in the canals were invasive fish species (ranging between 79 and 86%). All invasives caught during the survey were removed and restocking with native fish will occur as soon as water levels within the area decrease enough to gain access to the canals. The two most abundant fish species found were the invasive sailfin catfish and tilapia.

Sailfin catfishes (photo by University of Florida).

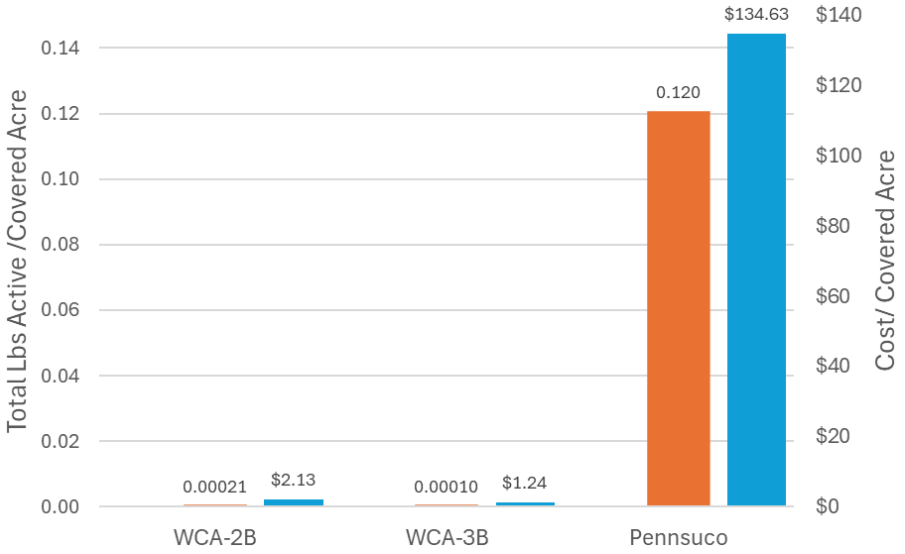
HERBICIDE REDUCTION THROUGH MAINTENANCE CONTROL: LAKE OKEECHOBEE HISTORY OF FLOATING AQUATIC VEGETATION MAINTENANCE CONTROL PROGRAM

The program controlling invasive floating plants on Lake Okeechobee is an example of long-term maintenance success if the control program progresses uninterupted. Maintenance control of these plants on the lake was paused for three months in 2019 and the unintended consequence was the quick rebound of invasive plants. The observed acres of invasive floating vegetation increased to over 11,000 acres due to the pause. Since then, there has been a successful return to maintenance control but with temporary increased use of herbicides and elevated costs. Less than 2,000 acres remained infested in 2024.

MELALEUCA MAINTENANCE CONTROL PROGRAM

Melaleuca is a fast-growing invasive tree from Australia that was widely planted across South Florida. By the 1990s, it had infested nearly 500,000 acres, including major wetlands such as the WCAs, Big Cypress National Preserve, and Everglades National Park. The successful maintenance control program within WCA-2 and WCA-3 led to restored native marsh habitat previously dominated by melaleuca. Current infestation covers less than 1% of the more than 120,000 acres within these areas. The sustained efforts to systematically remove dense infestations in these areas while preventing reinfestations through diligent monitoring and follow up treatments has resulted in significant reductions in the management costs and herbicide utilization. By contrast, the 4,867-acre Pennsuco Wetlands site, located east of WCA-3B, has not achieved maintenance-level

control and still has 97.7 acres of dense infestation requiring far higher herbicide use. The figure below compares the amounts of herbicides used and the cost of this use per acre between WCA-2B, WCA-3B, and the Pennsuco Wetlands site.



Comparison of per acre herbicide use and control costs for melaleuca management in two areas under maintenance control (WCA-2B and WCA-3B) and an initial melaleuca treatment in the Pennsuco Wetlands area.

NEW RESEARCH PUBLISHED IN 2024 AND 2025

Quite a few new publications containing important information related to invasive species in Florida became available during 2024 and 2025. These publications are as follows:

Ecological Impacts, Trophic Disruption

- Big pythons, big gape, and big prey (Jayne 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)
- State of knowledge for invasive green iguanas in Florida reveals negative impacts and pervasive research needs (Claunch et al. 2025)
- Trophic disruption by an invasive species linked to altered energy fluxes (Flood et al. 2025)
- Diet of spectacled caimans (*Caiman crocodilus*) removed from Broward and Miami-Dade counties, Florida, USA (Godfrey et al. 2025)
- Management of invasive iguanas mitigates deleterious impacts on an imperiled tortoise (McKnight et al. 2025)
- Invasive swamp eels reduce aquatic animal diversity and disproportionately reduce prey for nesting wading birds (Pintar and Dorn 2025)

Distribution, Spread and Invasion History

- Nile monitor distribution models to aid regional mitigation efforts (Bevan et al. 2024)
- Not one but two: Examining the genetic origin and characterization of the non-native spectacled caiman (*Caiman crocodilus*) in Florida (Parks et al. 2024)
- Asian swamp eels (Synbranchidae, Monopterus) in Florida: Distribution, spread and range of hydrologic tolerance over twenty-seven years (1997–2023) (Pintar et al. 2024)
- Flooding-induced failure of an invasive Burmese python nest in southern Florida (Sandfoss et al. 2024)
- Assessing the effects of climate change on the current and future global distribution of three tegu species using an optimized model (Fontanella 2025)

Monitoring and Survey Optimization

- Mammalian lures monitored with time-lapse cameras increase detection of pythons and other snakes (McCampbell et al. 2024)
- 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)
- Optimizing survey conditions for Burmese python detection and removal using community science data (McCaffrey et al. 2025)
- Using camera traps to estimate site occupancy of invasive Argentine black and white tegus (*Salvator merianae*) in South Florida (Smith et al. 2024)

Invasive Plant Management

- Two potential candidates for biological control of cogongrass in quarantine (Gazdick et al. 2024)
- Selective method for invasive plant removal enhances restoration (Hinkson et al 2024)
- Improving mass-rearing techniques for releases of *Floracarus perrepae*, a biological control agent for Old World climbing fern (Aquino-Thomas et al. 2025a)
- Post-release support of host range prediction of two *Lygodium microphyllum* biological control agents. (Aquino-Thomas et al. 2025b)
- Vertical distribution of *Floracarus perrepae* (Acariformes: Eriophyidae) galls on the invasive fern *Lygodium microphyllum* (Schizeales: Lygodiaceae) and a potential productivity-reproduction tradeoff (Aquino-Thomas et al. 2025c)
- An evaluation of reduced hack and squirt treatment with aminocyclopyrachlor and aminopyralid for invasive tree control in Florida (Enloe et al. 2025)

Public Outreach

- Employing targeted outreach to improve community involvement in detecting invasive Nile monitors (*Varanus niloticus*) in Florida (Mazzotti et al. 2024)

www.sfwmd.gov/our-work/vegetation

SUMMARY AND INTRODUCTION

Invasive species pose serious threats 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). Effective invasive species management also supports other strategic goals, as their widespread impacts must be addressed in numerous SFWMD activities—including Environmental Resource Permit evaluations, Everglades Stormwater Treatment Area (STA) operations, and restoration of 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. Authors from numerous partnering agencies and institutions provide 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 data are lacking for some invasive species, 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 2025 (FY2025; October 1, 2024–September 30, 2025).

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 participate on collaborative working groups focused on invasive species management including the Lake Okeechobee Interagency Aquatic Plant Management Team, South Florida Ecosystem Restoration Task Force (SFERTF), Florida Invasive Species Council (FISC), Florida Python Control Plan (FPCP) Working Group, regional cooperative invasive species management areas (CISMAs), and other cross-jurisdictional teams. These 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: Broward County, Collier County, Miami-Dade County, Monroe County Land Authority, Palm Beach County, Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Agriculture and Consumer Services (FDACS), Florida Fish and Wildlife Research Institute (FWRI), Miccosukee Tribe of Indians of Florida, 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 (SFWMD and USACE 2012). 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 60 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, 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), tropical American watergrass (*Luziola subintegra*), and crested floating heart (*Nymphoides cristata*) 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 FY2025, 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 4,000 release events resulting in the release of nearly 80 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. The Invasive Species Prioritization Tool can be found at https://www.evergladesrestoration.gov/ist.

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, 2025, the two programs have resulted in the removal of 18,203 Burmese pythons.

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 FY2025, 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 FY2025 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. SFWMD only utilizes non-restricted use (or general use) herbicides that have been determined by the United States Environmental Protection Agency (USEPA) to pose minimal risk to humans and animals

and are available to the general public. SFWMD requires all herbicide applications be applied under the supervision of an FDACS certified pesticide applicator. 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. Floating and submerged aquatic plants are controlled using several herbicides with 2,4-D, diquat, florpyrauxifen, 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, management costs, and reduced impacts to native vegetation (Enloe et al. 2025, Oberweger et al. 2025).

- 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 such as when native species are co-mingled with target species and precision with hand removal is necessary or when target species are in estuarine environments unsuitable for chemical control. At times, the entire removal of invasive plant biomass is necessary to achieve restoration or management objectives. Special consideration of the appropriate use of these tools must be taken as large equipment used in mechanical control can have long-term negative impacts such as soil disturbance and nutrient mobilization, as well as unintended consequences such as bycatch of wildlife in aquatic systems.
- 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 but consideration of the desired natural community and alignment with optimal hydroperiods must be taken to ensure the ecosystem maintains functionality. Manipulating hydroperiods so they mimic natural conditions in conjunction with other control tools can decrease reliance on any one control tool. 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. 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 (Reed et al. 2010).
- **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 due to the introduction of biocontrol agents (Vincent et al. 2025).
- **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 (Jacoblinnert et al. 2022).

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 FISC 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.

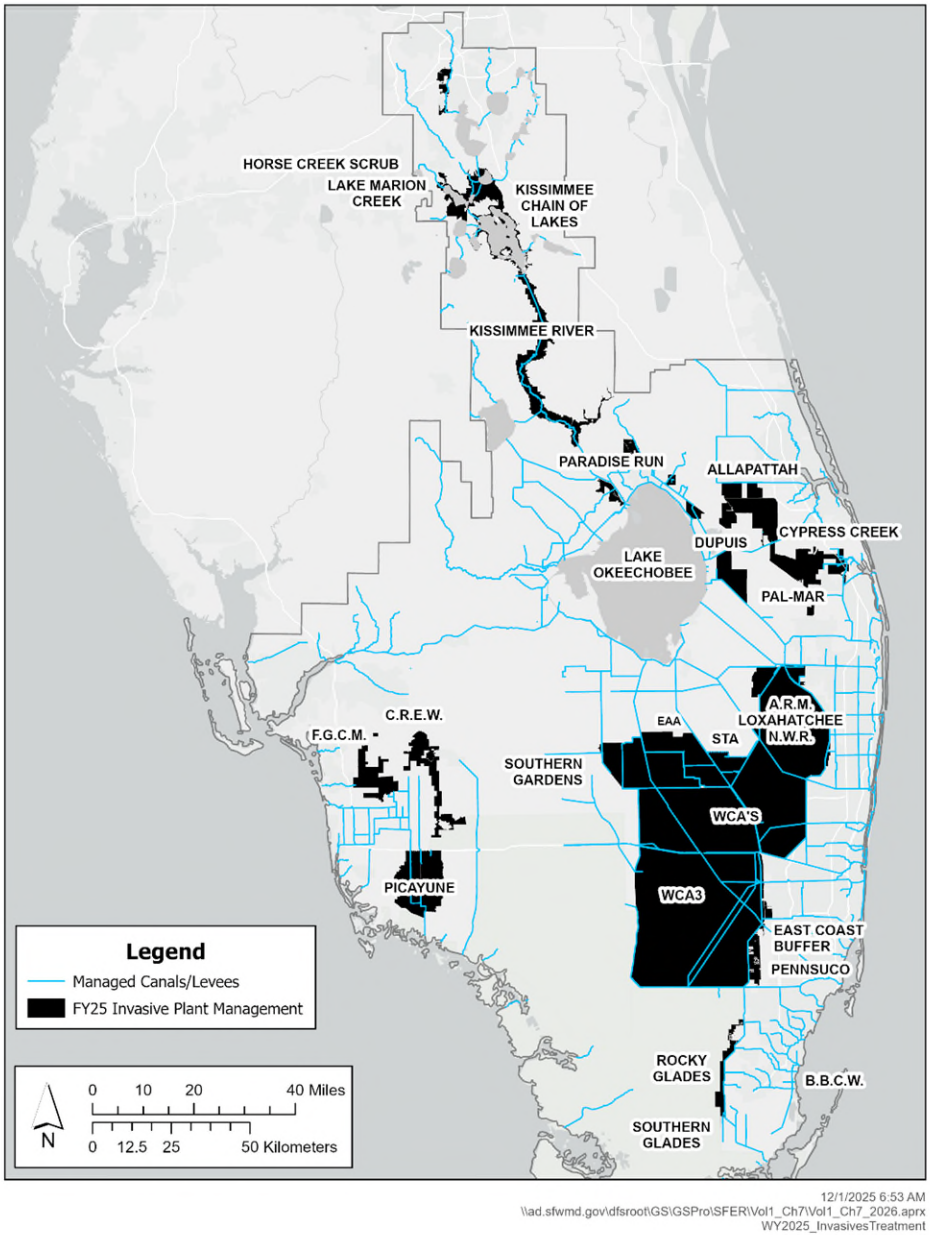


Figure 7-1. SFWMD-managed (or co-managed) lands and canals/levees where invasive plant control is routinely conducted. Black polygons indicate lands where invasive plant control occurred in FY2025. Nearly all canal/levee areas are subject to vegetation management each year, including control of priority 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 FISC (formerly the Florida Exotic Pest Plant Council) as Category I species (FISC 2025). 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 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.

Biological Control of Invasive Plant Species

Most nonnative plant species arrive in Florida without their co-evolved natural enemies, which facilitates the plants' larger growth, higher reproduction, and rapid spread (Keane and Crawley 2002, Liu et al. 2007). 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. Quarantine studies conducted both overseas and in the United States 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. Classical biological control has had very few cases of known nontarget attack of released biological control agents and of these known cases of nontarget attack their significance has been documented to be minor or minimal. Presently, cases of nontarget attack continue to decline with scientific advances and rigorous approval procedures (Hinz et al 2019, Suckling and Sforza 2014). Despite these hurdles, biological control research and implementation has led to the transformation of formerly intractable weeds into less invasive forms.

Brazilian Peppertree

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

Mass rearing and field releases of the Brazilian peppertree thrips (*Pseudophilothrips ichini*; (**Figure 7-2**) biological control agent began in May 2019. The thrips is being distributed throughout the Brazilian peppertree (*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 1.6 million thrips have been released since the project's inception, of which roughly 194,000 were released during FY2025 as of July 2025. 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 peppertree 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 kilometers (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 peppertree fruit and flower viability (Nestle et al. 2023). Trials have been completed testing methods of increasing mass production of thrips to increase the number of releases (Wheeler et al. 2024). A gall-inducing fungus that could impede Brazilian Peppertree growth is being researched for implementation in addition to thrips control (Halbritter et al. 2024).

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 first melaleuca (*Melaleuca quinquenervia*) biocontrol agent, the weevil *Oxyops vitiosa*, was introduced in 1997 and quickly established 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 *Boreioglycaspis melaleucae* 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.

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

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. Over 3.5 million moths have been released since the project's inception. 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, with additional sites showing 40 to 81% of leaflets with galls (Aquino-Thomas et al. 2025c). Furthermore, the mite can quickly colonize Old World climbing fern regrowth following prescribed burns and herbicide applications (David et al. 2020, 2021). Mass-rearing techniques were improved in recent years (Aquino-Thomas et al. 2025a) leading to field releases of millions of mites each year, with nearly 13 million in FY2025 alone and a total of over 71 million released since the project's inception. A recent survey showed none of the 13 native ferns occuring in close proximity to heavily damaged lygodium showed evidence of mite or moth damage, confirming the fidelity of these insects (Aquino-Thomas et al. 2025b). 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.

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. A more heat tolerant genotype of this planthopper was imported from South Africa during FY2025 with releases scheduled to begin towards the end of the year. 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 nearly 80 million insects and mites (**Figure 7-6**) during more than 4,000 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.*

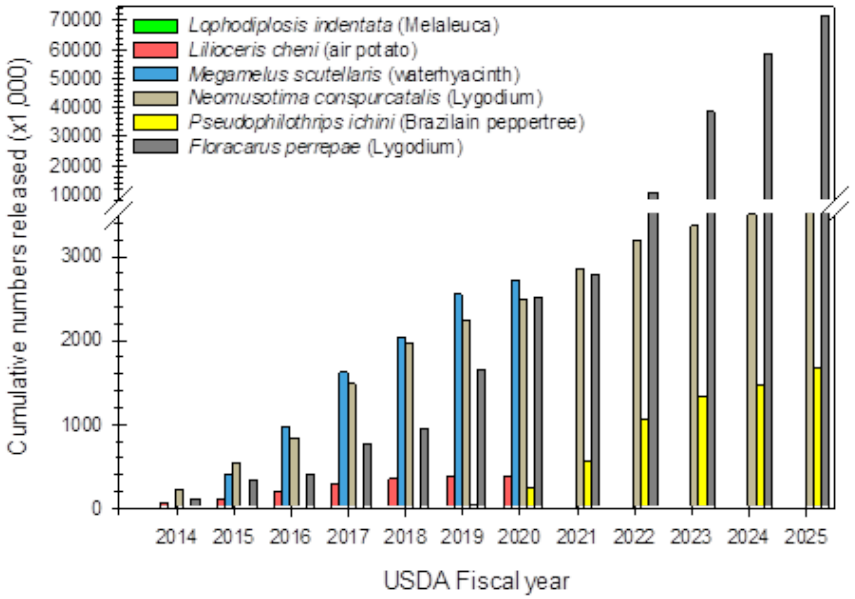


Figure 7-6. Cumulative numbers of biological control agents released between December 2013 and July 2025 within CERP project footprints.

Update on Invasive Plant Management of Water Conservation Area 1 Tree Islands

Despite decades of invasive plant management in the Everglades, significant infestations of priority invasive species persist within Water Conservation Area (WCA) 1, a major component of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR). To meet the growing challenge, beginning in 2014, SFWMD, FWC, and USFWS have collaborated to increase control efforts in WCA-1 and, in 2018, SFWMD and USFWS entered into a new license agreement for the USFWS to manage WCA-1 as part of LNWR. In the new agreement, SFWMD will take the lead role in invasive plant management and has completed a five-year strategic plan to complete all initial treatments in WCA-1. USFWS is to provide SFWMD with at least $1.25 million annually for invasive plant management. FWC continues to support this initiative with additional funding each fiscal year.

WCA-1 is a 58,275-hectare (ha) wetland landscape characterized by a matrix of peat-based bayheads (tree islands) and freshwater marsh (sawgrass marsh, slough, and wet prairie). This area represents the northernmost extent of the historic Everglades. The most prolific and damaging invasive plant species within WCA-1 are melaleuca and Old World climbing fern. Initial treatments of these two species have been conducted in many portions of WCA-1, and some areas have received multiple treatments. In the north central portion of WCA-1, a large portion of marsh contains moderate to high density stands of melaleuca that have yet to be initially treated. Large-scale aerial treatments of dense Old World climbing fern were carried out in 2007, 2008, 2013, 2015, 2017, 2023, 2024, and 2025. However, an abundance of suitable habitat and limited resources for control have resulted in a significant expansion of Old World climbing fern throughout WCA-1 over the last two decades.

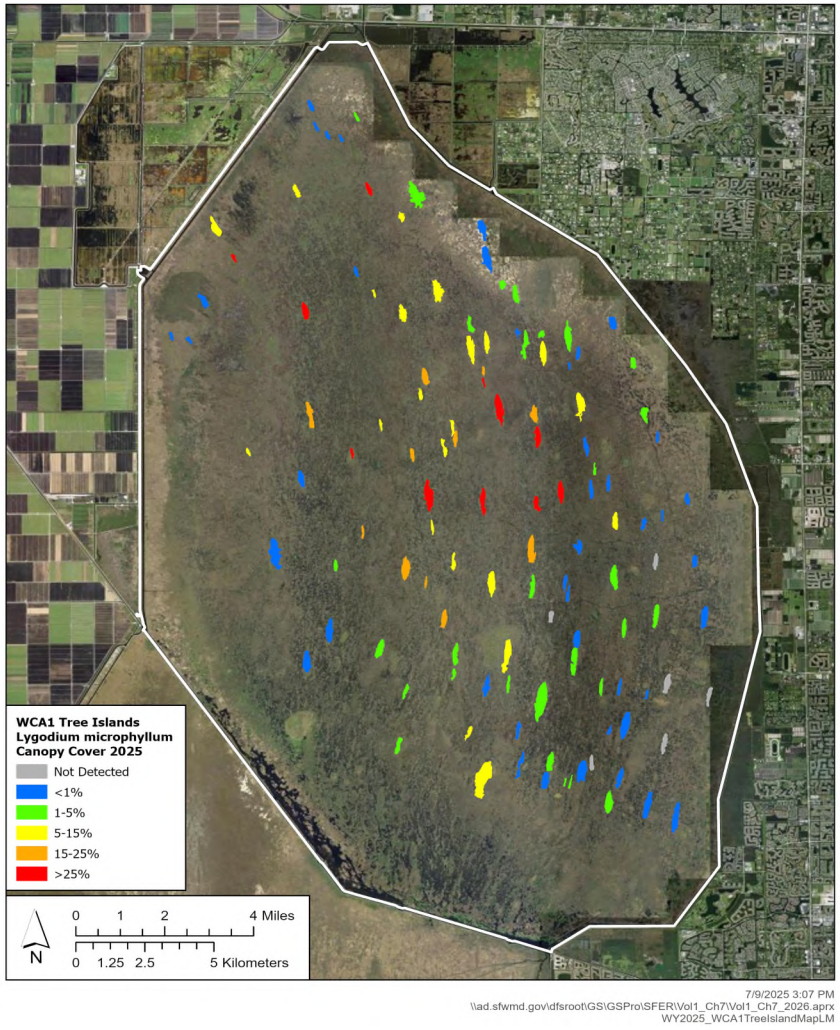
Invasive plant monitoring is an important component of SFWMD's focused efforts within WCA-1. SFWMD utilizes digital aerial sketch mapping (DASM) to determine distribution and abundance of priority plant species across geographically large areas in a timely and cost-effective manner. The DASM approach, which utilizes global positioning system (GPS)-linked tablet computers and specialized software, allows trained biologists to rapidly collect spatial data for invasive plant infestations during aerial reconnaissance flights (see Rodgers et al. 2014c for detailed descriptions of the DASM methodology). SFWMD and NPS have utilized this monitoring technique to meet multiple monitoring objectives within the Everglades restoration footprint since 2008, including landscape-level distribution and abundance assessments, detailed mapping to assist land managers with control strategies, and early detection of new infestations (Rodgers et al. 2018).

SFWMD has an established monitoring protocol —systematic reconnaissance flights (SRF)—to assess landscape-level changes in distribution and abundance of priority invasive species within WCA-1 but this protocol does not provide information about detailed infestation data for tree island plant communities. Tree islands provide critical wildlife habitat within WCA-1 (Brandt et al. 2002) and have an important mechanistic role in Everglades biogeochemical cycling (Wetzel et al. 2017). Unfortunately, ecologically important plant communities are extremely vulnerable to invasive plant species, particularly Old World climbing fern. As such, SFWMD's invasive plant management strategy requires more detailed, fine-scale distribution and abundance information specifically for tree islands. Small tree islands are easily surveyed from the ground, but large strand islands are more efficiently monitored from the air. To provide higher resolution spatial data for these larger tree islands, a 100-meter (m) grid was overlaid on all WCA-1 tree islands greater than 3.2 ha. The abundance of invasive, nonnative plants was recorded for each 100-m grid cell using the DASM technique during January, February, and March 2024. Mean aerial cover of each invasive species was calculated for each island. In addition, each island was assigned one of three canopy conditions: intact, moderately impaired, or impaired. The criteria for canopy condition included density of native canopy species and apparent health of canopy species (e.g., fire damage, laurel wilt disease, and non-target herbicide damage from past aerial treatments).

Mean Old World climbing fern canopy cover in 2025 ranged from 0 to 40.3% across the 125 tree islands surveyed. Eleven tree islands had cover exceeding 25%, representing a 54% decrease since 2019 (**Figure 7-7**). In contrast, the number of tree islands with low-level infestations (< 5% cover) increased by 119% from 2019 to 2025. Notably, 90% of the tree islands with < 5% Old World climbing fern cover in 2022 remained below this threshold in 2025, suggesting that follow-up treatments are effectively maintaining control. The total canopy area of Old World climbing fern declined from 271 ha in 2019 to 123.1 ha in 2022, and further to 112 ha in 2025. This reduction reflects an initial emphasis on treating the most vulnerable tree islands between 2019 and 2022, followed by a shift to maintenance retreatments from 2022 to 2025.

Mean melaleuca canopy cover on tree islands ranged from 0 to 40.2% in 2025. Only two tree islands had cover exceeding 25%, a 50% reduction from 2019 (**Figure 7-8**). The number of tree islands with melaleuca cover below 5% increased modestly by 20% during the same period. Melaleuca canopy area declined from 67.1 ha in 2019 to 38.1 ha in 2022 but increased to 50.1 ha in 2025. This uptick is attributed to continued melaleuca growth on three large, untreated tree islands.

Brazilian pepper remained relatively uncommon, with mean canopy cover ranging from 0 to 2.4% in 2025. It was detected on 32 of the 125 tree islands assessed (**Figure 7-9**). The combined canopy area of Brazilian pepper on large strand islands increased from 3 ha in 2019 to 4.3 ha in 2025. While still limited in extent, the upward trend is cause for concern. As a prolific colonizer of disturbed areas, Brazilian pepper may exploit canopy gaps created by melaleuca and Old World climbing fern removal. SFWMD biologists will continue to monitor its spread and respond as needed to prevent further expansion.



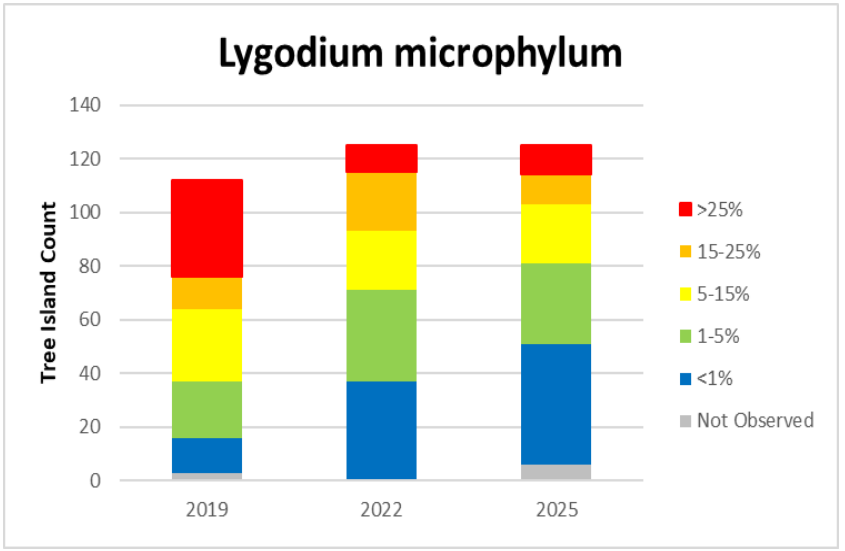
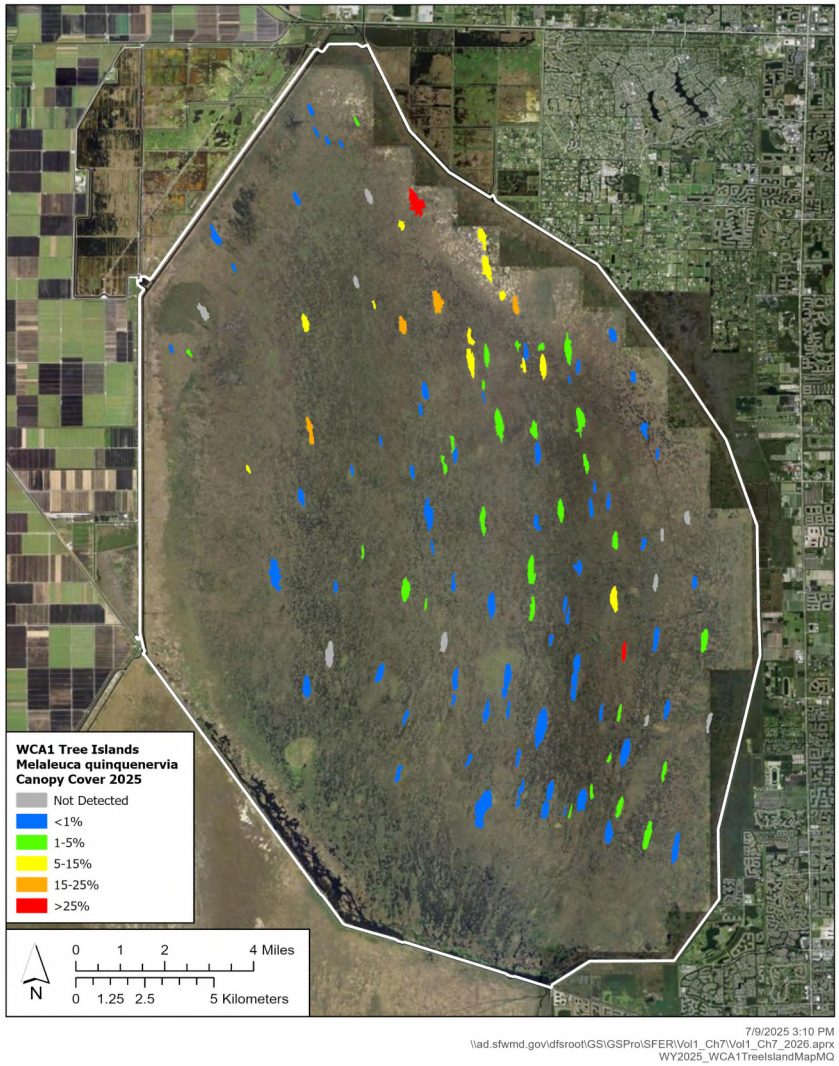


Figure 7-7. Distribution and frequency of Old World climbing fern (*Lygodium microphyllum*) on WCA-1 tree islands ranked by mean canopy cover.



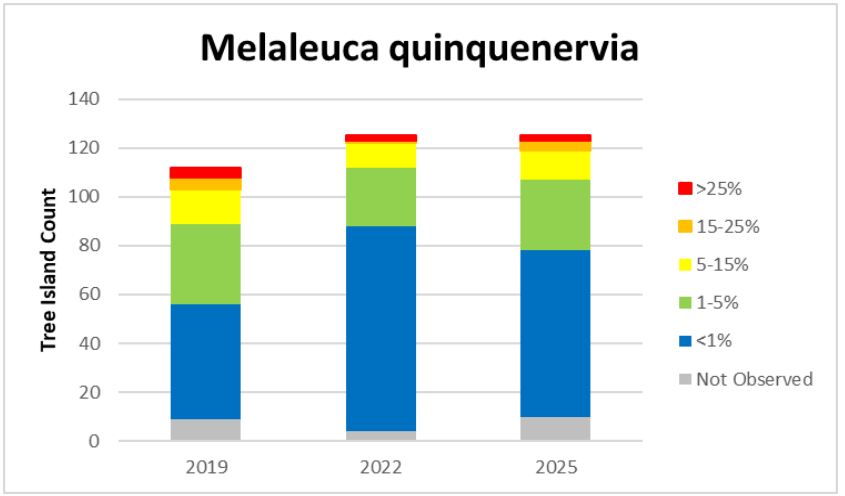
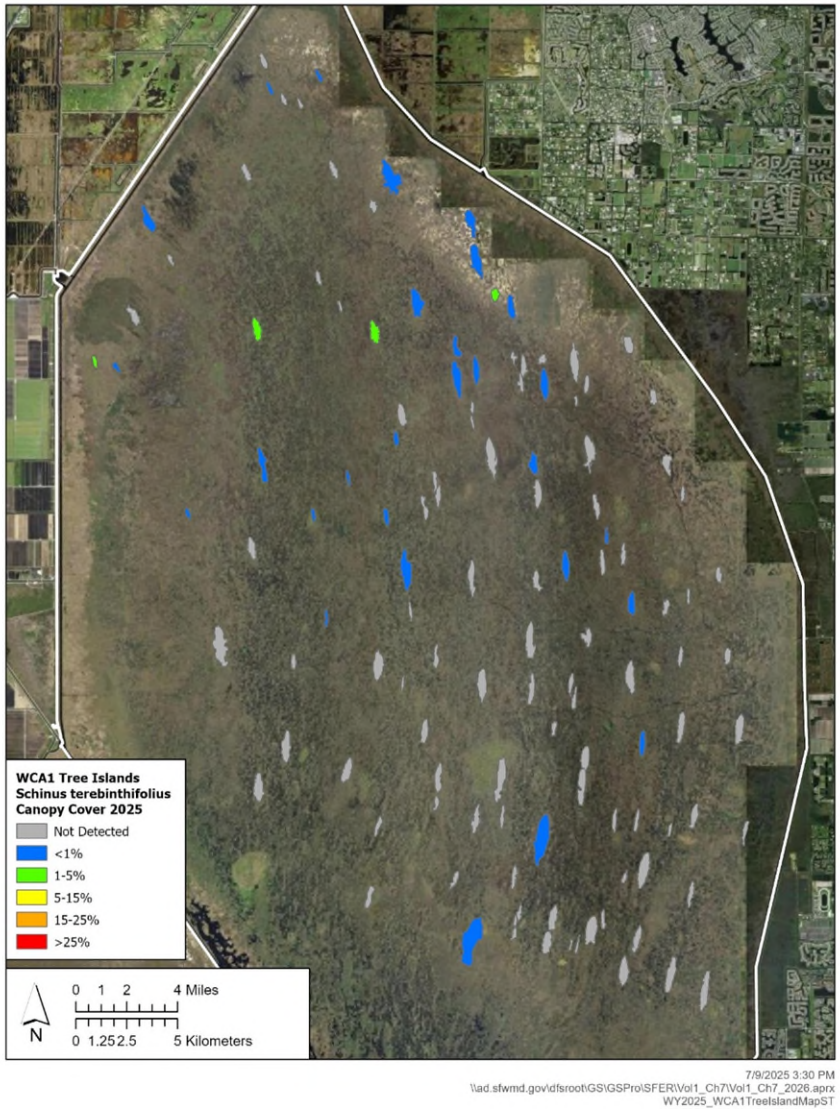


Figure 7-8. Distribution and frequency of melaleuca (*Melaleuca quinquenervia*) on WCA-1 tree islands ranked by mean canopy cover.



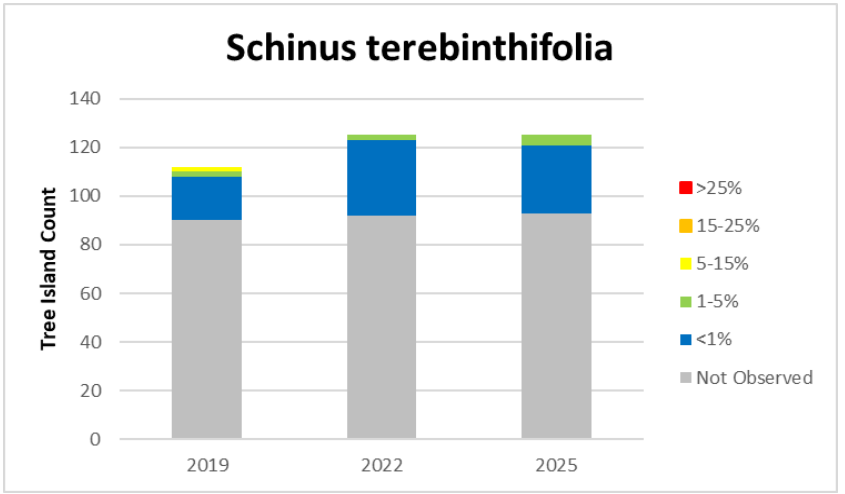


Figure 7-9. Distribution and frequency of Brazilian pepper (*Schinus terebinthifolia*) on WCA-1 tree islands ranked by mean canopy cover.

INVASIVE ANIMAL MANAGEMENT

Efforts to develop control tools and management strategies for several priority animal species and to further expand management programs continued in FY2025. 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. (2023) 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 FY2025 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 nonnative 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. A total of 90 surveys on designated routes were conducted during the October 2024–June 2025

period. Additionally, 16 opportunistic surveys were performed when conditions were favorable for detecting nonnative wildlife. During surveys, 1,865 animals were observed. Of these observations, 577 (31%) were species native to Florida, 1,221 (65%) were nonnative, and 67 (4%) could not be identified due to brief visual encounters. Therefore, 68% of animals identified consisted of nonnative species. We detected 47 native species and 16 nonnative species for a total of 63 species, including 9 nonnative reptiles, 4 nonnative mammals, and 3 nonnative amphibians. Priority nonnative species observed on standard survey routes included 5 Burmese pythons. On opportunistic surveys, opportunistic sightings, and rapid responses 8 additional nonnative reptiles were detected: 7 Burmese pythons and 1 spectacled caiman.

In FY2025, the most commonly observed (1) nonnative reptiles were brown anoles (*Anolis sagrei*), tropical house geckos (*Hemidactylus mabouia*), and green iguanas (*Iguana iguana*); (2) nonnative amphibians were greenhouse frogs (*Eleutherodactylus planirostris*), Cuban treefrogs (*Osteopilus septentrionalis*), and cane toads (*Rhinella marina*); and (3) nonnative mammals were feral cats (*Felis catus*) and hogs. The most observed (1) native amphibians were southern toads (*Anaxyrus terrestris*) and green treefrogs (*Hyla cinerea*); (2) native reptiles were cottonmouths (*Agkistrodon conanti*), ribbon snakes (*Thamnophis sauritus*), and garter snakes (*Thamnophis sirtalis*); and (3) native mammals were Virginia opossums (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), and raccoons (*Procyon lotor*). To date, 215 Burmese pythons have been detected during these visual surveys.

Figure 7-10. 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, 3,863 Argentine black and white tegus, 601 Oustalet's chameleons (*Furcifer oustaleti*), 1,117 veiled chameleons (*Chamaeleo calyptratus*), 321 spectacled caimans (**Figure 7-10**), 372 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*), two boa constrictors (*Boa constrictor*), a rainbow boa (*Epicrates cenchria*), a ball python (*Python regius*), two northern African pythons, 345 Peter's rock agamas (*Agama picticauda*), 8 brown basilisks (*Basiliscus vittatus*), a leopard gecko (*Eublepharus macularius*), two tokay geckos (*Gekko gecko*), a red-footed tortoise (*Chelonoidis carbonarius*), a rhinoceros iguana (*Cyclura cornuta*), 13 green iguanas, and five 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 FY2025, 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 7-11. SFWMD python removal contractor Megan De Angelis with a captured Burmese python (photo by SFWMD).

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 7-11**) 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 $14.00 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 $20.00 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 (ft) and an additional $25 per foot above four ft. 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, 2025, SFWMD and FWC program's contractors have conducted a combined 254,904 survey hours, resulting in the removal of 18,203 pythons (**Figure 7-12**), with an average of 14.00 hours of surveying per python caught. The mean body length of pythons removed by SFWMD and FWC contractors is 1.68 m (5.51 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 (NWRs), including LNWR, Crocodile Lake NWR, Everglades Headwaters NWR and Conservation Area, Florida Panther NWR, J.N. "Ding" Darling NWR, Nathaniel P. Reed Hobe Sound NWR, National Key Deer Refuge, and Ten Thousand Islands NWR. As of July 2022, FWC contractors also have access to Rookery Bay National Estuarine Research Reserve.

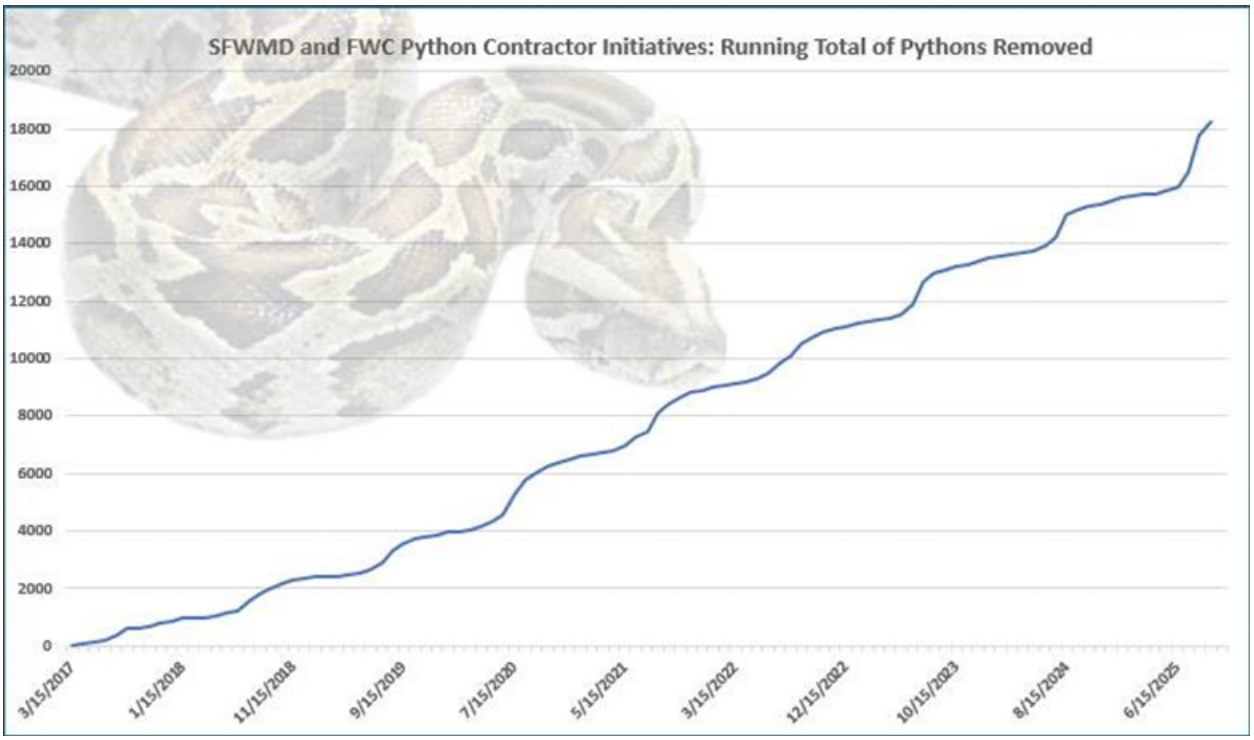


Figure 7-12. Running total of Burmese pythons removed from the Everglades region by SFWMD and FWC python removal contractors between March 25, 2017, and September 30, 2025.

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 (FDEP). 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 12 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 have collaborated to test the 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 despite numerous pythons having been removed from the study site during visual surveys. The lack of python captures in this study, and the low capture rates of pythons in traps in general, likely reflect the foraging behavior of pythons where they primarily sit and wait for prey and to a lesser extent, actively forage to seek out prey, the latter of which would be a prerequisite for entering baited traps. 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 or biologically sensitive locations where daily trap checks are undesired.

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, BCNP, Everglades and Francis S. Taylor WMA, Holey Land WMA, and Rotenberger WMA. In addition to removing pythons, collectively these programs encompass a wide array of habitats in South Florida and provide key data on python movement, reproduction, behavior, and vital rates (i.e., growth rates, survival), 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 GPS telemetry. This technology allows more data collection with less effort but does not work well in closed canopy habitats preferred by pythons (Smith et al. 2018). However, researchers are further assessing the utility of GPS tags as recent advances in technology, as well as assessment of external GPS tag placement, may increase the effectiveness of GPS telemetry, may also increase data collection while mitigating potential limitations due to specific habitats. 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 and Francis S. Taylor WMA 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). Recent work using camera traps to surveil mammals across the Greater Everglades ecosystem found populations of prey species decreased within the

python invasion front and mammal populations within the core of the python's distribution did not demonstrate resilience to python predation over time (Taillie et al. 2021). 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, the pentastome *Raillietiella orientalis,* to Florida that has spilled over to infect at least 18 species of native snakes (Miller et al. 2018, 2020, Metcalf et al. 2019, Palmisano et al. 2025). 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 the Florida panhandle and is expected to expand its range outside of the state in the near future (Palmisano et al. 2025). While additional study is needed to access the impact of this pentastome on native snake populations, it has been anecdotally linked to adverse effects on host health and survival (Farrell et al. 2019, Bogan et al. 2022). Burmese pythons have also been documented to carry a serpentovirus in their invasive Florida range. While the virus does not appear to have spread to native snakes, 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 study conducted by UF and funded by FWC and SFWMD demonstrated live domestic rabbits placed in pens will attract pythons to localized areas, where they may remain for extended periods of time with an increased chance for detection (McCampbell et al. 2024). McCampbell et al. (2024) detected 21 pythons using game cameras placed near the rabbit pens over the course of the study; however, as care for live rabbits is resource intensive, it may prohibit the wide use of this method as a means to increase python detection. To address this challenge, these researchers, along with funding from SFWMD, are currently examining use of robotic rabbits, capable of movement and containing a heating device to mimic real rabbits, to explore if robotic rabbits can attract pythons, and thus be easier to deploy in the field. 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 polymerase chain reaction (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; however, more recent work has explored increasing detection of tegus through eDNA. 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. 2015). 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. Tegus have also been observed utilizing gopher tortoise burrows (Offner et al. 2021) and therefore may compete with native wildlife for these resources as well. 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 tegus during the hottest months and surveying for them during the hottest parts of the day may increase detection and maximize removal. Tegus are often in more open habitats 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 in the core of the tegu distribution in Miami-Dade County yielded fewer tegus relative to 2019 supporting temporal consistency of a trending decline, demonstrating the effectiveness of long-term trapping efforts as a tool for tegu containment. However, trapping efforts must be robust and sustained to reduce tegu populations. 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). Smart traps are solar powered and are operated remotely through a web

application. A user receives a real-time alert message through the application when a tegu is captured; therefore, smart traps eliminate the need for in-person trap checks required for traditional trapping methods. A comparison study conducted by UF, Wild Vision Systems, and USDA, of 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 by 94%, and reduced costs to operate traps by 87% (Miller et al. in prep).

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 are suspected 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 increased 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. Initiation of a scout telemetry program for Northern African pythons to increase our understanding of their movement patterns, habitat preferences, and behaviors could improve our ability to detect these pythons while concurrently removing individuals from the population. 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. However, Nile monitor observations continue to be reported sporadically across the C-51 Basin area. Recent work utilizing species distribution models to assess habitat for monitors found low habitat suitability and predicted the spread of Nile monitors beyond Central Florida is unlikely (Bevan et al. 2024). A study by UF examined use of targeted outreach to increase detection and reporting of Nile

monitors within the C-51 Basin and found that their efforts to relay a specific message to a targeted audience significantly increased reports of monitors within the basin (Mazzotti et al. 2024).

Spectacled caiman were introduced to South Florida in the 1970s and 321 caiman have been removed from populations established within CERP project lands. Caiman are dietary generalists (Godfrey et al. 2025) and may pose a threat to native wildlife due to predation. As caiman are found in habitats also shared by American alligators and American crocodiles (*Crocodylus acutus*), they pose a risk to these native species through competition. A UF study by Godfrey et al. (2023) examined a long-term caiman removal data set to assess the potential for extirpation of caiman from CERP projects. Analysis of removal data collected during 2012 –2021 found that maximum control (removal of most individuals from the population with continued monitoring required to remove stragglers or new introductions) of caiman was possible and eradication of the species, with continued sustained removal efforts, was likely (Godfrey et al. 2023). An understanding of caiman movement patterns and nesting sites could increase our ability to detect and remove this species. A molecular study of caiman genetics by Parks et al. (2024) identified two distinct lineages of caiman in Florida, with caiman populations originating from either Columbian or Brazilian origins. These results raise concerns of hybrid vigor if mixing should occur among caiman populations of different origins as this interbreeding could increase genetic diversity and thus increase the ability of caiman to adapt to their nonnative range.

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 7-13**) 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*, [RECOVER 2024]).

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).

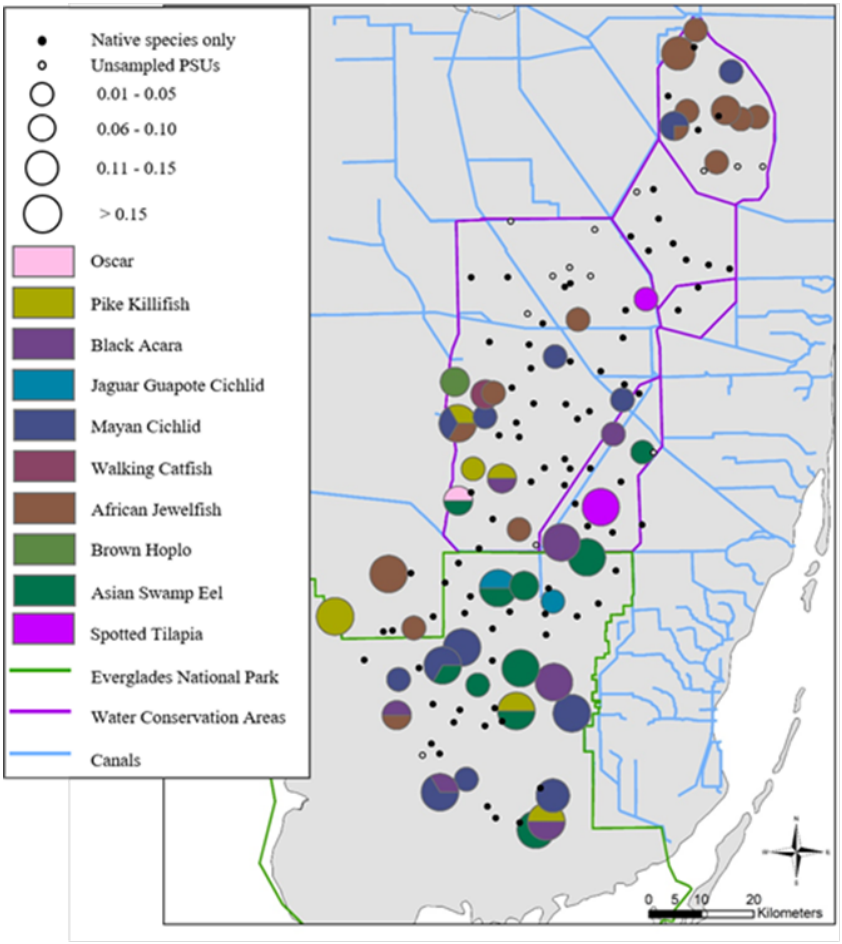


Figure 7-13. Nonnative fish proportions and composition from the CERP MAP throw trap data in WY2022. The overall percentage nonnative for the Everglades was 2.5%. Figure is reprinted from Brandt et al. 2022.

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 7-14**). 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 7-14. 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 7-15. 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. multi-radiatus*, and *P. pardalis*) (**Figure 7-15**) 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. The international aquaculture industry trade these *Pterygo-plichthys* catfishes and collectively this group of fish (16 species) is within the top five traded 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 7-16. 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 7-16**). 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 of 16 (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*] and marsh killifish [*Fundulus confluentus*]) (Pintar et al. 2023b).

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 2025 (**Figure 7-17**).

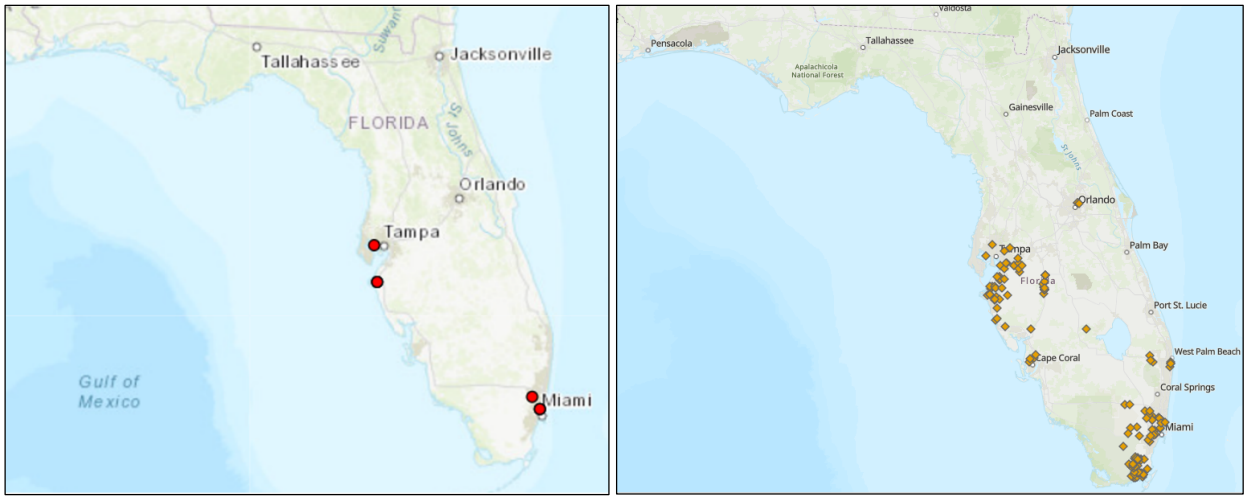


Figure 7-17. Maps of Florida displaying Asian swamp eel sightings in a pre-CERP environment in 1998 (left panel) and 2025 (right panel).

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 is 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 AI, 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 bolstered 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.

INVASIVE SPECIES MANAGEMENT CASE STUDIES

This section presents five case studies that highlight the diversity of invasive species management efforts in the region. Together, these case studies showcase integrated approaches—biological, mechanical, chemical, and sociological—tailored to the invasive species' biology and program objectives. They also underscore two recurring themes: collaboration among partner agencies and stakeholders, and the importance of sustained, science-based control strategies. Each example offers transferable lessons for invasive species programs throughout the South Florida ecosystem.

Inundative Releases of Biocontrol Agents of Water Hyacinth

Classical biological strategies typically involve initial mass releases of approved agents to encourage establishment, after which time agents are left to reproduce in the field without frequent additional releases. This can be effective but is dependent on the unique circumstances of the target species, agent species, and the environment in which the agents are released. In many cases, and particularly for invasive aquatic plants, eutrophication in the water systems acts as a strong bottom-up force driving high rates of plant growth and reproduction, and achieving maintenance control through biological control can be challenging, since one is required to overwhelm such high rates of plant growth. To counteract this challenge, inundative releases of insects can be conducted to create a strong top-down force, but this requires the production of large numbers of insects to be released frequently. In South Africa, researchers have achieved promising results using inundative releases of the water hyacinth planthopper (*Megamelus scutellaris* Berg [Delphacidae]) to manage water hyacinth populations in a highly eutrophic system without the use of herbicides (Coetzee et al. 2022). Hence, there is interest in determining if the same effect can be achieved in Florida using inundative releases of *M. scutellaris*.

M. scutellaris is established in Florida after it was initially released in the early 2010s, but abundances in the field are far lower than those in South Africa. This lower abundance may be the result of lower release efforts/rates compared to the South African researchers, climatic differences between Florida and South Africa, presence of difference species of parasitoids, and several other factors. Additionally, the source populations of the *M. scutellaris* in Florida and South Africa are different. A *M. scutellaris* population from Argentina was originally imported to the USDA-ARS quarantine facility before being released and exported to South Africa after host specificity tests. Subsequently, a population from Paraguay was also imported and released in Florida, and future release efforts continued with this species. Currently, the dominant population found in Florida originates from Paraguay, and the dominant population used in South Africa originates from Argentina (*N. Salinas* and *A. Sosa*, personal comm.). Therefore, it is possible that each population has differing abilities to survive and reproduce as biological control agents.

In this study, researchers' goals were threefold:

- Establish mass rearing facilities for *M. scutellaris*.
- Conduct crossbreeding experiments to determine if there are differences in the number of offspring produced by each population and their hybrids.
- Conduct frequent releases of *M. scutellaris* from both populations at select sites and compare abundances and management of waterhyacinth.

Figure 7-18. Mass rearing facility using troughs and insect netting to grow colonies of *M. scutellaris* (photo by Megan Reid).

Mass rearing facilities (**Figure 7-18**) were successfully established, using troughs, mesocosms, and insect cages and/or netting to enclose water hyacinth plants and grow colonies of *M. scutellaris*, keeping both populations separated after importing the Argentina population from South Africa into quarantine, and clearing them for release. The population from South Africa was imported since they already had large mass rearing facilities, and it was desired to account for potential genetic divergence from the original source population in Argentina that might have occurred in South Africa more than a decade after they were imported. Crossbreeding experiments were conducted by comparing the number of offspring after mating a newly eclosed male and female from each population to compare "pure" Argentina and Paraguay populations, as well as hybrids created by mating females from the Paraguay population with males from the Argentina population (hybrid 1) and mating males of the Paraguay population with females from the Argentina population (hybrid 2). Preliminary results indicated that similar abundances of offspring were produced for each crossbreeding treatment, but that there were slightly elevated numbers of offspring for the hybrid 1 treatment. Experiments are still being conducted, but it is possible that increasing the genetic diversity of *M. scutellaris* by crossbreeding populations could have beneficial (or minimally beneficial) effects.

Frequent field releases of the Paraguay population of *M. scutellaris* began in April 2024 at a selected site near Indiantown, Florida, during which time water hyacinth coverage and average biomass, as well as abundances of *M. scutellaris* and *Neochetina eichhorniae* (another well-established biological control agent for water hyacinth released in the 1970s) were measured once a month following monthly releases of 1,000 to 2,000 *M. scutellaris*. Coverage was reduced from 95% water body coverage to under 5% coverage by

January 2025 (**Figure 7-19**), and coverage has remained low to date. However, abundances of *M. scutellaris* did not increase substantially, but populations of *N. eichhorniae* exploded, resulting in high levels of feeding damage on the leaves. Currently, the water body is covered in water lettuce, with only a few heavily damaged water hyacinth plants present. Another site was selected to begin releases of the Argentina population, but extremely low water levels have hindered surveys and releases. Additional sites are being selected to conduct releases and aim to include releases of *N. eichhorniae*. Rearing capacity has recently been improved to include indoor colonies with grow lights to counter the deleterious effects of high summer temperatures on insect colonies. It is expected that releases of both species of biological control agents will achieve promising results, and experiments will continue to be conducted to compare the two populations of *M. scutellaris* and determine if one or the other performs better through mass releases. In addition, experiments are being conducted to test integrated pest management (IPM) through inundative releases and the use of different herbicides to measure effects on biological control agents and develop improved techniques to manage water hyacinth with minimum cost. This research is supported by funding from (and collaboration with) FWC and the USDA-ARS Areawide Management program.

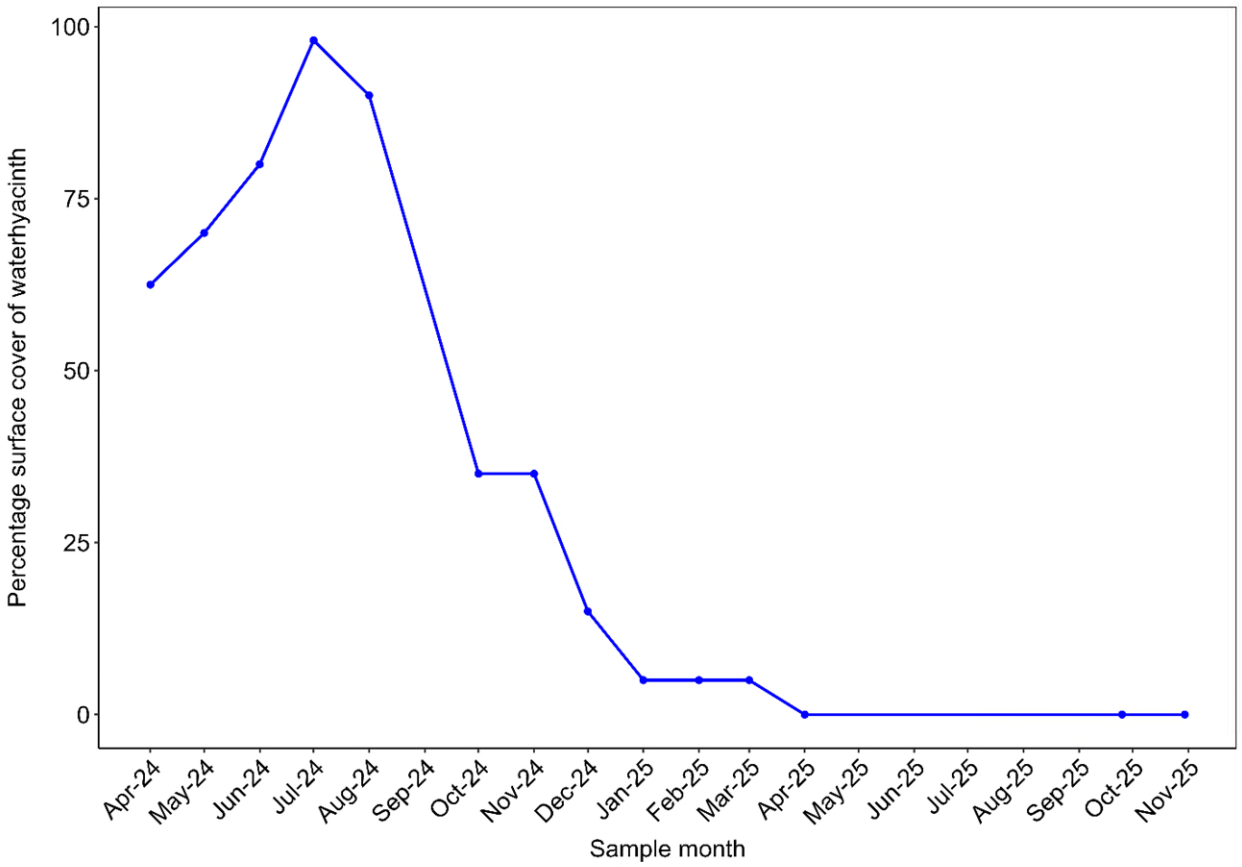


Figure 7-19. Water hyacinth coverage over time during monthly surveys and mass releases of *M. scutellaris*. Rapid decrease in cover after July is likely the result of an explosion in populations of *N. eichhorniae* in addition to releases of *M. scutellaris*.

Picayune Strand Invasive Fish Project

In partnership with FWC, USACE participated in an operational invasive fish project in Picayune Strand in 2025. The purpose of the project is to assess fish biodiversity in both the Miller and Faka Union restored canal systems. This information will help biologists extrapolate fish biodiversity patterns throughout the surrounding regions of the Everglades.

The first phase of this project began in early 2025. Biologists surveyed both the Faka Union and Miller canal systems using electrofishing. All identifiable species—both native and nonnative—were recorded to allow comparisons with species observed during phase 2 of the project. A mark/recapture study was also incorporated to estimate fish populations within each canal segment and to determine electrofishing catchability rates for each species.

Figure 7-20. Trailer of invasive fishes removed from the Picayune Strand project (photo by USACE).

In spring 2025, biologists returned to the previously surveyed sites and applied a rotenone treatment—a naturally derived fish toxicant used by fisheries biologists as a population assessment tool—to fully assess fish biodiversity in each canal system. Fish collected (**Figure 7-20**) during the treatment were sorted by species, counted, and analyzed by FWRI. Initial survey results showed that the overwhelming majority of fish in both canal systems were invasive species. A native fish restocking effort was planned for summer 2025, but water levels had risen too high to allow access. Restocking will occur as soon as access becomes possible. Post-restocking surveys will be conducted annually via electrofishing during the winter/spring timeframe to assess the reestablishment of both native and non-native species in stocked and unstocked canal sections.

Non-native fish species dominated the canal sections in both number and biomass (**Table 7-1**). Fish densities during low water periods were extremely high exceeding those found in most aquaculture settings. Next year, several dissolved oxygen loggers will be deployed to monitor oxygen levels in these canal segments during low water periods. Given the high fish densities, oxygen levels could crash at any time. The reasons for the success and proliferation of non-native species in this area remain unclear, but continued assessments are planned to answer this question to prevent it from happening in future restoration areas. Percent composition by number and weight comparing native and non-native fish species collected during recent rotenone treatments are provided in **Table 7-2**.

Table 7-1. Fish species abundance, density in fish/ha, and biomass in kilograms per hectare (kg/ha) estimates for the four restored canal segments in the Picayune Strand State Forest.

Common Name	Scientific Name	Native	Number of Individuals	Density (fish/ha)	Biomass (kg/ha)
Faka Union 2 (Surface Area: 0.36 ha)					
Sailfin Catfish	*Pterygoplichthys* spp.		4,797	11,849	2,694
Tilapia	*Oreochromis* spp.		4,180	10,325	2,481
Largemouth Bass	*Micropterus salmoides*	x	525	1,297	756
Florida Gar	*Lepisosteus platyrhincus*	x	311	768	511
Mayan Cichlid	*Cichlasoma urophthalmus*		1,164	2,875	481
Walking Catfish	*Clarias batrachus*		2,600	6,422	400
Mixed Centrachids	*Centrarchidae* spp.	x	1,176	2,905	133
Bullhead	*Ameiurus* spp.	x	191	472	83
Brown Hoplo	*Hoplosternum littorale*		444	1,097	61
Bowfin	*Amia calva*	x	8	20	22
Bluegill	*Lepomis macrochirus*	x	9	22	3
Oscar	*Astronotus ocellatus*		4	10	3
Black Acara	*Cichlasoma bimaculatum*		23	57	3
Faka Union 3 (Surface Area: 0.31 ha)					
Tilapia	*Oreochromis spp.*		2,729	6,741	1,594
Sailfin Catfish	*Pterygoplichthys spp.*		8,575	21,180	2,226
Florida Gar	*Lepisosteus platyrhincus*	x	585	1,445	300
Mayan Cichlid	*Cichlasoma urophthalmus*		1,057	2,611	261
Largemouth Bass	*Micropterus salmoides*	x	61	151	226
Brown Hoplo	*Hoplosternum littorale*		584	1,442	206
Mixed Centrachids	*Centrarchidae spp.*	x	1,193	2,947	197
Bullhead	*Ameiurus spp.*	x	266	657	194
Walking Catfish	*Clarias batrachus*		236	583	42
Bluegill	*Lepomis macrochirus*	x	162	400	29
Tarpon	*Megalops atlanticus*	x	1	2	16
Oscar	*Astronotus ocellatus*		13	32	13
Black Acara	*Cichlasoma bimaculatum*		50	124	10
Bowfin	*Amia calva*	x	2	5	6
Peacock Bass	*Cichla ocellaris*		1	2	3
African Jewelfish	*Hemichromis letourneuxi*		107	264	3
Merritt 3 (Surface Area: 0.69 Ha)					
Tilapia	*Oreochromis spp.*		4,436	10,957	1,954
Florida Gar	*Lepisosteus platyrhincus*	x	1,105	2,729	1,286
Sailfin Catfish	*Pterygoplichthys spp.*		7,214	17,819	758
Oscar	*Astronotus ocellatus*		273	674	91
Largemouth Bass	*Micropterus salmoides*	x	103	254	83
Mayan Cichlid	*Mayaheros urophthalmus*		811	2,003	64
Bullhead	*Ameiurus spp.*	x	310	766	64

Table 1. Continued.

Common Name	Scientific Name	Native	Number of Individuals	Density (fish/ha)	Biomass (kg/ha)
Brown Hoplo	*Hoplosternum littorale*		611	1,509	64
Bluegill	*Lepomis macrochirus*	x	1,088	2,687	19
Bowfin	*Amia calva*	x	12	30	19
Warmouth	*Lepomis gulosus*	x	438	1,082	14
Mixed Centrachids	*Centrarchidae spp.*	x	519	1,282	9
Walking Catfish	*Clarias batrachus*		114	282	6
African Jewelfish	*Hemichromis letourneuxi*		306	756	3
Black Acara	*Cichlasoma bimaculatum*		53	131	1
Spotted Sunfish	*Lepomis punctatus*	x	43	106	0
Redear Sunfish	*Lepomis microlophus*	x	27	67	0
Merritt 4 (Surface Area: 0.57 Ha)					
Tilapia	*Oreochromis spp.*		4,691	11,587	1,830
Florida Gar	*Lepisosteus platyrhincus*	x	1,284	3,171	1,277
Sailfin Catfish	*Pterygoplichthys spp.*		5,192	12,824	1,182
Oscar	*Astronotus ocellatus*		283	699	137
Brown Hoplo	*Hoplosternum littorale*		300	741	118
Largemouth Bass	*Micropterus salmoides*	x	106	262	104
Mayan Cichlid	*Cichlasoma urophthalmus*		183	452	56
Bowfin	*Amia calva*	x	17	42	32
Bullhead	*Ameiurus spp.*	x	188	464	23
Warmouth	*Lepomis gulosus*	x	253	625	23
Bluegill	*Lepomis macrochirus*	x	307	758	14
Walking Catfish	*Clarias batrachus*		119	294	7
Mixed Centrachids	*Centrarchidae spp.*	x	119	294	5
Black Acara	*Cichlasoma bimaculatum*		32	79	4

Table 7-2. Percent composition by number and weight comparing native and non-native fish species collected during recent rotenone treatments on four restored canal segments in the Picayune Strand State Forest.

Canal Segment	% Composition By Number		% Composition By Weight	
	Native	Non-Native	Native	Non-Native
Faka Union 2	14	86	20	80
Faka Union 3	15	85	18	82
Merritt 3	21	79	34	66
Merritt 4	17	83	31	69

Melaleuca Maintenance Control Program

Melaleuca (*Melaleuca quinquenervia*), a fast-growing invasive tree from Australia, was widely planted across South Florida in the early 20th century. By the 1990s, it had infested nearly 200,000 ha (Ferriter 1999), including major wetlands such as the WCAs, BCNP, and ENP. In response, melaleuca was listed as a federal noxious weed, and the Melaleuca Task Force formed a regional plan of attack.

SFWMD, in collaboration with federal, state, and local partners, launched a three-phase melaleuca control strategy:

1. Eliminate major infestations of all mature and seedling trees.
2. Revisit previously treated sites to control previously missed trees and/or to remove new seedlings.
3. Conduct surveillance and inspections of those previously treated areas to monitor and to maintain minimal reinfestation levels.

This integrated approach combined aerial and ground-based herbicide applications, biological controls (e.g., melaleuca weevil, psyllid, and stem-gall midge), and consistent surveillance.

Comparison of Control Efforts Under Maintenance Control and Heavy Infestation

WCA-2B was historically one of the most heavily infested areas within the Everglades, with up to 30% canopy coverage. WCA-3B also contained substantial infestations, while the Pennsuco Wetlands Area, east of WCA-3B along the urban fringe, experienced varying levels of invasion with some areas containing dense single species stands.

Decades of coordinated treatment in the WCAs have yielded dramatic results. WCA-2A, WCA-2B, WCA-3A, and WCA-3B are now considered under maintenance control (**Figure 7-21**) and areas once dominated by melaleuca have been restored to native marsh habitat. The sustained efforts to systematically remove dense infestations while preventing reinfestations through diligent monitoring and follow up treatments has resulted in significant reductions in the management costs and herbicide utilization. In 2024, the SFWMD's melaleuca removal contractors swept the entire 94,452-acre WCA-3B at a cost of just $1.24 per acre, with melaleuca occupying less than 1% of the area. Only 3.18 pounds (lb) of imazapyr and 6.3 lb of glyphosate were applied—virtually negligible when distributed over the entire management area. Likewise, in 2025, WCA-2B's 26,844 acres were gridded for maintenance treatments, with less than 1% infested and herbicide inputs similarly minimal (1.8 lb imazapyr and 3.7 lb glyphosate total, or near-zero per acre).

The efficiency of sustaining maintenance control can be demonstrated by contrasting the WCAs with areas that have varying degrees of melaleuca infestations. For example, a 2025 control effort at Pennsuco Wetlands site covered 4,867 acres, with 97.7 acres of dense infestation requiring far higher herbicide use—89.4 lb of imazapyr and 496.3 lb of glyphosate. Treatment costs were $134.63 per acre due to higher plant density and more intensive labor requirements. Unlike the WCAs, parts of the Pennsuco Wetlands Area are still in initial or overdue maintenance phases and suffer from reinvasion from neighboring properties.

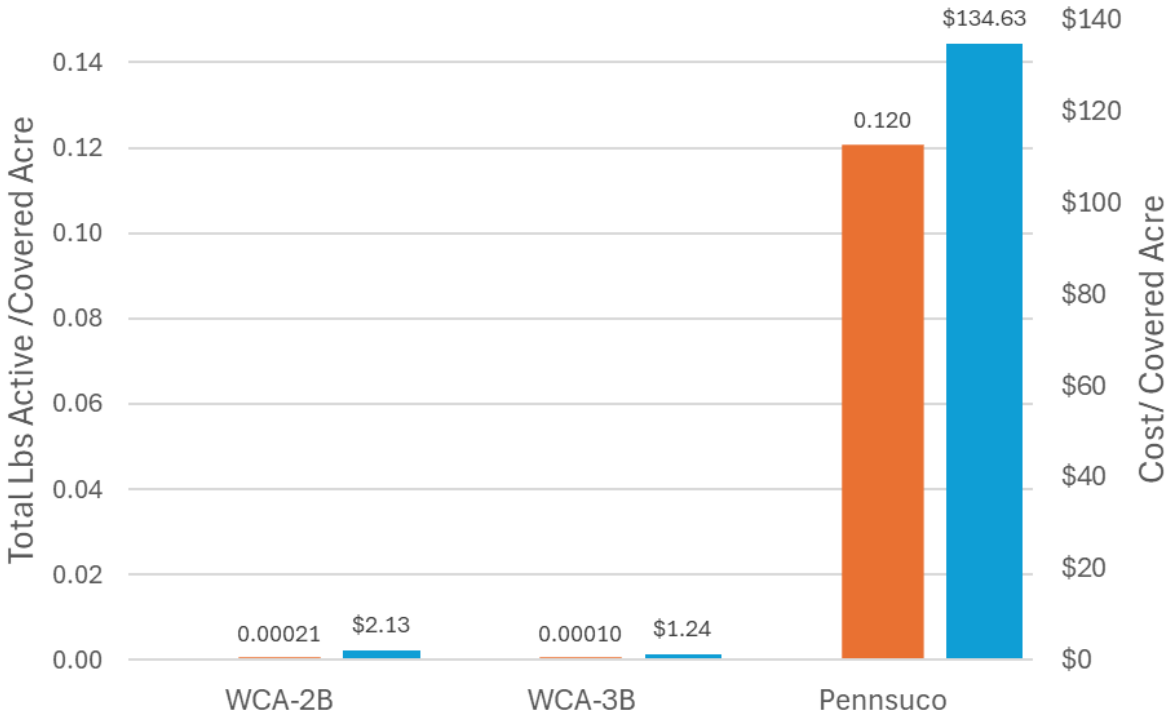


Figure 7-21. Comparison of per acre herbicide use and control costs for melaleuca management in two areas under maintenance control (WCA-2B and WCA-3B) and an initial melaleuca treatment in the Pennsuco Wetlands Area.

Long-Term Strategy and Outcomes

The WCAs now operate under sustained maintenance control, with small teams gridding thousands of acres by airboat every 3 to 4 years. This model has proven cost-effective, herbicide-efficient, and ecologically responsible. The melaleuca program's progression from large-scale removal to precise, low-impact maintenance exemplifies how early, coordinated action and long-term commitment can reverse even widespread infestations. Maintenance control remains central to keeping melaleuca—and other invasive species—in check across South Florida.

Herbicide Reduction Through Maintenance Control: Lake Okeechobee History of Floating Aquatic Vegetation Maintenance Control Program

Invasive floating plants, particularly water hyacinth (*Pontederia crassipes*) and water lettuce (*Pistia stratiotes)*, pose persistent challenges in Lake Okeechobee even after 105 years of management. Maintenance control, which is a proactive strategy focused on keeping plant populations at the lowest feasible level through consistent and early intervention, has shown to be the most cost-effective and environmentally responsibly approach. The overarching goal of any management strategy should be to support the health of the ecosystem, which includes applying only the minimum amount of herbicide necessary to keep these invasive species in check. However, when conditions or public interference allow these plants to grow unchecked, it becomes necessary, for the sake of the ecosystem's health, to restore invasive populations to manageable levels.

Water hyacinth first invaded Lake Okeechobee by the 1920s. At that time, only mechanical removal was available to manage these infestations. This approach proved slow, ineffective, and costly. A significant shift occurred in the mid-1940s with the introduction of the herbicide 2,4-D, which allowed managers to implement a more efficient, targeted chemical control strategy. Research (Joyce 1985) has since shown that

maintaining low levels of invasive plants through integrated management techniques, not only reduces herbicide use but also limits muck accumulation and long-term costs.

Today, FWC and USACE continue to employ maintenance control tactics on Lake Okeechobee. These efforts have shown measurable success after the statewide 2019 three-month spray pause, which caused floating plants to quickly get out of hand (**Figure 7-22**). By 2025, floating plant levels were reduced to just three acres of infestation that could be identified during interagency helicopter surveys, which is the lowest levels since 1989. Additionally, since reestablishing maintenance control post 2019, the agencies have achieved significant gains: a 27.5% reduction in spending, a 44% reduction in treated acres, and a 80% reduction in pounds of active ingredient use per year and a 93% reduction in the amount of acres of invasive floating plants observed throughout the lake (**Figure 7-22**).

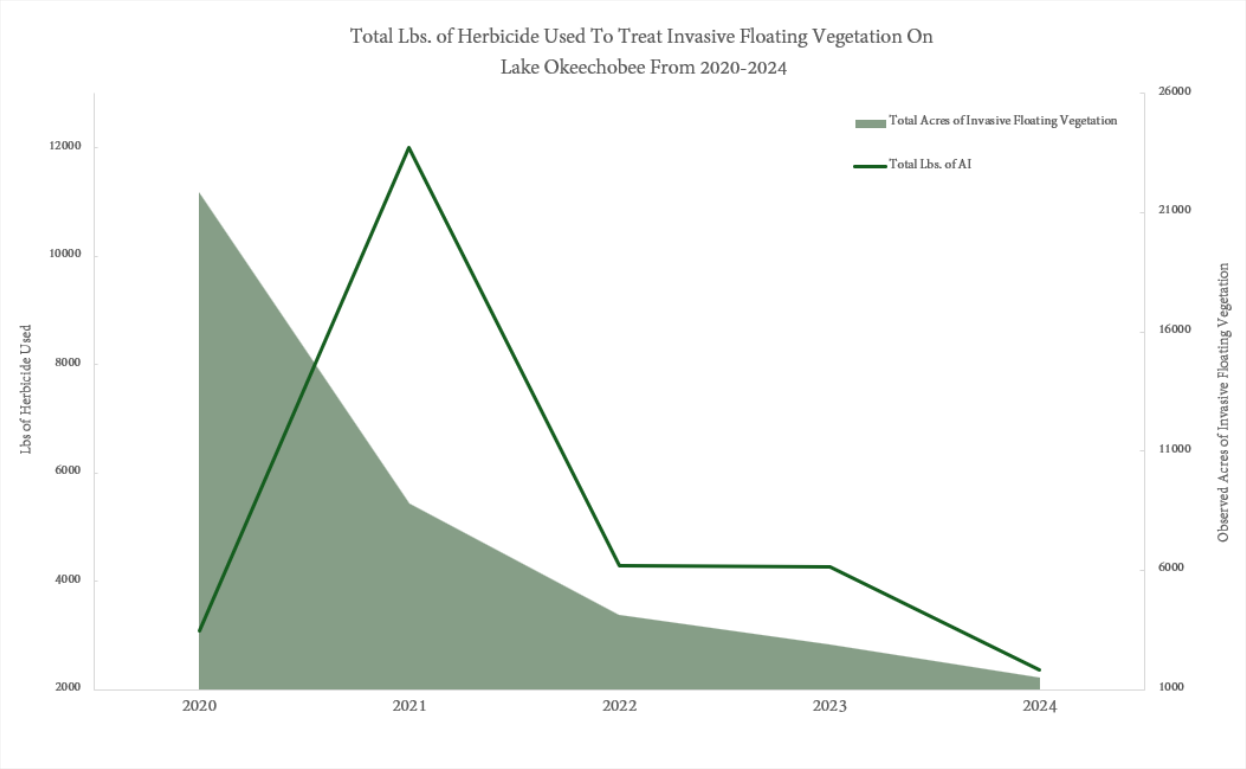


Figure 7-22. The relationship between yearly observed acres of invasive floating vegetation and the yearly pounds (Lbs) of active ingredients used to treat invasive floating vegetation throughout Lake Okeechobee since the 3-month spray pause of 2019 caused a disruption in maintenance control.

However, the greatest threat to the sustainability of this program is not biological, but public perception. When plant levels are low and visible impacts diminish, stakeholders may question the need for continued treatment. This misunderstanding has led to repeated shifts from proactive to reactive management. For example, in 1989 after "Operation Clean Sweep" by USACE, plant levels were well controlled, prompting public outcry over continued herbicide use. A resulting three-month spray pause allowed hyacinth and lettuce populations to rebound dramatically, leading to increased herbicide use and costs.

A similar scenario unfolded in 2019 when public pressure caused FWC to halt herbicide applications statewide. This pause resulted in more than 3,500 acres of floating plants on Lake Okeechobee, disrupted boat navigation, and forced the closure of the Julian Keen Jr. federal navigation lock for two weeks. Moored boats were surrounded overnight as drifting mats of hyacinth spread across the lake. Once treatment

resumed, efforts had to intensify to regain control, reversing earlier gains in cost savings and ecological stability.

As of May 2025, Lake Okeechobee's invasive plant levels are under control, and management is more efficient than it has been in decades. Yet, the risk remains that shifting public perception and political pressure may once again undermine progress.

Ultimately, the success of invasive plant management on Lake Okeechobee hinges not just on science and strategy, but also on effective communication and public education. The lesson is clear that proactive, sustained intervention works but only if it is allowed to continue, regardless of whether the threat is immediately visible.

A Termite Tale: The Significance of Public Outreach for Early Detection and Rapid Response and Eradication Programs

While the importance of public outreach for early detection and rapid response (EDRR) is likely a well understood concept in invasive species management, a recent example of success in the detection, reporting and quick action taken to prevent establishment of a novel termite species discovered on Florida soil is highlighted here.

The Florida Department of Agriculture and Consumer Services (FDACS) has been working for over a decade to eradicate the conehead termite (*Nasutitermes corniger*) from Broward County. The Conehead Termite Eradication Program is both a management and education program whose focus is on awareness of the dangers of this invasive species as well as on the high potential likelihood of new introductions from abroad or unintentional human spread of this species across the state. While the currently known populations in Florida are limited to a small area of southeast Broward County, FDACS places a high priority on spreading awareness via both targeted and broad outreach opportunities to identify any potential unknown populations that may exist in other areas.

It can often be difficult to assess if an outreach program is successful, especially if the target species population is not widespread. However, the Conehead Termite Eradication Program received a report in late April 2024 that proved the years of outreach and education shared by the program was indeed succeeding.

A discovery by staff at the Port of Palm Beach in Riviera Beach, Florida, of a large and strange looking insect nest prompted a quick call to their contracted pest control company. While the port staff may not have known what they were seeing, the termite experts from the pest control company knew right away that this was not something they had previously encountered. A quick best guess of species by the termite team told them that this may be a conehead termite, which they knew, by way of those years of FDACS' targeted outreach to the pest control industry, was a species of high concern, and under eradication from the state. The pest control company also knew how to contact the program and quickly completed both an online reporting form and a phone call to the program lead.

Once contacted, and after seeing the initial photographs, FDACS conehead termite staff knew that this needed to be addressed immediately. Not only was this location over 50 miles removed from the current known infestation of conehead termites, but it was days away from what is considered the beginning of swarming season. They knew that if this nest were to swarm, that the new kings and queens that would emerge could quickly spread this colony across the region making it potentially a much larger problem.

Figure 7-23. FDACS staff and the Conehead Termite Program's Science Advisor stand with Truly Nolen pest control termite staff around the *Nasutitermes acajulae* nest as it was found at the Port of Palm Beach on May 1, 2024. (Photo by FDACS.)

Amazingly, the pest control company was just as interested in helping to eliminate this termite colony as they were quick about reporting it. *In just over 24 hours*, a team of not only FDACS biologists, but local pest control field technicians and company termite experts from other regions of the state met at the port to investigate and immediately treat and remove this termite nest (**Figure 7-23**).

It was quickly apparent to FDACS staff who knew so much about the conehead termite that this termite found at the Port of Palm Beach was not the same species, although closely related by appearance and behavior. After closer inspection, this discovery turned out to be of *Nasutitermes acajutlae*, which is the first documented on-land detection of this species in the state of Florida. The large approximately 3-foot-wide nest was removed from its crane pad substrate, destroyed to the best ability, and treated with pesticide. While it was full of worker and soldier termites, there was no sign of any ongoing reproduction within the nest structure. No immature termites, no kings or queens, and no alate reproductives ready to swarm were found. A follow up survey of the entire port also did not locate any additional signs of ongoing *N. acajutlae* activity.

Because of the cryptic nature of young termite colonies, it is premature to say that this one treatment event completely removed this species from Florida shores, however the lack of colony reproductive activity and no additional sightings in the past year make this an optimistic EDRR success story. It especially highlights the collaboration between government biologists who are tasked with protecting the state from invasive species threats, and the industry workers who are often the first line of discovery when unusual species are spotted. The public outreach efforts of FDACS' Conehead Termite Eradication Program had reached the audience that it needed with a message that highlighted the importance of quick action and best reporting procedures. Without this knowledge network built of trust and urgency, successful EDRR events such as this would not be possible.

INTERAGENCY COORDINATION

This section provides updates on key interagency coordination activities pertaining to invasive species in South Florida during FY2025. 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 in the document *Filling the Gaps: Ten Strategies to Strengthen Invasive Species Management in Florida* (Environmental Law Institute 2004) available online at http://www.eli.org/sites/default/files/eli-pubs/fillingthegaps.pdf.

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 2025), 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 the Florida 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 7-24**). Of these 16 CISMAs, seven occur either wholly or partially within the CERP footprint.

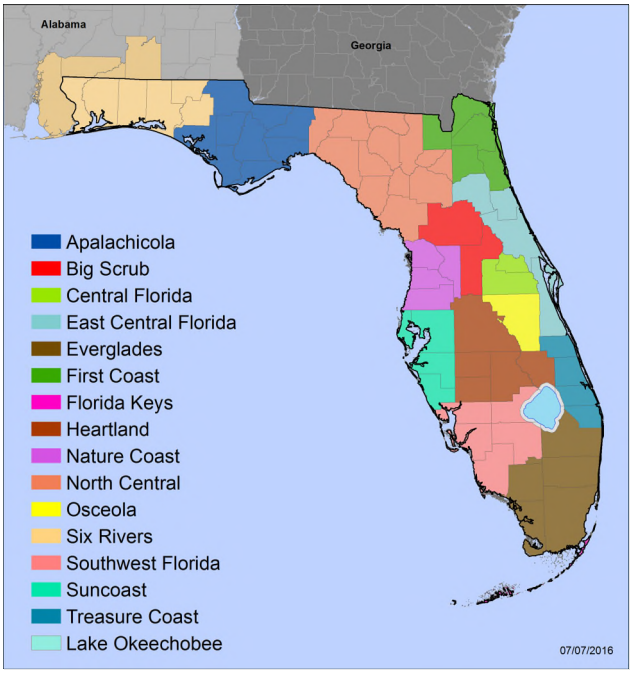


Figure 7-24. Locations of Florida's CISMAs.
(Note: this map was produced by the Center for Invasive Species and Ecosystem Health at the University of Georgia.)

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 FY2025, 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 Juno Dunes natural areas in Palm Beach County as well as within the Biscyane Bay Coastal Wetlands project footprint in Miami-Dade County. A northern African python removal survey was also conducted during National Invasive Species Awareness Week. ECISMA also hosted its annual Everglades Invasive Species Summit on July 22 and 23, 2025. 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, FDEP-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 County, Aquatic Vegetation Control Inc., Habitat Specialists Inc., The Florida Native Plant Society, and several private citizens.

In 2025, 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 nine 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 12 workdays which involved actively surveying for and removing invasive species within the region. TC-CISMA and partners hosted a workshop offering continued education units to participants with Restricted Use Pesticide licenses, covering common invasives within the CISMA and two hands on workshops discussing management, identification and capture techniques of the invasive Burmese python and redhead agama (*Agama agama*). The continued focus of TC-CISMA is planning and 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/.

Southwest Florida CISMA

The Southwest Florida CISMA (SWFLCISMA), founded in 2008, is a partnership between the SFWMD, Florida Forest Service, FWC, FDEP-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, are held in conjunction with the annual SWFLCISMA Invasive Species Symposium to engage members of the CISMA and the public 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 annual Weed Wrangle events. The Invasive Fish Roundup incentivizes participant anglers to target nonnative and/or invasive fish for removal with the chance of earning prizes for their catch.

Other CISMAs

In addition to ECISMA, TC-CISMA, and SWFLCISMA, 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 benefited 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 FDEP, and FWC, along with state universities. 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 conduct aerial surveys 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. A newsletter is prepared each month to provide updates on ongoing and upcoming projects from FWC, SFWMD, USACE, and FDEP. 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 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 predomently 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. SFWMD and UF have partnered on a research project investigating optimal control options for the most abundant and challenging invasive grasses on the floodplain; West Indian marsh grass (*Hymenachne amplexicaulis*) and para grass (*Urochloa mutica*). The goal of the research is to determine the influence of treatment timing, the habitat response post treatment, and the monitoring and retreatment intervals needed to maintain control of these species while promoting desirable native vegetation. Operational treatments are being conducted on a larger scale that mirror the experiments and data and results from these experiments are expected to be published in 2027.

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.

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-exotic-species-archive.

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, the 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 the link provided above.

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 7-25** 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 options 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 the Seminole and Miccosukee 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 7-25**) 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.

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.

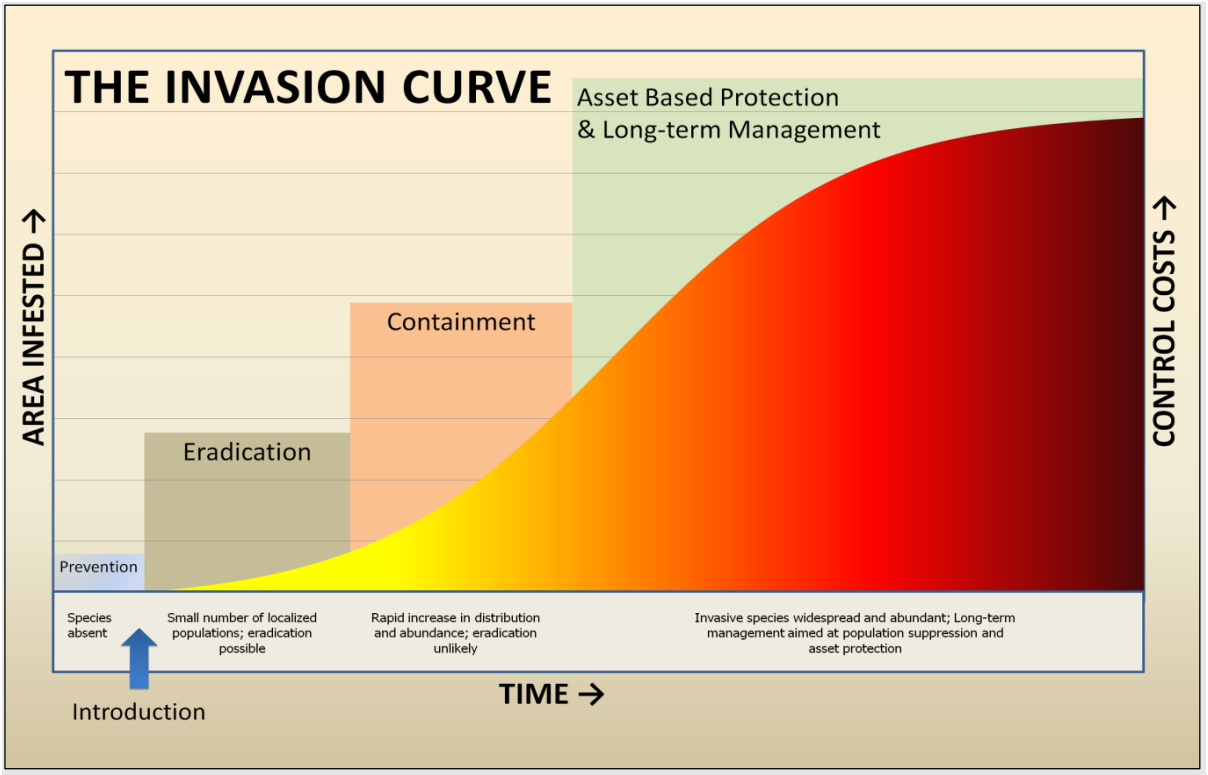


Figure 7-25. The Invasion Curve (Rodgers 2010) depicts four major categories of management actions that may be taken as the invasion progresses from initial establishment to widespread dominance on the landscape.

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 online 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 7-3**). 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 7-3. 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.

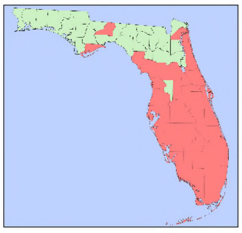
Plants	
Australian pine (*Casuarina* spp.)	Old World climbing fern (*Lygodium microphyllum*)
Brazilian pepper (*Schinus terebinthifolia*)	Shoebutton ardisia (*Ardisia elliptica*)
Cogongrass (*Imperata cylindrica*)	Torpedograss (*Panicum repens*)
Downy rose myrtle (*Rhodomyrtus tomentosa)*	Water hyacinth (*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.)

Figure 7-26. Australian pines form dense litter mats that inhibit understory native species (photo by UF).

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 7-26**; Batish et al. 2001), making the plant particularly destructive to native plant communities. Australian pine can interfere with sea turtle and American crocodile nesting (Klukas 1969), and small mammal populations are lower in habitats dominated by this invader (Mazzotti et al. 1981).

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. Aminocyclopyrachlor has been shown to be highly effective in a reduced hack and squirt application, with similar results to triclopyr. This method reduces the quantity of herbicide applied and is faster than a cut stump treatment (Enloe et al 2025).

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.

2025 Status of Australian Pine by Management Region

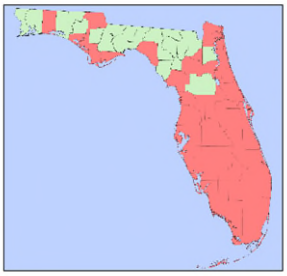
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Brazilian Pepper (*Schinus terebinthifolia*)

SUMMARY: Brazilian pepper (**Figure 7-27**) 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 7-27. 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. 2014c).

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. A reduced hack-and-squirt method with aminocyclopyrachlor or aminopyralid have shown similar effectiveness to triclopyr applications, with the benefit of decreased herbicide volume (Enloe et al. 2025). One biological control agent, a thrip (*Pseudophilothrips ichini*) that targets Brazilian pepper has been released since 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 are needed to reduce propagule pressure on conservation lands.

2025 Status of Brazilian Pepper by Management Region

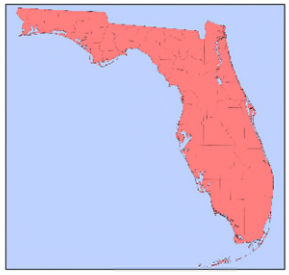
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Cogongrass (*Imperata cylindrica*)

SUMMARY: Cogongrass (**Figure 7-28**) 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 7-28. Cogongrass aggressively invades disturbed soils and pine flatwoods (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Cogongrass is documented in natural areas throughout Florida. 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 with glyphosate and imazapyr, prescribed fire, mechanical disruption, and native revegetation (Sellers et al. 2018). The selective herbicide, fluazifop-P-butyl, may provide control of cogongrass alone when mixed with desirable species, allowing for accelerated native plant recovery after repeat applications (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.

2025 Status of Cogongrass by Management Region

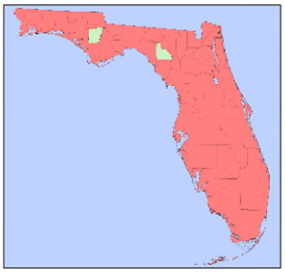
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Water Primroses (*Ludwigia* spp.)

Figure 7-29. Monotypic stands of *Ludwigia hexapetala* dominate large areas of the Kissimmee River floodplain (photo by SFWMD).

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 7-29**), *L. peruviana,* and *L. peploides*. Genetic 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, Drexler et al. 2024).

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 stage prostrate creeping water primrose, but they are less effective on dense, emergent populations. SFWMD uses triclopyr and glyphosate or a combination of carfentrazone and imazamox, though with limited success. Herbicides tend to be more effective in spring when water levels are low, just before the rainy season (Enloe et al. 2020b). USDA-ARS is evaluating South American insects for biocontrol potential but the number of native *Ludwigia* species in Florida make this development unlikely.

Monitoring: There is no comprehensive monitoring program for this species.

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 to improve habitat for native species and reduce tussock formation.

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.

2025 Status of Creeping Water Primroses by Management Region

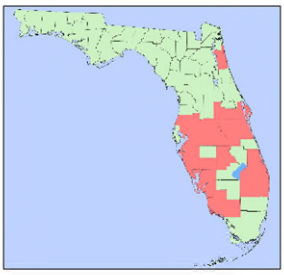
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 7-30**). 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. Often this plant can be hard to differentiate from some other pineland woody shrubs leading to missed plants or nontarget mortality. Downy rose myrtle is characterized by leaves with 3 distinct veins, short hairs on the underside of the leaf, and rose pink flowers in the spring to early summer.

Figure 7-30. 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. Plants are often multi-stemmed or are found clumped together as separate plants sprouting from scat piles. On smaller plants, 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 when time and care is taken to ensure excellent coverage; these can be time consuming and labor-intensive treatments in dense infestations. Every stem is required to be cut and have herbicide applied for effective control. Often times, repeated applications are necessary due to heavy seed production and the tendency to resprout. Multiple candidate biological control agents have been evaluated and rejected as they are not specific to the species.

Monitoring: Because downy rose myrtle is difficult to detect from the air, monitoring is currently limited to observations by land managers on the ground and can be more effective in spring and early summer when flowers are present.

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.

2025 Status of Downy Rose Myrtle by Management Region

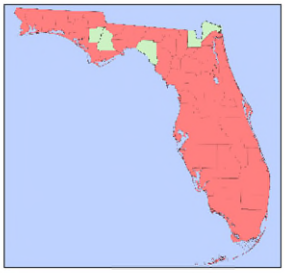
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Hydrilla (*Hydrilla verticillata*)

SUMMARY: Hydrilla is a rooted submerged plant that often forms dense monotypic stands through the water column, competitively excluding native aquatic plant communities (**Figure 7-31**). It is native to the Old World and Indo-Pacific and was likely first introduced to Florida in the 1950s as an aquarium plant. Hydrilla is now the dominant submerged plant in much of the state, forming large infestations that can obstruct flood control structures and hinder navigation. Hydrilla also supports the growth of a cyanobacterial epiphyte, *Aetokthonos hydrillicola*, which produces a toxin affecting waterbirds and their avian predators (e.g., coots [*Fulica americana*] and bald eagles [*Haliaeetus leucocephalus*]; Wilde 2005, Martin 2015, Wilde et al. 2014) and a broad range of wildlife, including amphibians, reptiles, and fish (Breinlinger et al. 2021).

Figure 7-31. Dense hydrilla mats aggressively overtake native aquatic vegetation (photo by USDA).

KEY MANAGEMENT ISSUES



Distribution: Hydrilla infests a wide range of aquatic systems and for decades has dominated a significant portion of the Kissimmee Chain of Lakes.

Control Tools: Herbicide is the primary control tool for hydrilla management. Fluoridone is highly effective on this species, but some populations have developed resistance after widespread, repeated use. Agencies involved in hydrilla management often rely on an integrated approach to reduce herbicide usage and to reduce the likelihood of new resistance development. Tools available include 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 management.

Interagency Coordination: FWC allocates funds from the Florida Invasive Plant Management Control Trust Fund to local agencies for coordinated management of hydrilla.

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.

2025 Status of Hydrilla by Management Region

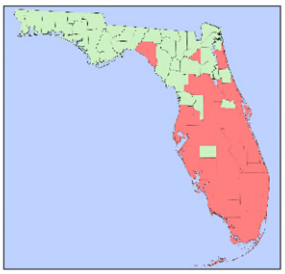
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Melaleuca (*Melaleuca quinquenervia*)

SUMMARY: Before organized state and federal invasive plant control operations were initiated in 1990, melaleuca (**Figure 7-32**) was widely distributed throughout the WCAs, ENP, BCNP, and Lake Okeechobee. 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 7-32. Melaleuca converts diverse marsh habitat to single species melaleuca swamps (photo by SFWMD).

KEY MANAGEMENT ISSUES



Distribution: Dense infestations of melaleuca have been systema-tically cleared from Lake Okeechobee, WCA-2, WCA-3, and Holey Land and Rotenberger WMAs and these areas are now considered under maintenance control (see the Melaleuca Maintenance Control Program subsection earlier in the chapter). Significant infestations remain in WCA-1 (LNWR), throughout public and private lands along the west coast, and along portions of the Eastern Everglades Buffer areas.

Control Tools: Chemical, mechanical, physical, and biological controls are all used as part of an integrated management technique that has resulted in the maintenance control over large areas of 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.

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.

2025 Status of Melaleuca by Management Region

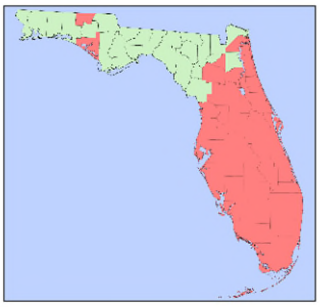
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 7-33**). 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 7-33. 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 WCA-1 (LNWR; see the *Update on Invasive Plant Management of Water Conservation Area 1 Tree Islands* subsection earlier in this chapter) 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 (Richard 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 and on a 2-year cycle within WCA-1 (LNWR).

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, ground-based monitoring programs, and private lands initiatives are also needed.

2025 Status of Old World Climbing Fern by Management Region

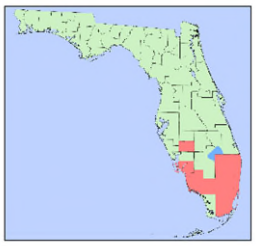
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Dwarf Rotala (*Rotala rotundifolia*)

SUMMARY: Dwarf rotala (**Figure 7-34**) is a submersed aquatic plant native to India and Southeast Asia. It was introduced into Florida systems through the aquarium trade (Gettys and Della Torre 2014). Dwarf rotala was first collected in Florida in 1996 in Broward County and can now be found in numerous other counties in South Florida (UF IFAS 2025/EDDMapS). In South Florida, dwarf rotala grows year-round and can alter its growth habit to suit the changing water levels of the region. This, along with its ability to reproduce from seeds and fragmentation, contributes to its invasive advantage. Once introduced, proliferations of dwarf rotala lead to the accretion of thick vegetative clumps that can block waterways and alter water flows.

Figure 7-34. Dwarf rotala growing in a canal (photo by SFWMD).

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. The emergent variety has also shown up along degraded and leveled road and canal segments within the Picayune Strand Restoration Project. There has been a recent expansion of the plant into Lee and DeSoto counties (EDDMaps).

Control Tools: Control of dwarf rotala has been achieved using surface applications of glyphosate and imazamox or submersed applications of fluoridone in quiescent waters. 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). Florpyrauxifen-benxyl has shown promising results at low rates to provide long-term control of this species (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.

2025 Status of Dwarf Rotala by Management Region

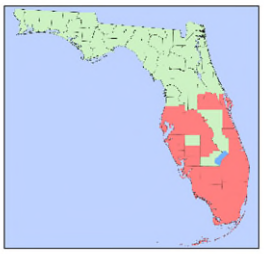
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Shoebutton Ardisia (*Ardisia elliptica*)

SUMMARY: Shoebutton ardisia (**Figure 7-35**) 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 plants following removal of dense thickets of this species (Pascarella and Horvitz 1999). Early infestations may go unnoticed due to this species' morphological similarity to the common native marlberry (*Ardisia escallonioides*).

Figure 7-35. 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 amine or acid as a basal application can be more cost effective for lighter infestations. The ester formulation of triclopyr can only be applied when no water is present. A mix of aminocyclopyrachlor and metsulfuron methyl can be used as a low volume foliar spot treatment. 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.

2025 Status of Shoebutton Ardisia by Management Region

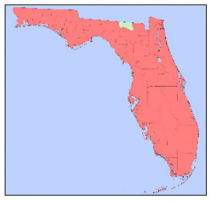
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Torpedograss (*Panicum repens*)

Figure 7-36. Imazapyr treatments of torpedograss at Abiaki Prairie Restoration site in Hendry County (photo by SFWMD).

SUMMARY: Torpedograss (**Figure 7-36**), 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, where the plant stores the majority of its biomass, enable this plant to recover from fire, drought, herbicide application, frost, and mechanical disturbance. One study found that 87% of the total torpedograss biomass was within the rhizomes (Busey 2003). This carbon reservoir allows the plant to quickly rebound following a disturbance and then 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.

KEY MANAGEMENT ISSUES



Distribution: Torpedograss is ubiquitous in South Florida, occurring in sites as distinct as disturbed wetlands and sandy upland sites. Due to the veracity of its phenotypic plasticity, managers struggle with this species' 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 are currently the best method for long-term control. In mixed vegetative communities, selective graminicides such as fluazifop-p-butyl and sethoxydim have proven effective, though repeated treatments are needed (Enloe and Netherland 2017). When selectivity is not a concern, non-selective herbicides such as imazapyr and glyphosate have been shown to better reduce rhizome biomass (Enloe et al. 2020a) (**Figure 7-35**). 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.

2025 Status of Torpedograss by Management Region

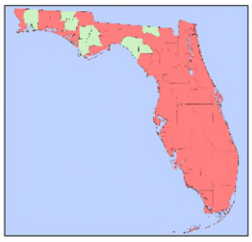
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Water Lettuce (*Pistia stratiotes*)

SUMMARY: Water lettuce is a free-floating aquatic plant that is heavily managed in South Florida. However, the recent discovery of macrofossil seeds has raised questions about the plant's origin and the possibility of its nativity to the region, although the invasion of non-native genotypes appears likely (Evans et al. 2024). Water lettuce primarily spreads through rapid production of vegetative daughter plants, although new plants are also readily produced from seed which are found to be up to 80% viable (Dray and Center 1989). Water lettuce was first 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 7-37**).

Figure 7-37. 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 lakes and canal systems. However, if left unmanaged, these water bodies would harbor significant populations. Aquatic vegetation barriers installed in many canal systems help prevent water management structures from clogging and reduce the spread of water lettuce to downstream water bodies. Routine management 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 or shredding for water lettuce can be practical when it forms a dense mat.

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 allocating funds from the FWC Invasive Plant Management Control Trust Fund to cooperating local agencies.

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

Critical Needs: Development of additional biological controls is needed. Development of remote sensing capabilities to identify populations of water lettuce before they become problematic.

2025 Status of Water Lettuce by Management Region

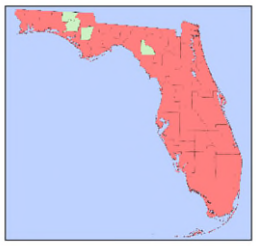
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Water hyacinth (*Pontederia crassipes*)

SUMMARY: Water hyacinth (**Figure 7-38**), a floating aquatic plant native to tropical South America, was brought to Florida in 1884. Shortly after its introduction, it quickly spread and clogged the St. Johns River, hindering navigation. The severity of this infestation caused the United States to initiate its first aquatic plant management program under of the Rivers and Harbors act of 1899 (Center 1996). 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 7-38. 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. Most large lakes continue to harbor significant populations requiring frequent control.

Control Tools: Water hyacinth is readily controlled by herbicides, but chronic reintroduction 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 research plots, public events, or Everglade snail kite (*Rostrhamus sociabilis*) nesting. 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 can make the plant more susceptible to herbicides. In 2010, a 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).

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

Interagency Coordination: FWC coordinates interagency management of water hyacinth via allocated 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 and continued research into augmented releases as for management is needed.

2025 Status of Water Hyacinth by Management Region

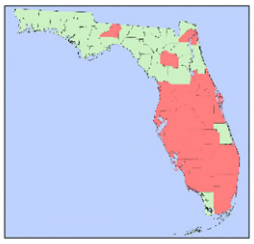
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 7-39. 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 7-39**) 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 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 are needed.

2025 Status of West Indian Marsh Grass by Management Region

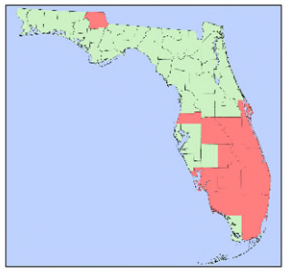
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Wright's Nutrush (*Scleria lacustris*)

SUMMARY: Wright's nutrush is a robust annual, aquatic sedge, considered native throughout the Caribbean, northern South America, and originating in parts of Africa (Jacono 2001). The first recorded occurrence in Florida 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 7-40**).

Figure 7-40. 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 seedbank.

Monitoring: Land managers survey for this species each spring when water levels begin to rise, and the sedge is actively growing. Interagency surveys and management of Wright's nutrush occur in WCA-3A and WCA-1.

Interagency Coordination: There is no formal rapid response plan or regionwide 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.

2025 Status of Wright's Nutrush by Management Region

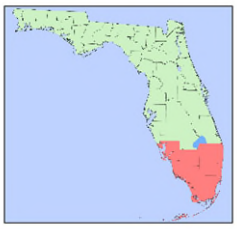
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Burmese Python (*Python molurus bivittatus*)

Figure 7-41. Detection of Burmese pythons is primarily along levees and roads (photo by UF).

SUMMARY: The Burmese python (**Figure 7-41**) 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 18,000 pythons between 2017 and October 2025. Statewide, more than 21,000 Burmese pythons have been removed as of October 2026 (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, 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.

2025 Status of the Burmese Python by Management Region

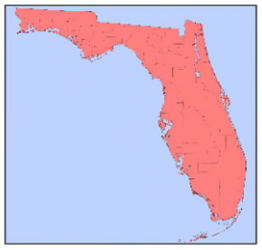
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Feral Hog (*Sus scrofa*)

SUMMARY: Feral hogs (**Figure 7-42**) 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 2020).

Figure 7-42. 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.

2025 Status of Feral Hogs by Management Region

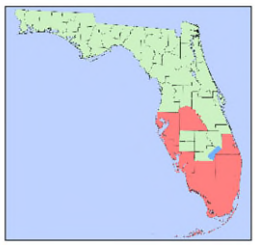
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys

Green Iguana (*Iguana iguana*)

SUMMARY: The green iguana (**Figure 7-43**) 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. Green iguanas directly impact stakeholders as a pest species because they destroy ornamental vegetation and deface property with feces, which may contain *Salmonella* bacteria.

Figure 7-43. Adult male green iguana (photo by SFWMD)

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 dominantly found along human-modified waterways and on the periphery of natural areas. Recent reports indicate that iguanas will utilize more remote locations in natural areas and have been found using marsh and tree island habitat. Anecdotal reports suggest iguana abundance is increasing but their range is still limited by colder temperatures, which can cause mortality, especially after extreme cold weather events.

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: Green iguanas are listed as a Prohibited Species under Chapter 68-5 of the Florida Administrative Code, which restricts pet ownership and commercial sales with some limited exceptions. In May 2025, FWC implemented a rule change to allow for increased capture and out-of-state sale of invasive green iguanas by authorized entities.

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.

2025 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 7-4**). Two graminoid species—tropical American watergrass and tropical nutrush (*Scleria microcarpa*)—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 7-4**). 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 7-4. Priority species currently managed within the South Florida ecosystem for geographic containment or eradication, ranked by taxonomic group and then alphabetically by common name.

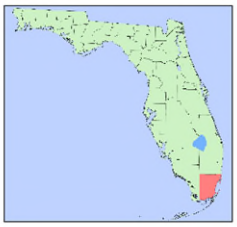
Plants	Reptiles
Asian black mangrove (*Lumnitzera racemosa*)	Argentine black and white tegu (*Salvator merianae*)
Mile-a-minute (*Mikania micrantha*)	Chameleons (*Furcifer oustaleti*/ and *Chamaeleo calyptratus*)
Tropical American watergrass (*Luziola subintegra*)	Nile monitor (*Varanus niloticus*)
Tropical 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 (**Figure 7-44**), is native to Asia and Australia. It 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, however 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, ECISMA and Fairchild Tropical Botanic Garden launched a rapid response effort almost immediately after the invasion was detected.

Figure 7-44. 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 easily controlled by herbicides and hand pulling, its persistent seedbank necessitates repeated treatments. Unlike most other mangrove species, lumnitzera forms a true seedbank. Early interagency efforts removed many plants, and later FWC funding supported more aggressive contractor-led treatments. Annual removals from the 8-ha area have steadily declined and now mostly consist of seedlings and saplings, suggesting the seedbank is shrinking. However, after 15 years of annual removal efforts, new lumnitzera saplings still appear.

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

Interagency Coordination: In the absence of a formalized, regional rapid response program, the 15-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 FY2025, 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.

2025 Status of Asian Black Mangrove or Lumnitzera by Management Region

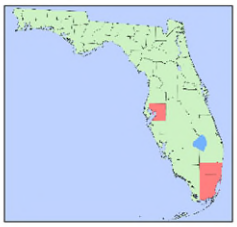
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Mile-a-minute (*Mikania micrantha*)

SUMMARY: Mile-a-minute (**Figure 7-45**) 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 7-45. Mile-a-minute can quickly smother and kill trees and shrubs (photo by FDACS Division of Plant Industry).

KEY MANAGEMENT ISSUES



Distribution: Discovered at a single site 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 and in one location in Hillsborough 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. Many population cores of the plant may be eradicated but annual maintenance work on county properties is 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: There is not currently an active monitoring program for this species.

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

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.

2025 Status of Mile-a-minute by Management Region

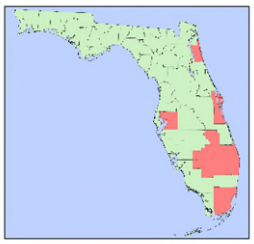
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Tropical American Watergrass (*Luziola subintegra*)

SUMMARY: Tropical American watergrass (**Figure 7-46**) 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. On Lake Okeechobee, higher water levels seem to help with control. Significant increases in *L. subintegra* on the lake in 2025 coincided with low water levels during the dry season. Managers aim to treat the plants before the onset of fall flowering.

Figure 7-46. 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.

2025 Status of Tropical American Watergrass by Management Region

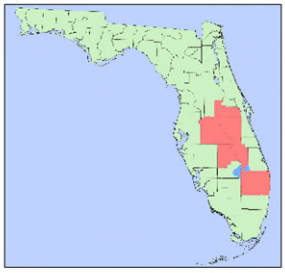
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Tropical Nutrush (*Scleria microcarpa*)

Figure 7-47. Tropical nutrush under cypress canopy (photo by SFWMD).

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 7-47**). 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.

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, TC-, and Osceola CISMAs have provided outreach to engage land managers in the region in detection, reporting, and management of this species.

Interagency Coordination: Heartland and TC-CISMAs makes this species a priority for regional reporting and control 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. TC-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 optimal treatment intervals are needed.

2025 Status of Tropical Nutrush by Management Region

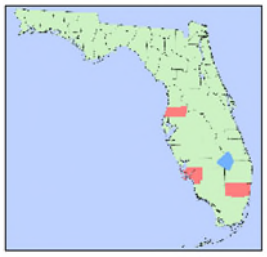
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Giant African Land Snail (*Lissachatina fulica*)

Figure 7-48. The giant African land snail is a host of the rat lungworm (photo by FDACS).

SUMMARY: The giant African land snail (**Figure 7-48**) 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 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 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. Moving the giant African land snail or any regulated item—such as plants, yard waste, or building materials—within, through, or out of a quarantine area without a compliance agreement is prohibited by law.

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

2025 Status of Giant African Land Snail by Management Region

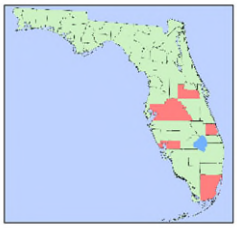
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Argentine Black and White Tegu (*Salvator merianae*)

SUMMARY: The Argentine black and white tegu (**Figure 7-49**) 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. 2015). Eradication from Florida is now considered unlikely.

Figure 7-49. 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), Charlotte County (Quinn et al. 2022), St. Lucie County (Sarah Funck, FWC, personal communication; Miller et al. in prep), and an emerging population in Orange County (David Lingenfelser, FWC, communication). 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 were examined by UF and were found to significantly increase detection and removal of tegus while reducing resources needed to operate trap lines. As of October 1, 2025, over 740 traps have been deployed by FWC, SFWMD, NPS, UF, and FPL for FY2025.

Monitoring: Interagency collaborators have conducted regional monitoring for tegus in Miami-Dade County since 2011. Monitoring methods include camera surveillance, visual surveys, detector dogs, and eDNA.

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

Regulatory Tools: As of April 29, 2021, tegus (genera *Salvator* and *Tupinambis*) are listed as a Prohibited Species per Chapter 68-5, Florida Administrative Code.

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.

2025 Status of the Argentine Black and White Tegu by Management Region

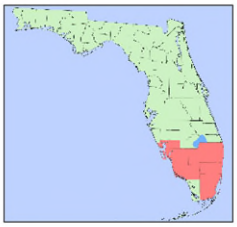
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 7-50**) 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 7-50. 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. In 2025, UF and partners have initiated surveys at this site 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).

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

Monitoring: An interagency team, led by FWC, began a rapid assessment monitoring project in July 2011 for Oustalet's chameleons.

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 require 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.

2025 Status of Chameleons by Management Region

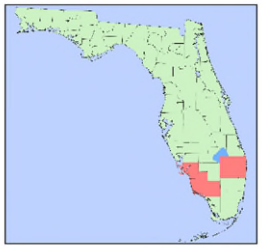
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Nile Monitor (*Varanus niloticus*)

SUMMARY: The Nile monitor (**Figure 7-51**) 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 7-51. 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, but populations are not believed to be established in these areas.

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. Between discovery and October 2025, the total number of Nile monitors that have been removed from Palm Beach and Lee counties are 135 and over 647, respectively.

Monitoring: FWC is 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. An understanding of the ecology of Nile monitors concerning movement and habitat use, particularly in the C-51 Basin, is needed to increase our ability to detect and remove monitors.

2025 Status of the Nile Monitor by Management Region

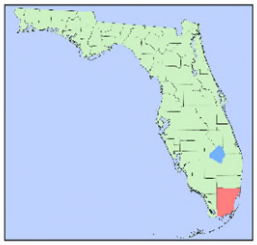
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Northern African Python (*Python sebae*)

SUMMARY: Since 2001, over 46 northern African pythons (**Figure 7-52**) 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 expansion beyond its established population in Miami-Dade County throughout South Florida (Reed and Rodda 2009).

Figure 7-52. 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.

Control Tools: Control options for this species are limited, primarily due to low detectability and lack of dedicated resources for this species. 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.

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, or develop new tools, are constrained by limited resources.

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 to inform detection and removal surveys). As this species is similar to Burmese pythons, a concerted and sustained effort is needed to attempt eradication of northern African pythons and ensure that this species does not expand beyond its current distribution.

2025 Status of Northern African Python by Management Region

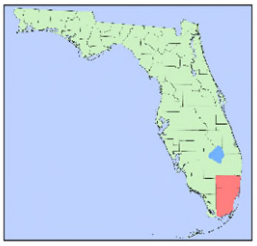
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Spectacled Caiman (*Caiman crocodilus*)

Figure 7-53. A spectacled caiman (photo by UF).

SUMMARY: Spectacled caiman (**Figure 7-53**) 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.

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, or eradication of this species in the Greater Everglades ecosystem.

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 350 caimans since 2011.

Monitoring: 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 need to continue to sustain maximum control of caiman populations. An understanding of the extent of potential immigration and additional release of caiman, as well as identifying movement patterns and nesting habitats, are needed.

2025 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 7-54**). 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 7-54. Gambian pouched rat (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 of the population (Engeman et al. 2007). Control efforts 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.

2025 Status of Gambian Pouched Rat by Management Region

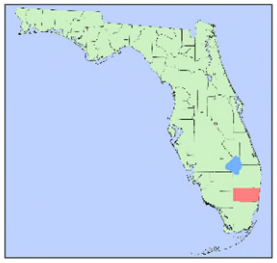
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Conehead Termite (*Nasutitermes corniger*)

Figure 7-55. Photo of conehead termite nest and inset of termite (photo by

SUMMARY: Conehead termites were first discovered in Dania Beach, Florida in 2001 (**Figure 7-55**). 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.

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 presumed eliminated and include residential, commercial, and natural landscapes. Currently known active populations are restricted to approximately 10 acres of land near the Fort 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. While officially an arboreal termite, meaning nests are typically located aboveground and often in trees, the conehead termites in Broward County have recently been found with increasing frequency in, or just below, the ground surface. This has complicated the surveying and treatment efforts as subsurface nests can be more difficult to locate and remove.

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

2025 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 7-5**). 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 7-5. Priority species not currently managed within the South Florida ecosystem for geographic containment, ranked by taxonomic group and then alphabetically by common name.

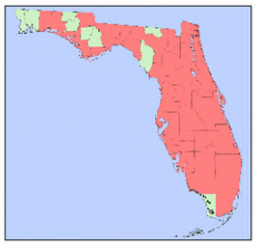
Mollusks & Planarians	**Birds**
Island apple snail (*Pomacea maculata*)	Grey-headed swamphen (*Porphyrio porphyrio*)
New Guinea flatworm (*Platydemus manokwari*)	
Insects	**Amphibians**
Laurel wilt (*Raffaelea lauricola*), vectored by an ambrosia beetle (*Xyleborus glabratus*)	Cuban treefrog (*Osteopilus 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 7-56**) 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, vacuolar myelinopathy (VM), 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 VM in laboratory birds fed affected snails (Dodd et al. 2016), suggesting a significant risk to the snail kite and other avifauna.

Figure 7-56. 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.

2025 Status of Island Applesnail by Management Region

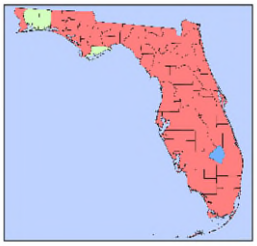
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Laurel Wilt (*Raffaelea lauricola*)

SUMMARY: Laurel wilt (**Figure 7-57**) 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). Documented reductions in abundance of Palamedes swallowtail butterflies (*Papilio palamedes*) in laurel wilt infested stands raises serious concerns for this and other obligate specialists of host plants vulnerable to laurel wilt (Riggins et al. 2019).

Figure 7-57. Dying red bay trees in a mixed hardwood forest (photo by UF).

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. 2014b) and is now throughout the Greater Everglades. Laurel wilt is also widespread throughout SFWMD's East Coast land management region.

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 ambrosia 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).

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 continued evaluation of *Persea* resistance, *Persea* seed/germplasm conservation efforts, potential chemical or biological control tools, discovery of chemical attractants for *X. glabratus*, and impacts on native flora, ecological processes, and native fauna such as the Palamedes swallowtail butterfly.

2025 Status of Laurel Wilt by Management Region

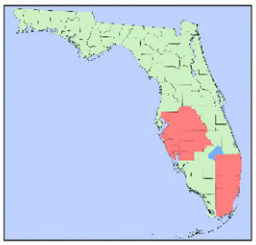
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
		not applicable				not applicable	

Asian Swamp Eel (*Monopterus albus*)

SUMMARY: Asian swamp eels (**Figure 7-58**) 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 7-58. 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, and 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, the mud eel (*Amphipnous cuchia*) was recently discovered in Lake Underhill in Orange County. While currently not documented in the wild in South Florida, it is sold in live food markets in Florida suggesting 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. A 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.

2025 Status of Asian Swamp Eel by Management Region

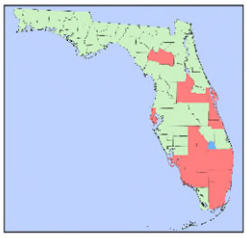
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Grey-headed Swamphen (*Porphyrio porphyrio*)

SUMMARY: The grey-headed swamphen (**Figure 7-59**) 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 7-59. 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.

2025 Status of Grey-headed Swamphen by Management Region

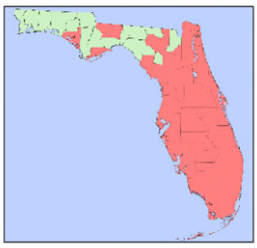
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Cuban Treefrog (*Osteopilus septentrionalis*)

Figure 7-60. The Cuban treefrog is now widely dispersed throughout Florida (photo by UF).

SUMMARY: The Cuban treefrog (**Figure 7-60**) 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.

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 is 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.

2025 Status of the Cuban Treefrog by Management Region

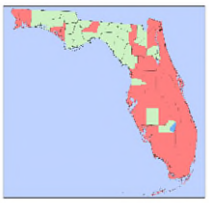
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

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 7-61**). 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. 2025).

Figure 7-61. New Guinea flatworm (photo by Lawrence Lopez).

KEY MANAGEMENT ISSUES



Distribution: From North Florida to the Florida Keys, 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 geographic spread of this species.

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: 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. 2025).

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 NGF to native species of tree snails has been observed by FIU researchers (Lopez et al. 2025), prompting the need to implement control measures for this invasive species.

2025 Status of New Guinea Flatworm by Management Region

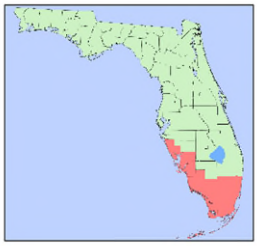
Upper Lakes	Kissimmee	Lake Okeechobee	East Coast Region	West Coast Region	Everglades	Florida Bay & Southern Estuaries	Florida Keys
							

Black Spiny-tailed Iguana (*Ctenosaura similis*)

SUMMARY: The black spiny-tailed iguana (**Figure 7-62**) 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 iguanas across South Florida emphasizes the necessity to develop and implement management strategies, potentially in tandem with green iguana management.

Figure 7-62.
Black spiny-tailed iguana (photo by Jenna Cole).

KEY MANAGEMENT ISSUES



Distribution: Black spiny-tailed iguanas inhabit mostly human-modified habitats throughout 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.

2025 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
							

EMERGING ISSUES

South Florida is particularly vulnerable to ongoing biological invasions due to its subtropical climate, diverse ecosystems, extensive human activity, numerous international ports, and large population centers (Searcy et al. 2023). The state hosts more non-native species than any other region in the continental United States. Climate change—through rising temperatures and shifting precipitation patterns—is further accelerating the spread of non-native species, complicating management efforts and underscoring the need for a proactive, adaptive approach to invasive species control.

This chapter has explored a range of invasive species issues, with a focus on the highest priority species affecting South Florida's native ecosystems. This section highlights several newly identified non-native invasive species that may pose significant ecological risks. As with earlier parts of the chapter, this is not an exhaustive review, but rather a snapshot of species that have recently drawn the attention of invasive species researchers and natural resource managers. Rapid assessments and preliminary studies are currently underway to evaluate their potential impacts and to determine possible control measures to slow their spread.

Halophila Seagrass (*Halophila stipulacea)*

Halophila seagrass (*Halophila stipulacea*) (**Figure 7-63**) is a fast-growing species of seagrass native to the Red Sea region. This marine plant grows in sublittoral sediments on sand, mud and coral rubble (Winters et al. 2025). *H. stipulacea* is listed as an invasive species in the Mediterranean Sea (Bourdouresque and Verlaque 2002) and is also included on a list of the 100 worst alien species in Europe (EEA 2007). *H. stipulacea* is reported to grow faster than native plants and dominate native sea grass communities. This species is documented to have a negative effect on native sea grass species.

Figure 7-63. *Halophila stipulacea* (photo courtesy of the National Oceanic and Atmospheric Administration's [NOAA's] National Ocean Service)

H. stipulacea was documented for the first time in the continental United States in August 2024 at a marina on Key Biscayne, Florida (Campbell et al. 2025). Subsequent surveys have confirmed that *H. stipulacea* had already spread beyond the marina into adjacent waters. The seagrass was assessed by UF IFAS using the Predictive Tool and found *H. stipulacea* to have a high invasion risk in Florida's marine waters (UF IFAS 2025). Researchers suspect that its introduction to Florida occurred via recreational boats traveling from the Caribbean, where the species is already established (Ruiz Ballantine 2004). The ecological implications of this invasion are concerning, as *H. stipulacea* has been documented to be more aggressive in Caribbean waters compared to invasions in the Mediterraean Sea (Winters et al. 2023). For example, the extirpation of congener *H. decipiens* from the island of Dominica has been documented, where invasive *H.stipulacea* now occurs in habitats where *H. decipiens* previously existed (Steiner and Willette 2015). FWC has distributed an invasive plant advisory for *H. stipulacea* urging the public and partner agencies to report sightings in support of ongoing monitoring efforts. Individuals are advised not to remove the plant as disturbance can cause the plant to fragment and spread via currents.

Vacuolar Myelinopathy

Vacuolar myelinopathy (VM) is a fatal neurodegenerative disease marked by extensive vacuolization—formation of fluid-filled spaces—in the white matter of the brain. First identified in 1994 in bald eagles in the southeastern United States (Thomas et al. 1998), VM has since been documented across a growing number of sites in the region. Although initially observed in avian species such as waterfowl and raptors (Haram et al. 2020), the disease has also been found to affect a broader range of wildlife, including amphibians, reptiles, and fish. Both field observations and laboratory experiments have demonstrated that VM can move through the food web, transferring from herbivorous species to their predators (Dodd et al. 2016, Breinlinger et al. 2021).

The causative agent of VM is aetokthonotoxin, a potent neurotoxin produced by the cyanobacterium *Aetokthonos hydrillicola* (Breinlinger et al. 2021). This cyanobacterium grows epiphytically—on the surface—of submerged aquatic vegetation, most notably the invasive plant *Hydrilla verticillata* (Wilde et al. 2014). Although *A. hydrillicola* was first discovered on hydrilla, it has also been found growing on other aquatic plant species. The geographic origin of *A. hydrillicola* remains unknown, and it is still unclear whether the organism is native to North America or introduced.

In aquatic systems, *H. verticillata* forms dense mats that serve as an ideal substrate for the proliferation of *A. hydrillicola*. Studies conducted across the southeastern United States have shown that 45% of surveyed watersheds with hydrilla were colonized by *A. hydrillicola* (Breinlinger et al. 2021). Notably, wildlife deaths from VM have only been reported in reservoirs where both hydrilla and *A. hydrillicola* are present in high densities, suggesting a strong correlation between colonization and disease outbreaks.

The link between plant and pathogen is made more complex by environmental chemistry. *H. verticillata* provides an optimal substrate for *A. hydrillicola* (Wilde et al. 2014), which has been shown to hyperaccumulate bromide from its surroundings—a key precursor in the biosynthesis of aetokthonotoxin. Laboratory studies confirm that exposure to potassium bromide significantly increases toxin production by *A. hydrillicola*, indicating that environmental conditions can directly influence the virulence of this disease pathway.

The ecological relationship between *H. verticillata*, *A. hydrillicola*, and the toxin aetokthonotoxin represents a unique and concerning example of how an invasive plant can facilitate a cascading disease outbreak across trophic levels in aquatic and avian wildlife. Of particular concern for the Everglades ecosystem is the detection of aetokthonotoxin in five of ten Burmese python tail tissue samples (Susan Wilde, University of Georgia, unpublished data). This raises the risk of toxin transfer through the food web and has led to speculation that the neurological disease affecting Florida panthers (*Puma concolor coryi*) and bobcats (*Lynx rufus*) may be linked to aetokthonotoxin. This hypothesis is based on the presence of the toxin in affected animals and the similarity in clinical signs to those observed in other wildlife known to have been exposed to aetokthonotoxin (Susan Wilde and Tobias Elliott Haymes, University of Georgia, personal communication, unpublished data).

Further research is needed to confirm this connection and determine whether aetokthonotoxin is contributing to mortality in panthers and bobcats. To date, this plant-cyanobacterium interaction has only been documented in artificial reservoirs and eutrophic lakes in the southeastern United States, including confirmed detections in the Kissimmee River Watershed (e.g., Lake Tohopekaliga).

Toungeworms

Raillietiella orientalis is a species of an invasive pulmonary pentastomid parasite, commonly referred to as toungueworms, with an indirect lifestyle that includes snakes as its definitive host and invertebrates, anurans, lizards, and likely small mammals, as intermediate hosts. This pentastome is native to Southeast Asia where it infects a diversity of native snakes including Burmese pythons. Introduction of this species

was likely due to human mediated dispersal pathways including the exotic pet trade of Burmese pythons (Miller et al. 2018).

Raillietiella orientalis has been documented in over half of the counties in Florida since its initial discovery in South Florida by Miller et al. (2018). Many species of native snakes exhibit high parasite prevalence and intensity, which has facilitated the spread of *R. orientalis* beyond the known range of Burmese pythons (Miller et al. 2020). Unlike the often inconsequential impacts to snakes infected by *R. orientalis*' within the parasites native range, when a parasite such as *R. orientalis* is introduced to hosts that do not share a coevolutionary history with the parasite, such as our native snakes in Florida, the impacts of infection may be more severe. *R. orientalis* often achieves high prevalence and intensity, and larger size, in Florida's native snakes compared to pythons (Miller et al. 2020). More research is needed to understand the implications of infection to native snake populations as well as physiological impacts to hosts and this is currently underway by UF, USGS, and USDA as well as other researchers. Anecdotal evidence suggesting *R. orientalis* may result in host mortality is concerning and stresses the need for robust examination of the impacts of this pentastome. Evidence from research suggests *R. orientalis* can infect a diversity of native snake species in Florida and North America and that this parasite may continue to expand and invade a broad geographic range and infect additional snake species (Miller et al. 2020). Endangered native snake species such as the eastern indigo snake (D*rymarchon couperi*) could be impacted from this nonnative parasite as *R. orientalis* infection may be associated with an incidence of mortality observed for a captive individual of this species (Bogan et al. 2022) and wild populations of indigo snakes have been documented to be infected by the pentastome (Miller et al. 2018). In addition to the threat of *R. orientalis* to Florida's native snakes, *R. orientalis* has also been documented to infect Argentine black and white tegus and tokay geckos (Goetz et al 2021, Fieldsend et al. 2021) in Florida. The extent to which invasive lizards, and other nonnative taxa, may be aiding transmission of *R. orientalis* is unknown and warrants further investigation.

The introduction, establishment, and spread of a nonnative pentastome attributed to an invasive species highlights additional unintended and indirect consequences of invasive species on the landscape, the far-reaching impacts to native fauna beyond the range of the invader, and the importance of proactive prevention of invasive species introductions.

Vallisneria × pseudorosulata

An important component of aquatic ecosystems eelgrass (*Vallisneria*) is often used in restoration of aquatic habitats in Florida and elsewhere due to its native status and desirable ecological benefits. Historically, all species of *Vallisneria* within the United States were classified as American eelgrass (*Vallisneria americana*). However, recent genetic studies have verified that there are two species of *Vallisneria* native to the eastern United States (*V. americana* and *V. neotropicalis*) (Martin and Mort 2022). Additionally, nonnative *Vallisneria* species and hybrid cultivars are being identified in Florida that were widely used in restoration efforts because they were thought to be native to Florida. This cultivar, dubbed "Rock Star" is in fact a hybrid whose parental species are *V. spiralis* L. and *V. denseserrulata* Makino and is referred to as *Vallisneria* x *pseudorosulata* (**Figure 7-63**) (Gebhart et al. 2024).

Figure 7-63. *Vallisneria* x *pseudorosulata* growing in Florida waterway (photo by FWC).

Identification of *Vallisneria* x *pseudorosulata* and *V. americana* in situ is challenging due to limited diagnostic characteristics between the two but the collections of samples that have been genetically

analyzed have confirmed that the nonnative hybrid *Vallisneria* x *pseudorosulata* is outcompeting native *V. americana*, becoming established as the dominant species in water bodies and is aggressively spreading and displaying the ability to disperse over long ranges (Gebhart et al. 2024). Management of nonnative *Vallisneria* species with herbicide is an option for aquatic habitat managers but research is limited into the ability to selectively control nonnative species of *Vallisneria* without adversely impacting native species, an issue that is compounded by their frequent co-occurrence in water bodies in Florida (Beets et al. 2024).

State agencies are working with partners and researchers to try to determine how widely spread nonnative *Vallisneria* populations are within the state and elsewhere as well as how these species respond to management activities and how they interact with other *Vallisneria* species through competitive ability. Mangers and researchers are also interested in how the nonnative species of *Vallisneria* interacts with aquatic flora and fauna and how they may alter ecosystems or impact recreational opportunities for stakeholders.

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. However, several legislative and regulatory barriers make controlling animal introduction and establishment significantly harder than controlling invasive plant spread. A key example is the D.C. Circuit decision in USARK v. Zinke (2017), which held that the Lacey Act does not prohibit the interstate transport of injurious wildlife among the 49 continental states. While the USFWS may still restrict importation into the United States, it cannot use the act to limit movement of invasive animals between states, reducing the federal government's ability to prevent new introductions. Compounding this challenge, the live-animal pet and wildlife trade remains large and generally under-regulated with respect to ecological invasion risk; pre-import screening tends to emphasize disease and human safety rather than ecosystem impacts, and enforcement and risk-assessment staffing remain limited. 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 Management 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 ecological 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. SFWMD and partner agencies are working to strengthen regional monitoring capacity, including "Corridors of Invasion" surveys conducted by SFWMD and the National Park Service at high-risk introduction points (e.g., boat ramps), and systematic Everglades monitoring by the USACE and SFWMD in collaboration with UF IFAS. These efforts increasingly incorporate tools such as environmental DNA (eDNA). Although these programs improve early detection, substantial geographic and species gaps remain, and more comprehensive and standardized monitoring across jurisdictions is needed to support effective EDRR. Advanced prioritization and predictive screening tools would be a boon for managers, aiding in the identification of potential detrimental threats so resources could be allocated to maintain them at the bottom of the invasion curve (**Figure 7-25**) prior to unanticipated rapid spread and infestation.

With hundreds of potential invaders and limited resources, agencies must continually engage in prioritization exercises to direct management decisions. Like other partner agencies, SFWMD focuses on species that are documented or reasonably anticipated to be strong competitors with native species, capable of ecosystem engineering (e.g., altering fire regimes, habitat structure, or biogeochemical cycling), altering food webs, or invading otherwise intact ecosystems rather than only disturbed areas. Such prioritization ensures that limited resources are directed toward species with the greatest potential to affect restoration and conservation goals.

Species like the sacred ibis 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). Although Florida has no single, centralized EDRR program, a loose but functional network exists—ranging from state and federal policy and response programs (e.g., FWC's nonnative wildlife program, USDA and FDACS programs for agricultural pests) to scientific guidance through UF IFAS and USGS, to on-the-ground, often underfunded EDRR activities implemented by regional CISMAs. The Everglades Restoration Task Force has recently collaborated with UF and teams of subject matter experts to begin developing more formal EDRR prioritization tools, but dedicated funding is needed for consistent, timely rapid-response actions.

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 30 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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