

Chapter 7: Status of Invasive Species

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HIGHLIGHTS

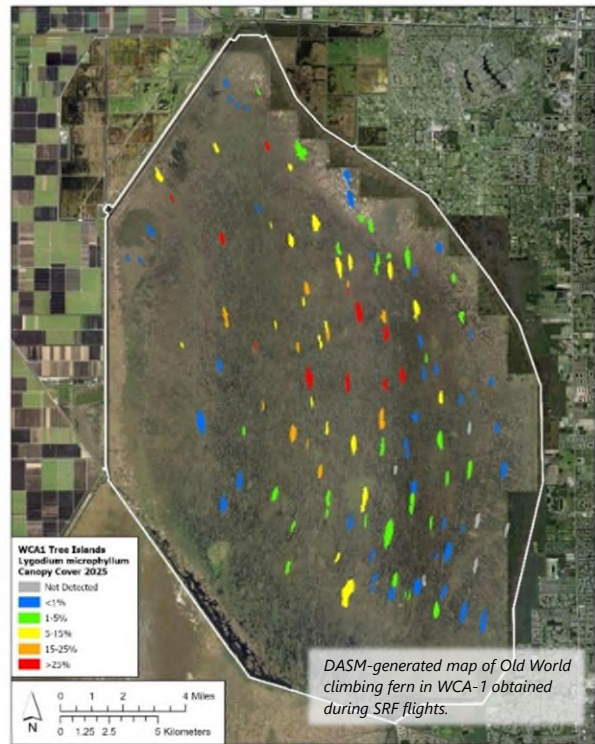
Quite a few accomplishments related to invasive species were made just prior to or during Fiscal Year 2025 (October 1, 2024–September 30, 2025). Several are highlighted here.

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 priority species. The monitoring program is allowing for informed decision making on control efforts.



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32 **INUNDATIVE RELEASES OF BIOCONTROL AGENTS OF WATER HYACINTH**



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

44 conducted at a site near Indiantown, Florida. Water hyacinth coverage in the nearby Allapattah area was reduced from
 45 95% water body coverage in July 2024 to less than 5% water body coverage in January 2025. There is now the potential for
 46 decreased herbicides in areas populated by this and other water hyacinth biocontrol agents.

47 **PICAYUNE STRAND INVASIVE FISH**
 48 **PROJECT**

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



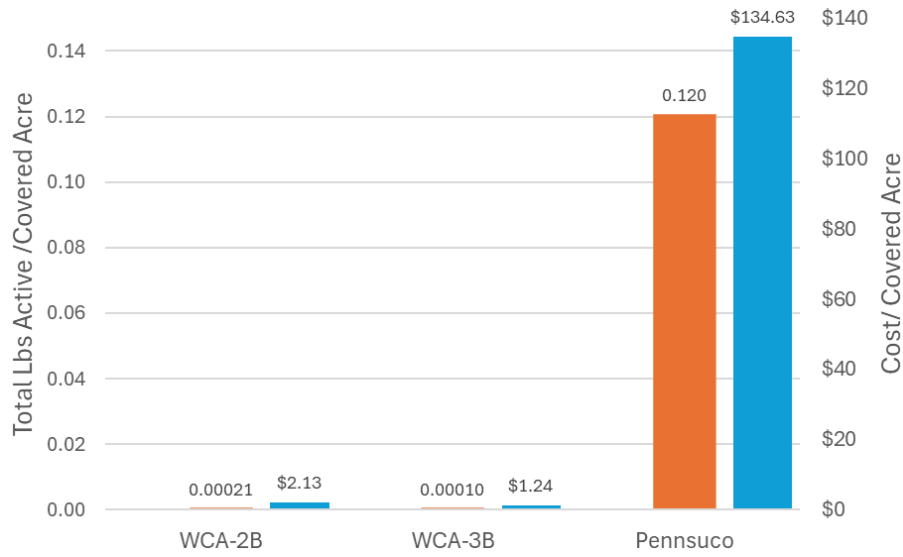
59 **HERBICIDE REDUCTION THROUGH MAINTENANCE CONTROL: LAKE**
 60 **OKEECHOBEE HISTORY OF FLOATING AQUATIC VEGETATION**
 61 **MAINTENANCE CONTROL PROGRAM**

62 The program controlling invasive floating plants on Lake Okeechobee is an example of long-term maintenance success if the
 63 control program progresses uninterrupted. Maintenance control of these plants on the lake was paused for three months in
 64 2019 and the unintended consequence was the quick rebound of invasive plants. The observed acres of invasive floating
 65 vegetation increased to over 11,000 acres due to the pause. Since then, there has been a successful return to maintenance
 66 control but with temporary increased use of herbicides and elevated costs. Less than 2,000 acres remained infested in 2024.

67 **MELALEUCA MAINTENANCE CONTROL PROGRAM**

68 Melaleuca is a fast-growing invasive tree from Australia that was widely planted across South Florida. By the 1990s, it had
 69 infested nearly 500,000 acres, including major wetlands such as the WCAs, Big Cypress National Preserve, and Everglades
 70 National Park. The successful maintenance control program within WCA-2 and WCA-3 led to restored native marsh habitat
 71 previously dominated by melaleuca. Current infestation covers less than 1% of the more than 120,000 acres within these areas.
 72 The sustained efforts to systematically remove dense infestations in these areas while preventing reinfestations through
 73 diligent monitoring and follow up treatments has resulted in significant reductions in the management costs and herbicide
 74 utilization. By contrast, the 4,867-acre Pennsuco Wetlands site, located east of WCA-3B, has had inconsistent past melaleuca

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



77 Comparison of per acre herbicide use and control costs for melaleuca management in two areas under
 78 maintenance control (WCA-2B and WCA-3B) and an initial melaleuca treatment in the Pennsuco Wetlands area.
 79

80 **NEW RESEARCH PUBLISHED IN 2024 AND 2025**

81 Quite a few new publications containing important information related to invasive species became available during 2024 and
 82 2025. These publications are as follows:

- 83 • Invasive swamp eels reduce aquatic animal diversity and disproportionately reduce prey for nesting wading birds
 84 (Pintar and Dorn 2025)
- 85 • Improving mass-rearing techniques for releases of *Floracarus perrepae*, a biological control agent for Old World
 86 climbing fern (Aquino-Thomas et al. 2025)
- 87 • Employing targeted outreach to improve community involvement in detecting invasive Nile monitors (*Varanus*
 88 *niloticus*) in Florida (Mazzotti et al. 2024)
- 89 • Diet of spectacled caimans (*Caiman crocodilus*) removed from Broward and Miami-Dade counties, Florida, USA
 90 (Godfrey et al. 2025)
- 91 • Optimizing survey conditions for Burmese python removals: Insights from contractor program data (McCaffrey et al.
 92 2025)
- 93 • State of knowledge for invasive green iguanas in Florida reveals negative impacts and pervasive research needs
 94 (Claunch et al. 2025)
- 95 • Management of invasive iguanas mitigates deleterious impacts on an imperiled tortoise (McKnight et al. 2025)
- 96 • Nile monitor distribution models to aid regional mitigation efforts (Bevan et al. 2024)
- 97 • Big pythons, big gape, and big prey (Jayne et al. 2024)
- 98 • Mammalian lures monitored with time-lapse cameras increase detection of pythons and other snakes (McCampbell
 99 et al. 2024)
- 100 • Flooding-induced failure of an invasive Burmese python nest in southern Florida (Sandfoss et al. 2024)
- 101 • Trophic disruption by an invasive species linked to altered energy fluxes (Flood et al. 2025)
- 102 • An evaluation of reduced hack and squirt treatment with aminocyclopyrachlor and aminopyralid for invasive tree
 103 control in Florida (Enloe et al. 2025)
- 104 • Two potential candidates for biological control of cogongrass in quarantine (Gazdick et al. 2024)

- 105 • Selective method for invasive plant removal enhances restoration (Hinkson et al 2024)
- 106 • Vertical distribution of *Floracarus perrepae* (Acariformes: Eriophyidae) galls on the invasive fern *Lygodium*
- 107 *microphyllum* (Schizeales: Lygodiaceae) and a potential productivity-reproduction tradeoff (Aquino-Thomas et al.
- 108 2025)
- 109 • When to target control efforts? Using novel GPS telemetry to quantify drivers of invasive Argentine black and white
- 110 tegu (*Salvator merianae*) movement (Mason et al. 2024)
- 111 • Using camera traps to estimate site occupancy of invasive Argentine black and white tegus (*Salvator merianae*) in
- 112 South Florida (Smith et al. 2025)
- 113 • Assessing the effects of climate change on the current and future global distribution of three tegu species using an
- 114 optimized model (Fontanella 2025)
- 115 • Not one but two: Examining the genetic origin and characterization of the non-native spectacled caiman (*Caiman*
- 116 *crocodilus*) in Florida (Parks et al. 2024)
- 117 • Asian swamp eels (Synbranchidae, Monopterus) in Florida: Distribution, spread and range of hydrologic tolerance
- 118 over twenty-seven years (1997–2023) (Pintar et al. 2024)
- 119 • Mammal declines correspond with increasing prevalence of Burmese pythons at their southern invasion front in the
- 120 Florida Keys (Redinger et al. 2024)
- 121 • Post-release support of host range prediction of two *Lygodium microphyllum* biological control agents. (Aquino-
- 122 Thomas et al. 2025)

123

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SUMMARY AND INTRODUCTION

124

125 Invasive species pose serious threats to ecosystem community structure and function throughout South
126 Florida. Controlling invasive species is cited as a critical resource management activity in the South Florida
127 Water Management District (SFWMD) *Strategic Plan, 2021–2026* (SFWMD 2020). Effective invasive
128 species management also supports other strategic goals, as their widespread impacts must be addressed in
129 numerous SFWMD activities—including Environmental Resource Permit evaluations, Everglades
130 Stormwater Treatment Area (STA) operations, and restoration of natural fire regimes. In support of
131 collective activities of the many agencies involved in Everglades restoration, this chapter reviews the broad
132 issues involving invasive species in South Florida and their relationship to restoration, management,
133 planning, organization, and funding. Authors from numerous partnering agencies and institutions provide
134 updates for many priority invasive species, programmatic overviews of regional invasive species initiatives,
135 and key issues linked to managing and preventing biological invasions in South Florida ecosystems. While
136 detailed data are lacking for some invasive species, this document attempts to provide an update and
137 annotations for priority plant and animal species, including summaries of new research findings. As part of
138 continued efforts to streamline reporting, this year’s update emphasizes new information obtained during
139 Fiscal Year 2025 (FY2025; October 1, 2024–September 30, 2025).

140 COLLABORATION

141 In addition to providing the status of invasive species programs and outlining programmatic needs, this
142 document summarizes what, if any, control or management is under way for priority invasive species
143 considered capable of impacting the resources SFWMD is mandated to manage or restore. SFWMD
144 continues to participate on collaborative working groups focused on invasive species management
145 including the Lake Okeechobee Interagency Aquatic Plant Management Team, South Florida Ecosystem
146 Restoration Task Force (SFERTF), Florida Invasive Species Council (FISC), Florida Python Control Plan
147 (FPCP) Working Group, regional cooperative invasive species management areas (CISMAs), and other
148 cross-jurisdictional teams. These collaborations have facilitated the implementation of regionwide invasive
149 species monitoring programs, rapid response efforts, standardized data management, and outreach
150 initiatives. As such, this report includes a great deal of information and summaries of accomplishments
151 attributed to the efforts of these collaborative teams. Active partners in invasive species management within
152 the South Florida ecosystem include but are not limited to the following entities: Broward County, Collier
153 County, Miami-Dade County, Monroe County Land Authority, Palm Beach County, Florida Fish and
154 Wildlife Conservation Commission (FWC), Florida Department of Agriculture and Consumer Services
155 (FDACS), Florida Fish and Wildlife Research Institute (FWRI), Miccosukee Tribe of Indians of Florida,
156 Seminole Tribe of Florida, United States Army Corps of Engineers (USACE), United States Department
157 of Agriculture (USDA) – Agricultural Research Service (ARS), United States Department of the Interior,
158 United States Geological Survey (USGS), National Park Service (NPS), United States Fish and Wildlife
159 Service (USFWS), and University of Florida (UF).

160 A NOTE ON TERMINOLOGY

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

169 **INVASIVE SPECIES IN THE RESTORATION CONTEXT**

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

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

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

188 Despite the challenges biologists and land managers face regarding Everglades restoration and invasive
189 species management, significant accomplishments have resulted from CERP-related activities and
190 initiatives. For example, SFWMD and USACE partner with USDA to fund a biological control program
191 focused on integrated invasive plant control within the CERP footprint. Because of this partnership, more
192 than 60 million insects and mites have been released in South Florida, helping to control hundreds of acres
193 of invasive plant species.

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

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

217 will be introduced into Florida each year, and it is impossible to predict which of those species will be the
218 next to persist and spread throughout the landscape and thereby impact restoration gains or goals. Having
219 the capability to quickly respond to such species is integral in restoring the Greater Everglades ecosystem
220 to its historic state. In the future, having flexible EDRR funds available to respond to new introductions in
221 combination with additional prevention efforts (i.e., education and public outreach) will allow for the
222 Everglades to not only remain as it was, but return it to its natural state.

223 **INVASIVE PLANTS**

224 Ninety-four invasive plant species are SFWMD priorities for control. Old World climbing fern
225 (*Lygodium microphyllum*), melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus*
226 *terebinthifolia*), and Australian pine (*Casuarina* spp.) continue to be systemwide priorities in terrestrial
227 natural areas, while aquatic plants such as hydrilla (*Hydrilla verticillata*), water hyacinth (*Pontederia*
228 *crassipes*), tropical American watergrass (*Luziola subintegra*), and crested floating heart (*Nymphoides*
229 *cristata*) are priorities in the Kissimmee Basin, Lake Okeechobee, and SFWMD’s STAs and canal systems.

230 Efforts to control invasive plants continue throughout SFWMD-managed natural areas, STAs, project
231 lands, lakes, and flood control canals and levees. SFWMD and partner agencies continue ongoing efforts
232 to refine invasive plant management strategies with the goal of achieving cost-effective and
233 environmentally responsible maintenance control of the most harmful species.

234 The Interagency Melaleuca Management Program is a national model for regional, interagency invasive
235 plant control programs. Melaleuca has been systematically controlled in Water Conservation Area (WCA)
236 2, WCA-3, northern Everglades National Park (ENP), and Lake Okeechobee and is now under maintenance
237 control in these regions.

238 SFWMD, FWC, and USFWS are actively engaged in aggressive control efforts in WCA-1 (part of the
239 Arthur R. Marshall Loxahatchee National Wildlife Refuge [LNWR]) where melaleuca and Old World
240 climbing fern remain problematic. NPS resource managers are collaborating with FWC and SFWMD
241 invasive species biologists to leverage resources towards achieving maintenance-level control of melaleuca,
242 Brazilian pepper, and other aggressive invaders in ENP and Big Cypress National Preserve (BCNP).
243 Biologists with Palm Beach County, FWC, and SFWMD are coordinating treatments of missiongrass
244 (*Cenchrus polystachios*), a recently discovered federal noxious weed in Palm Beach County. USACE,
245 FWC, and SFWMD continue to manage invasive plants on Lake Okeechobee. In addition, USACE manages
246 Brazilian pepper, Old World climbing fern, several invasive grass species, and melaleuca on private
247 easements for the Natural Resources Conservation Service (NRCS).

248 Biological control of several invasive plants is showing promising outcomes. The CERP’s Biological
249 Control Implementation project continues rearing and releasing approved agents at the USDA-ARS
250 biological control laboratory in Davie, Florida. During FY2025, the program continued releases of
251 biological control agents for Old World climbing fern, Brazilian pepper, and melaleuca. Since the CERP
252 project’s inception in 2013, there have been over 4,000 release events resulting in the release of nearly
253 80 million biological control agents.

254 Range expansions of nonnative plant species into new areas remain a concern for resource managers.
255 Agencies charged with invasive plant control are assessing the threats posed by new introductions and are
256 monitoring and controlling these populations, when deemed appropriate, based on threat prioritization and
257 financial resource availability. Interagency groups are utilizing and curtailing screening tools to aid in
258 prediction of potential introductions of new nonnative or invasive species.

259

260 **INVASIVE ANIMALS**

261 Considerable numbers of nonnative animals are known to occur in South Florida, ranging from
 262 approximately 62 species in the Kissimmee Basin to over 130 species in the Greater Everglades. Ranking
 263 invasive animal species for control is a technical challenge though recent efforts to develop risk assessment
 264 tools are helping with prioritization.

265 Burmese pythons (*Python molurus bivittatus*) continue to be observed and removed in the Everglades
 266 and surrounding rural areas. SFWMD remains an active partner in regional efforts to halt the spread of this
 267 invasive reptile by conducting regional search and removal operations. In addition to an established
 268 systemwide monitoring program for Burmese pythons and other priority invasive reptiles, SFWMD and
 269 FWC began independent python removal contractor programs in March 2017. As of September 30, 2025,
 270 the two programs have resulted in the removal of #### Burmese pythons (number to be provided in the
 271 final version of the chapter).

272 FWC continues to build its invasive animal management program and coordinates closely with
 273 SFWMD, NPS, USFWS, USACE, and other partners to manage nonnative animal species in South Florida.
 274 During FY2025, federal, state, local, and tribal partners continued efforts to control populations of several
 275 priority invasive animal species including northern African pythons (*Python sebae*), Argentine black and
 276 white tegus (*Salvator merianae*), Nile monitors (*Varanus niloticus*), and the spectacled caiman (*Caiman*
 277 *crocodilus*).

278 UF continues to operate the Everglades Invasive Reptile and Amphibian Monitoring Program
 279 (EIRAMP) in cooperation with and with support from SFWMD and USACE. The purpose of EIRAMP is
 280 to develop a system-wide monitoring program to assess status and trends of priority invasive reptiles and
 281 amphibians within Greater Everglades ecosystems.

282 **PROGRESS TOWARD MANAGEMENT AND CONTROL**

283 This section provides updates for FY2025 on control, research, monitoring, and coordination activities
 284 on invasive species that threaten the success of SFWMD's mission.

285 **SUMMARY OF INVASIVE SPECIES CONTROL TOOLS**

286 Many different techniques are used to control invasive plants and animals in South Florida (Wittenberg
 287 and Cock 2001, Enloe et al. 2018). SFWMD and other agencies typically use multiple tools in an integrated
 288 fashion with the goal of minimizing impacts of invasive species by the most cost-effective and
 289 environmentally sound means. The following is a summary of available management tools for controlling
 290 invasive species.

291 **Invasive Plant Control Tools**

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

- 296 • Herbicides are pesticides designed to control plants. Herbicides approved for aquatic use
 297 or in terrestrial natural areas are a vital component of most control programs and are used
 298 extensively for invasive plant management in South Florida. There are over 20 herbicides
 299 employed to control invasive plants in South Florida. SFWMD only utilizes non-restricted
 300 use (or general use) herbicides that have been determined by the United States
 301 Environmental Protection Agency (USEPA) to pose minimal risk to humans and animals

302 and are available to the general public. SFWMD requires all herbicide applications be
303 applied under the supervision of an FDACS certified pesticide applicator. Commonly used
304 herbicides for control of broadleaf species in wetlands include dichlorophenoxyacetic acid
305 (2,4-D), triclopyr, and imazamox. Glyphosate and imazapyr are non-selective herbicides
306 and are used for a variety of plant types. Floating and submerged aquatic plants are
307 controlled using several herbicides with 2,4-D, diquat, florypyrauxifen, fluoridone,
308 endothall, and triclopyr being the most used. Collaborative research is underway to
309 evaluate the use of newer herbicides in combination with novel application methods with
310 the goal of reduced use rates and management costs.

311 • Biological controls include the use of living organisms, such as predators, parasitoids, and
312 pathogens. “Classical” biological control seeks to locate host-specific natural enemies from
313 a plant’s native range and import these species to attack and stress the plant in regions
314 where it has become invasive. Some of the most notable successes include the
315 alligatorweed flea beetle (*Agasicles hygrophila*) used to control alligatorweed
316 (*Alternanthera philoxeroides*); the melaleuca weevil (*Oxyops vitiosa*), melaleuca psyllid
317 (*Boreioglycaspis melaleucae*), and melaleuca gall midge (*Lophodiplosis trifida*) used to
318 control melaleuca; and the giant salvinia weevil (*Cyrtobagous salviniae*), which attacks
319 giant salvinia (*Salvinia molesta*).

320 • Manual and mechanical controls include the use of bulldozers, specialized logging
321 equipment, aquatic plant harvesters, or hand pulling to control invasive plants. While
322 costly, these methods are often used when other control techniques may cause unacceptable
323 damage to native species or when removal of invasive plant biomass is necessary to achieve
324 restoration or management objectives.

325 • Cultural practices include the use of prescribed burning, water level manipulation, or native
326 species plantings to control invasive plants. Fire can be used to suppress plant growth,
327 reduce aboveground biomass, and kill both native and nonnative plants that are not fire
328 tolerant. Regulating water levels may reduce invasive plant species in aquatic and wetland
329 habitats. In some cases, planting native plant species may reduce a site’s susceptibility to
330 invasion by invasive species.

331 **Invasive Animal Control Tools**

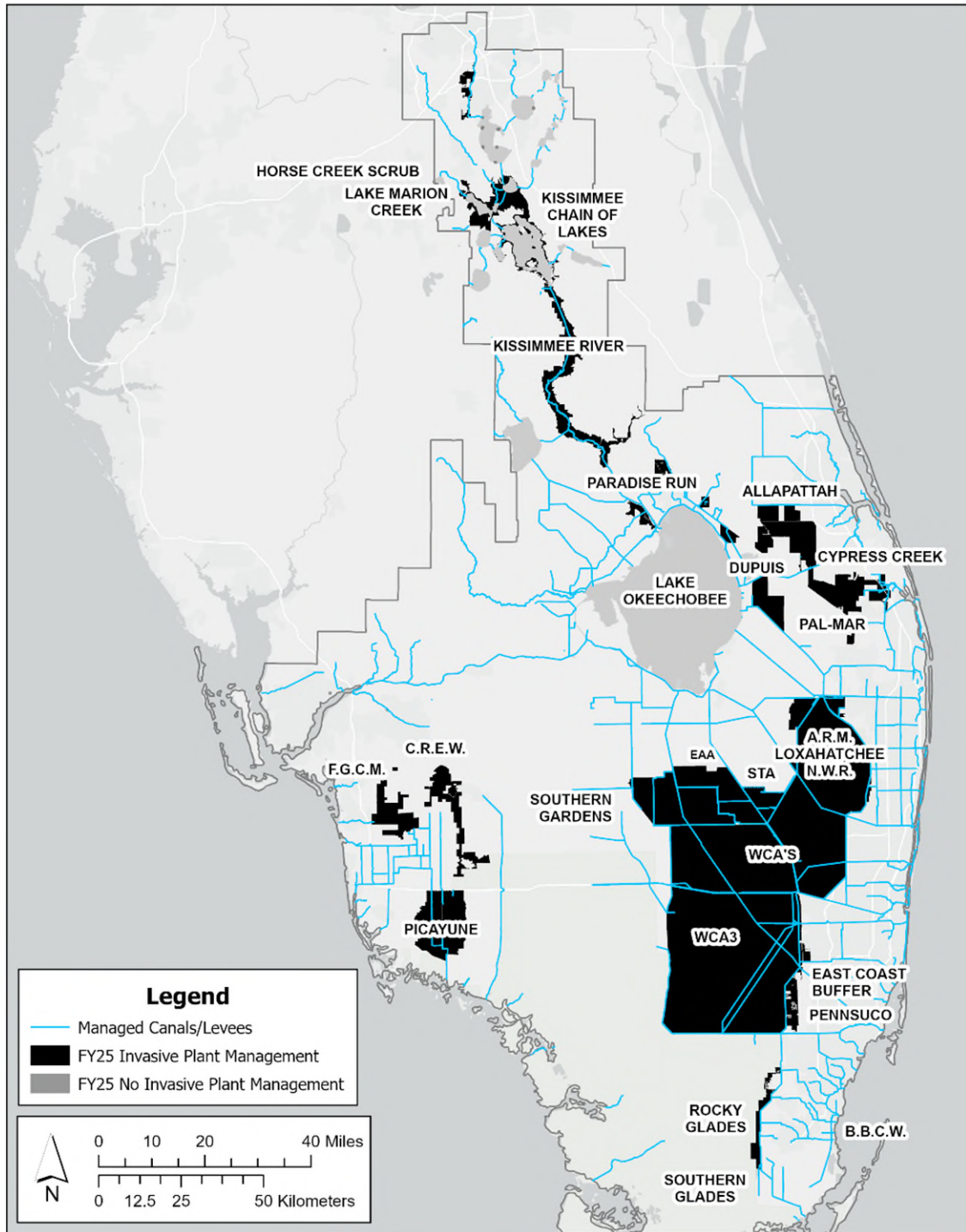
332 Operational management tools to control invasive animals in Florida’s natural areas have only been
333 developed within the past two decades and, in many cases, are developed but not fully implemented.
334 Agencies within the Everglades restoration footprint began collaborating on invasive animal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

345 • **Exclusion** is the use of barriers (e.g., electrical, hydraulic, and sound) in terrestrial or
346 aquatic environments to prevent target species from moving into unaffected areas. For
347 example, electrical barriers are currently being utilized to limit movement of Asian carp
348 (*Hypophthalmichthys* and *Ctenopharyngodon* spp.) from the Illinois River into the Great

- 349 Lakes. This specific technique has yet to be tested for controlling invasive species in the
350 Greater Everglades.
- 351 • **Habitat manipulation** is the removal of cover, food and/or water sources, or breeding
352 sites, or preventing the use of habitats by target species to reduce species population
353 growth or tendency to occupy an area. An example is the SFWMD removal of large
354 melaleuca slash piles in and around the area known to harbor the northern African
355 python. These large debris stockpiles were thought to provide nesting habitat for
356 this species.
 - 357 • **Trapping** is the use of snares, nets, or cage traps to catch and remove individuals of the
358 target species. Cage traps, or “live traps,” are the primary control tool for Argentine black
359 and white tegus.
 - 360 • **Expert catchers** are trained and managed members of the public who have the proclivity
361 and ability to catch target species. Expert catchers are contracted for Burmese python
362 management in Florida.
 - 363 • **Hunting or fishing** is the use of recreational hunting or fishing to reduce populations of
364 the target species. Hunting programs are frequently used to manage feral pigs (*Sus*
365 *scrofa*).
 - 366 • **Biological control or biocontrol** is the development, manipulation, or exploitation of
367 biological agents that can be introduced to reduce target species populations. In 2018, YY
368 male brook trout (*Salvelinus fontinalis*) were introduced into two streams in central Idaho
369 and as of 2024 it appears there are no more female nonnative brook trout in the streams,
370 indicating the likely collapse of this nonnative population of brook trout.
 - 371 • **Chemical control** is the use of direct chemical application or bait stations to dispatch
372 target species or interrupt breeding.
 - 373 • **Sterilization** reduces reproduction to phase out populations of the target species in
374 specific areas. For example, new chemical fertility control technologies are being utilized
375 in Australia and Asia to control invasive rodent species.

376 **INVASIVE PLANT MANAGEMENT**

377 SFWMD and other agencies continue to make significant progress toward controlling some invasive
378 plant species on public conservation lands, project lands, and waterways in South Florida (**Figure 7-1**).
379 Ninety-four plant species have been identified for control across the region. These include 77 Category I
380 and 12 Category II invasive species as defined by FISC and five additional priority non-native species.
381 Working with collaborating agencies, SFWMD continues to implement its invasive plant management
382 strategy, which uses integrated pest management to advance maintenance-level control of priority species.
383 The objective of maintenance control is to indefinitely keep the abundance of a targeted species at levels
384 below an impact threshold when complete eradication is not feasible (Panetta and Gooden 2017). Large
385 sections of the Greater Everglades and the marshes of Lake Okeechobee have reached or are nearing
386 maintenance control levels where melaleuca once dominated (Rodgers et al. 2023). However, many regions
387 in the Greater Everglades, including remote sections of the southwestern area of ENP and LNWR remain
388 moderately to heavily impacted by difficult-to-control invasive plants. In these areas, the challenges of
389 invasive plant control are immense due to inadequate financial resources and heavy infestations in difficult-
390 to-access areas. It will likely be decades until invasive plants in these areas are successfully under control.



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391
 392 **Figure 7-1.** SFWMD-managed (or co-managed) lands and canals/levees where invasive plant control
 393 is routinely conducted. Black polygons indicate lands where invasive plant control occurred in FY2025.
 394 Nearly all canal/levee areas are subject to vegetation management each year, including control of
 395 priority invasive plant species. To maintain legibility, not all management areas are labelled. For more
 396 detailed information on SFWMD-managed lands and annual land stewardship activities, see
 397 Chapter 6B: Land Stewardship Annual Report in Volume II of this report.

398 SFWMD directs its staff and contractors to control all invasive plant species identified by FISC
399 (formerly the Florida Exotic Pest Plant Council) as Category I species (FISC 2025). These species are
400 documented to alter native plant communities by displacing native species, changing community structures
401 or ecological functions, or hybridizing with native species. Other non-native plant species that have the
402 potential to disrupt natural communities (e.g., FISC Category II species) or impact restoration infrastructure
403 may also be targeted for control. As part of Everglades restoration and to reduce seed and propagule
404 pressure on neighboring lands, SFWMD continues to expand invasive plant treatment into new areas when
405 feasible. Because initial treatments require follow up control, new work areas must be planned and included
406 in budgets for subsequent fiscal years. Experience has shown vigilant reconnaissance and retreatment is
407 necessary to maintain low levels of established invasive species. Biological controls are proving to be
408 beneficial in this regard by reducing the rate of reestablishment for some species (Rayamajhi et al. 2008,
409 Overholt et al. 2009). However, successful biological control programs are in place for only a handful of
410 priority species so land managers must persist with frequent monitoring and control efforts (Rodgers et al.
411 2014a). Note SFERTF is compiling expenditure information for participating member agencies. This
412 information can used to create a cross-cut budget for invasive species to increase strategic coordination
413 efforts (SFERTF 2020).

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

433 **Integrated Pest Management in Florida Natural Areas**

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

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

446 land managers to keep pest plant populations at maintenance (the lowest feasible) levels and prevents
447 population explosions. Achieving maintenance levels of invasive plants is important (Panetta and Gooden
448 2017), particularly in aquatic settings. Uncontrolled aquatic invasive plants inhibit water conveyance and
449 facilitate environmental degradation (Netherland et al. 2005). Control of nuisance aquatic plants is required
450 for SFWMD to fulfill its water quality improvement and flood control missions. Additionally, high densities
451 of aquatic plants contribute to low dissolved oxygen levels and create impenetrable vegetation masses that
452 impede wildlife movement and foraging. Moreover, if aquatic invasive plants expand to large dense
453 populations, subsequent control efforts can lead to extreme fluxes in decaying plant biomass further
454 depleting dissolved oxygen and, in eutrophic waters, may trigger new disturbance regimes favoring blue-
455 green algae blooms (Bicudo et al. 2007).

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

468 **Biological Control of Invasive Plant Species**

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

476 Although several biological control projects have been successful in Florida, this method rarely controls
477 the target completely; rather it complements existing tactics by weakening the target plant and making it
478 less competitive while increasing its susceptibility to herbicides and fire. Developing biological control
479 agents is a long-term process due to the importance of ensuring the environmental safety of prospective
480 agents. Quarantine studies conducted both overseas and in the United States are used to confirm the identity
481 and specificity of an agent, which is then subjected to a rigorous and lengthy review by state and federal
482 regulatory agencies before it can be introduced. Despite these hurdles, biological control research and
483 implementation has led to the transformation of formerly intractable weeds into less invasive forms.

484 **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

500 infestations of naturalized herbivorous insects such as
 501 scale (**Figure 7-3**). In general, the thrips have persisted
 502 at up to 60% of survey sites surveyed two months after
 503 the last release (Wheeler et al. 2022). There are now at
 504 least 30 sites that have thrips detected and have not had
 505 a release in over a year. Natural dispersal has also been
 506 noted with cases of thrips being found at new sites up
 507 to 2 kilometers (km) from the nearest established
 508 release site. Moreover, while the thrips primarily feed
 509 on growing branch tips, they have been shown to feed
 510 on reproductive tissues of the weed when flushing
 511 branch tips are scarce, with potential to directly impact
 512 Brazilian peppertree fruit and flower viability
 513 (Nestle et al. 2023). Trials have been completed testing
 514 methods of increasing mass production of thrips to
 515 increase the number of releases (Wheeler et al. 2024).
 516 A gall-inducing fungus that could impede Brazilian
 517 Peppertree growth is being researched for
 518 implementation in addition to thrips control (Halbritter
 519 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*

539 *trifida*) and the melaleuca pea galling midge (*Lophodiplosis indentata*) (Diptera: Cecidomyiidae) (**Figure 7-**
 540 **4**) are the two newest releases. Both species oviposit on new growth, but *L. trifida* prefers tips and *L.*
 541 *indentata* prefers new leaves. Neonate larvae bore into the growing tips or leaves, stimulating the formation
 542 of galls, diverting the tree's resources away from growth and reproduction. When exposed to *L. trifida*,
 543 sapling height was reduced by 10%, leaf biomass by 42%, woody biomass by 43%, and root biomass by
 544 30% (Tipping et al. 2016). This agent also works in concert with the other melaleuca biological control
 545 agents in suppressing this tree, rendering it less invasive and easier to control using herbicides and fire.
 546 Although *L. indentata* was originally discovered alongside *L. trifida* in melaleuca stands in Queensland,
 547 Australia, they are observed to differentiate on leaves and shoots, and also spatially: *L. trifida* prefers foliage
 548 closer to the ground and *L. indentata* is more frequently found higher in the canopy (Kumaran et al.
 549 unpublished data). This feeding specialization will be particularly useful in areas where *O. vitiosa* has
 550 difficulty establishing because of hydrology. Melaleuca was recently surveyed and found to have increased
 551 its landcover in the Everglades region (Rodgers et al. 2023). This is primarily due to seedling recruitment
 552 after fires in BCNP and adjacent areas. Research from Belle Meade and plots within the Raccoon Point Fire
 553 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

569 tips and can reduce vine growth (David and Lake 2020). First released in 2008, mite establishment has been
570 patchy, yet the mite has shown the ability to undergo long distance dispersal and colonize Old World
571 climbing fern populations far from release sites. Monitoring shows that mites are especially abundant in
572 Martin County where > 75% of leaflets in a site can exhibit galls, with additional sites showing 40 to 81%
573 of leaflets with galls (Aquino-Thomas et al. 2025c). Furthermore, the mite can quickly colonize Old World
574 climbing fern regrowth following prescribed burns and herbicide applications (David et al. 2020, 2021).
575 Mass-rearing techniques were improved in recent years (Aquino-Thomas et al. 2025a) leading to field
576 releases of millions of mites each year, with nearly 13 million in FY2025 alone and a total of over 71
577 million released since the project's inception. A recent survey showed none of the 13 native ferns occurring
578 in close proximity to heavily damaged lygodium showed evidence of mite or moth damage, confirming the
579 fidelity of these insects (Aquino-Thomas et al. 2025b). Research is underway to determine how to integrate
580 biological control with herbicide applications. In addition to the two established agents, host range testing
581 has been completed at the USDA-ARS quarantine facility in Fort Lauderdale for three additional biocontrol
582 agents: *Lygomusotima stria* (moth), *Neostrombocerus albicomus* (sawfly), and *Calloplistria exotica* (moth).
583 The latter two species have already been recommended for release by the Technical Advisory Group for
584 Biological Control of Weeds and are undergoing the Animal and Plant Health Inspection Service (APHIS)
585 regulatory process. The *Lygomusotima* petition is still under review by the advisory group.

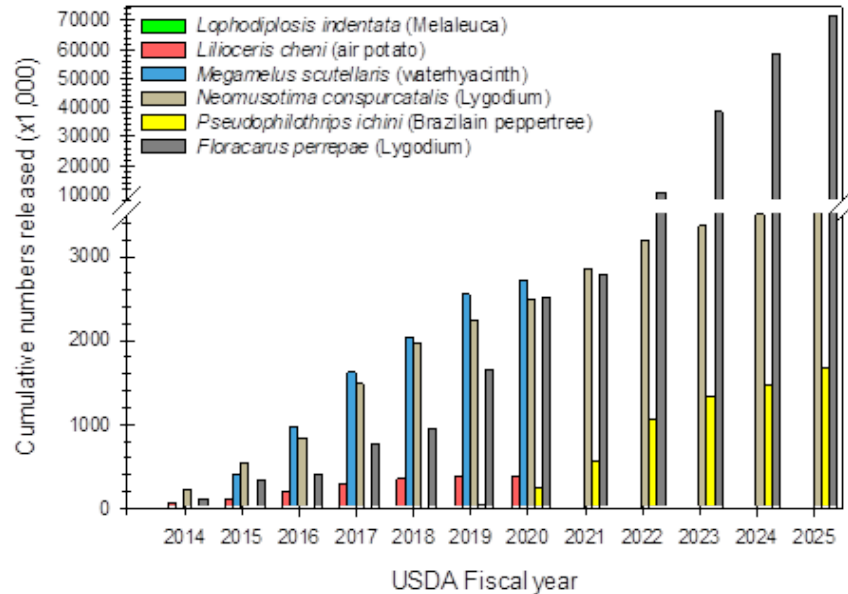
586 **Water Hyacinth**

587 Water hyacinth (*Pontederia crassipes*) is an invasive floating plant that aggressively colonizes
588 freshwater ecosystems in the southeastern and southwestern United States including the Everglades. Three
589 biological control agents of water hyacinth introduced during the 1970s have reduced biomass by more
590 than 50% and seed production by 90%, but additional agents are needed to reduce surface cover. The latest
591 biocontrol agent, the water hyacinth planthopper (*Megamelus scutellaris*), was released in February 2010
592 (Tipping et al. 2014b) at that time it was the first new agent released for water hyacinth in 30 years. The
593 species is cold tolerant and can overwinter at least as far north as Gainesville, Florida. A more heat tolerant
594 genotype of this planthopper was imported from South Africa during FY2025 with releases scheduled to
595 begin towards the end of the year. Experimental field evaluations of water hyacinth herbivory from the
596 plant hopper and the previously established water hyacinth weevils (*Neochetina* spp.) demonstrate these
597 agents can exert considerable herbivory pressure on the aquatic weed as well as increase the efficacy of
598 herbicidal control. Recently, a multi-year project was established with the South American Biological
599 Control Laboratory to explore the environmental safety and efficacy of the flies in the *Thrypticus* genus,
600 which have characteristics that make them potential agents for water hyacinth. This is part of a multi-year
601 USDA areawide project to develop effective integrated management techniques for water hyacinth in South
602 Florida. This project will also be exploring use of mass-rearing techniques employed by colleagues in South
603 Africa for inundating water hyacinth stands with huge numbers of the *Megamelus* planthopper.

604 **CERP Biocontrol Implementation Project**

605 The CERP Melaleuca Eradication and Other Exotic Plants – Implement Biological Controls Project is
606 dedicated to the implementation of biological control agents to address the spread of invasive plants
607 throughout the CERP area. The project included the construction of a mass rearing annex to the existing
608 USDA-ARS biological control facility in Davie, Florida, to mass rear, release, establish, and monitor
609 approved biological control agents for melaleuca and other invasive plants in the CERP area. The final
610 project implementation report and environmental assessment (USACE and SFWMD 2010), the project
611 partnership agreement and cooperative agreement on lands, and the design-build contract were all executed
612 in 2010 with the construction of the mass rearing facility completed in 2013. USDA-ARS, in close
613 coordination with SFWMD and USACE, has begun the operational phase of the project and, to date, has
614 released nearly 80 million insects and mites (**Figure 7-6**) during more than 4,000 release events for control
615 of four weed species: Old World climbing fern, air potato (*Dioscorea bulbifera*), water hyacinth, and
616 Brazilian pepper. Releases are continuing along with extensive field monitoring and evaluation of the

617 biological control agents. The highly successful projects for water hyacinth and air potato ended in 2021 to
 618 focus greater efforts on Old World climbing fern and Brazilian pepper. Most recently releases of the brown
 619 lygodium moth have ceased and preparations have begun for releasing the newest melaleuca agent, the leaf-
 620 galling fly *Lophodiplosis indentata*.



621 **Figure 7-6.** Cumulative numbers of biological control agents released
 622 between December 2013 and July 2025 within CERP project footprints.
 623

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

626 Despite decades of invasive plant management in the Everglades, significant infestations of priority
 627 invasive species persist within Water Conservation Area (WCA) 1, a major component of the Arthur R.
 628 Marshall Loxahatchee National Wildlife Refuge (LNWR). To meet the growing challenge, beginning in
 629 2014, SFWMD, FWC, and USFWS have collaborated to increase control efforts in WCA-1 and, in 2018,
 630 SFWMD and USFWS entered into a new license agreement for the USFWS to manage WCA-1 as part of
 631 LNWR. In the new agreement, SFWMD will take the lead role in invasive plant management and has
 632 completed a five-year strategic plan to complete all initial treatments in WCA-1. USFWS is to provide
 633 SFWMD with at least \$1.25 million annually for invasive plant management. FWC continues to support
 634 this initiative with additional funding each fiscal year.

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

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

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

671 Mean Old World climbing fern canopy cover in 2025 ranged from 0 to 40.3% across the 125 tree islands
672 surveyed. Eleven tree islands had cover exceeding 25%, representing a 54% decrease since 2019
673 (**Figure 7-7**). In contrast, the number of tree islands with low-level infestations (< 5% cover) increased by
674 119% from 2019 to 2025. Notably, 90% of the tree islands with < 5% Old World climbing fern cover in
675 2022 remained below this threshold in 2025, suggesting that follow-up treatments are effectively
676 maintaining control. The total canopy area of Old World climbing fern declined from 271 ha in 2019 to
677 123.1 ha in 2022, and further to 112 ha in 2025. This reduction reflects an initial emphasis on treating the
678 most vulnerable tree islands between 2019 and 2022, followed by a shift to maintenance retreatments from
679 2022 to 2025.

680 Mean melaleuca canopy cover on tree islands ranged from 0 to 40.2% in 2025. Only two tree islands
681 had cover exceeding 25%, a 50% reduction from 2019 (**Figure 7-8**). The number of tree islands with
682 melaleuca cover below 5% increased modestly by 20% during the same period. Melaleuca canopy area
683 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
684 to continued melaleuca growth on three large, untreated tree islands.

685 Brazilian pepper remained relatively uncommon, with mean canopy cover ranging from 0 to 2.4% in
686 2025. It was detected on 32 of the 125 tree islands assessed (**Figure 7-9**). The combined canopy area of
687 Brazilian pepper on large strand islands increased from 3 ha in 2019 to 4.3 ha in 2025. While still limited
688 in extent, the upward trend is cause for concern. As a prolific colonizer of disturbed areas, Brazilian pepper
689 may exploit canopy gaps created by melaleuca and Old World climbing fern removal. SFWMD biologists
690 will continue to monitor its spread and respond as needed to prevent further expansion.

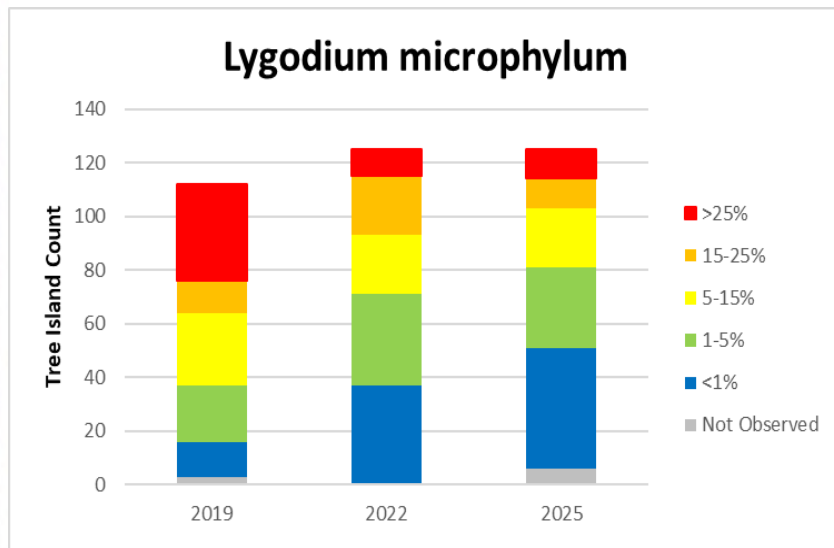
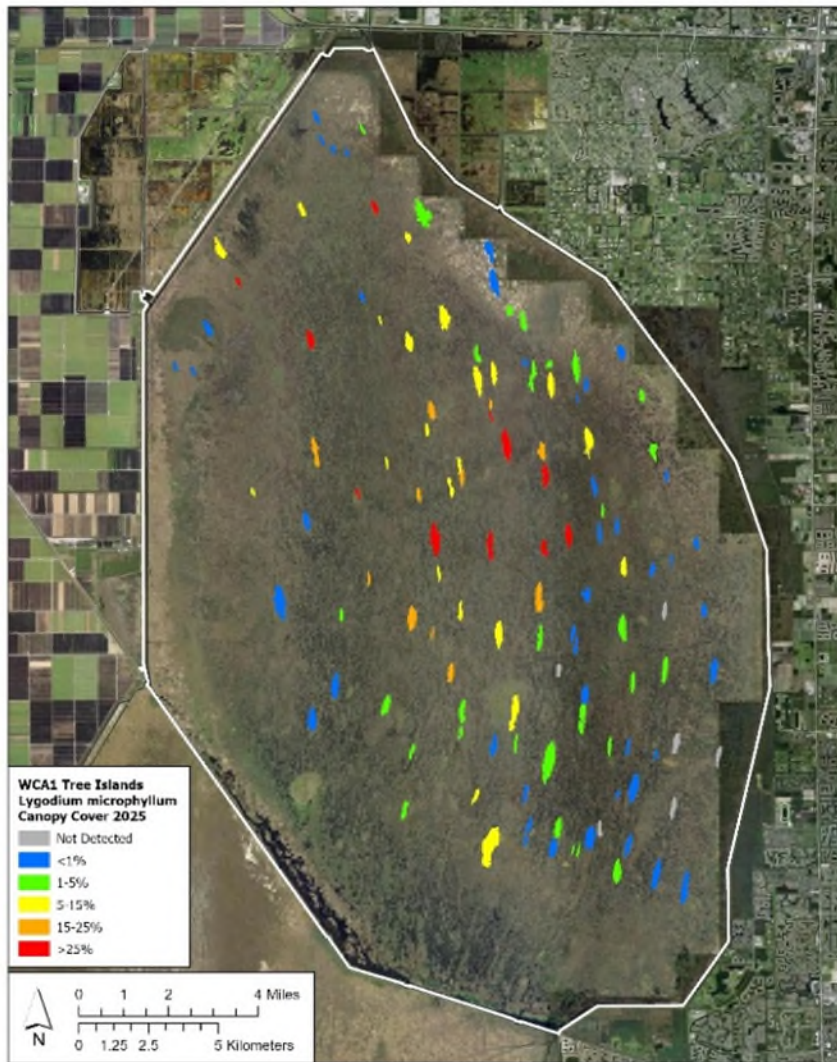
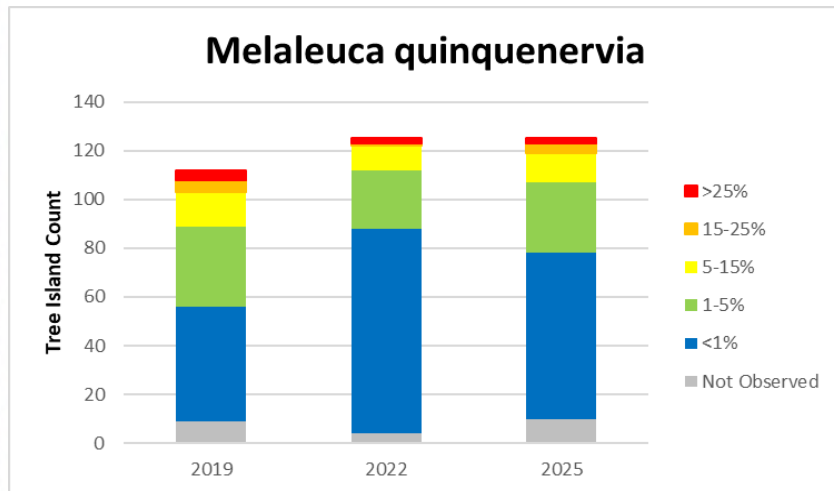
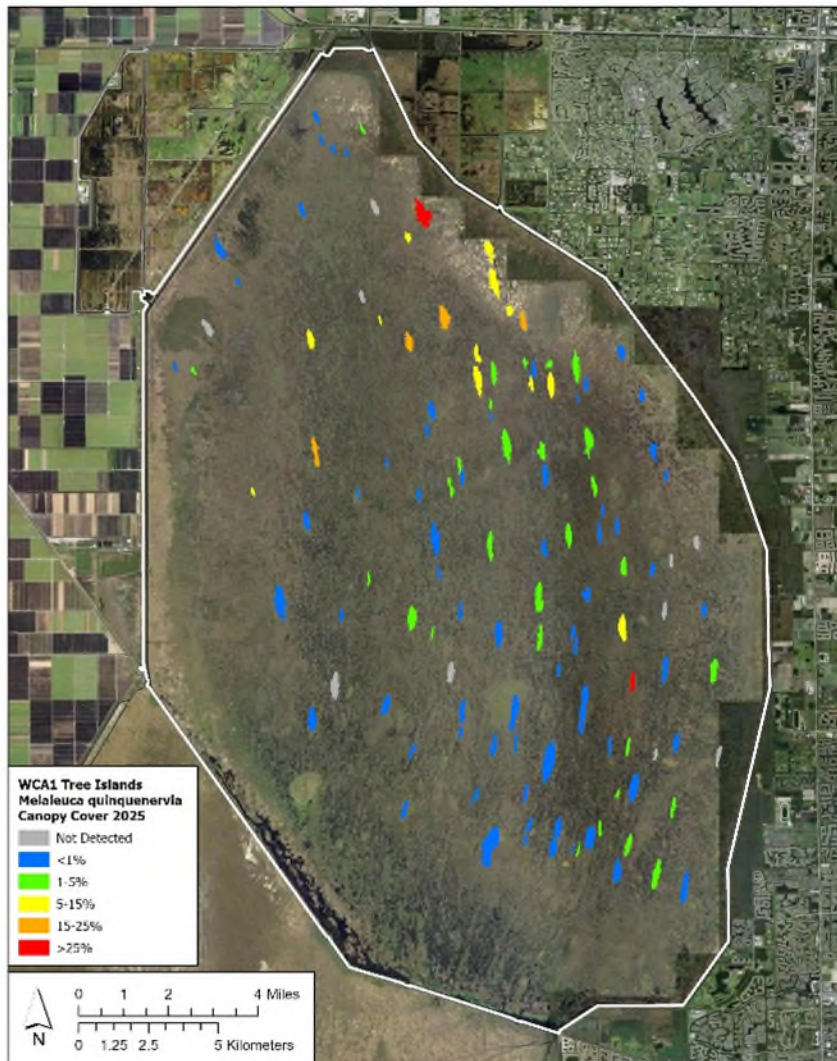


Figure 7-7. Distribution and frequency of Old World climbing fern (*Lygodium microphyllum*) on WCA-1 tree islands ranked by mean canopy cover.

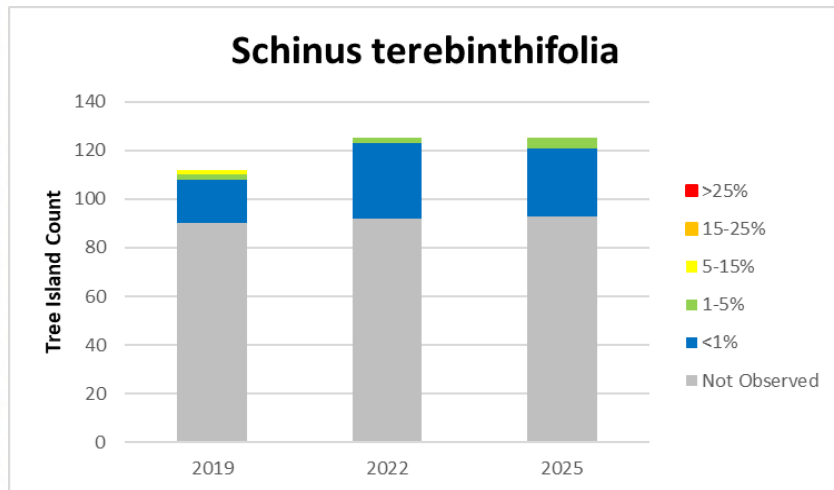
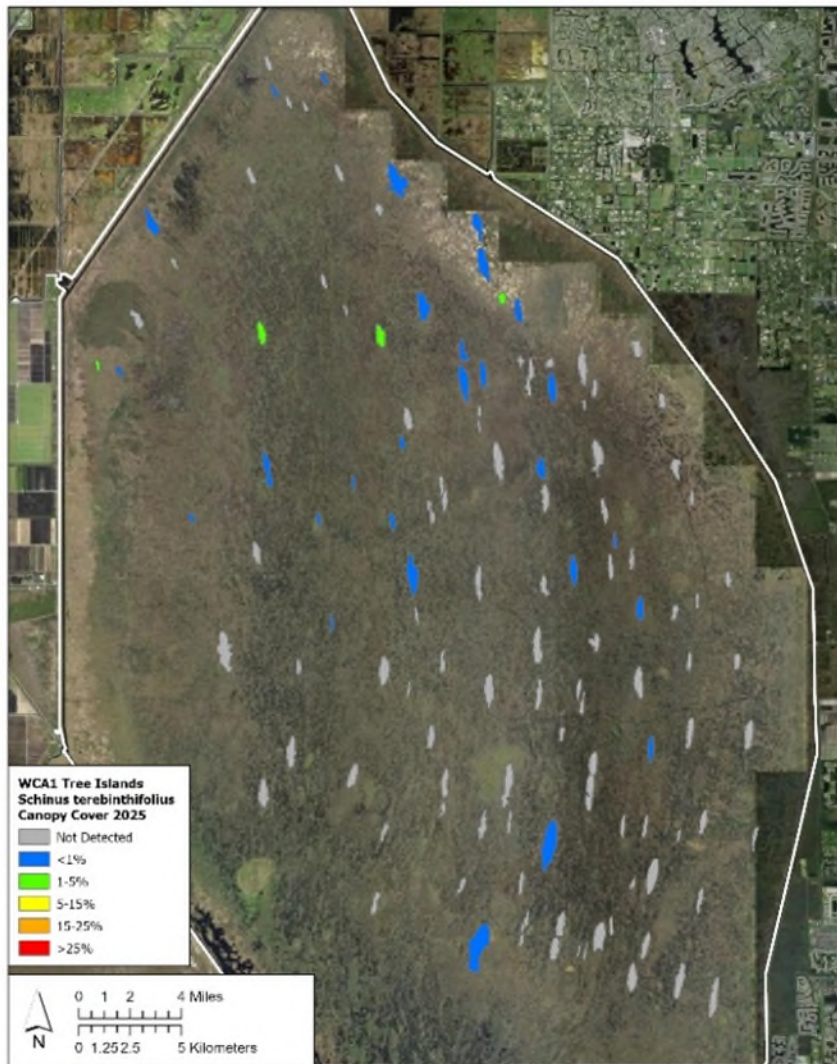
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Figure 7-8. Distribution and frequency of melaleuca (*Melaleuca quinquenervia*) on WCA-1 tree islands ranked by mean canopy cover.



696
697

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

698 **INVASIVE ANIMAL MANAGEMENT**

699 Efforts to develop control tools and management strategies for several priority animal species and to
700 further expand management programs continued in FY2025. Priority species for control included the
701 Burmese python and other giant constrictors, Nile monitor, and Argentine black and white tegu. Despite
702 years of investigation, control tools remain limited for free-ranging reptiles, and the application of
703 developed methods is often impracticable in sensitive environments where impacts to non-target species
704 are unacceptable. Potential tools for removing reptiles generally include catching, trapping, species-specific
705 toxicants, barriers, detector dogs, introduced predators (Witmer et al. 2007), visual searching, and
706 pheromone attractants. Guzy et al. (2023) provides a thorough synthesis of control tools for
707 Burmese pythons.

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

720 There were several ongoing invasive animal initiatives in FY2025 including ongoing monitoring and
721 research efforts for Burmese python, northern African python, Argentine black and white tegu, Nile
722 monitors, spectacled caiman, and numerous invasive freshwater fish species among others.

723 **Everglades Invasive Reptile and Amphibian Monitoring Program**

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

735 The EIRAMP monitoring program utilizes a multi-method approach to EDRR, monitoring, and
736 removal with activities detailed annually in a report provided by UF to SFWMD and USACE. A primary
737 component of the EIRAMP involves surveys to detect and remove targeted invasive species on fixed routes
738 along levees and roads within LNWR, BCNP, ENP, Corkscrew Swamp Sanctuary, US-1, Card Sound Road,
739 US-27, Frog Pond Wildlife Management Area (WMA), Everglades and Francis S. Taylor WMA (consisting
740 of the Everglades WCAs), and other areas such as the C-51 Basin and Southern Glades WMA. Visual
741 encounter surveys and amphibian call surveys are conducted to monitor invasive species and their potential
742 prey species. Twenty-one routes have been established since inception of the program and nine are currently
743 active. A total of 90 surveys on designated routes were conducted during the October 2024–June 2025

744 period. Additionally, 16 opportunistic surveys were performed when conditions were favorable for
 745 detecting nonnative wildlife. During surveys, 1,865 animals were observed. Of these observations, 557
 746 (42%) were species native to Florida, 1,221 (65%) were nonnative, and 67 (4%) could not be identified due
 747 to brief visual encounters. Therefore, 68% of animals identified consisted of nonnative species. We detected
 748 47 native species and 16 nonnative species for a total of 63 species, including 9 nonnative reptiles,
 749 4 nonnative mammals, and 3 nonnative amphibians. Priority nonnative species observed on standard survey
 750 routes included 5 Burmese pythons. On opportunistic surveys, opportunistic sightings, and rapid responses
 751 8 additional nonnative reptiles were detected: 7 Burmese pythons and 1 spectacled caiman.

752 In FY2024, the most commonly observed (1) nonnative reptiles were brown anoles (*Anolis sagrei*),
 753 tropical house geckos (*Hemidactylus mabouia*), and green iguanas (*Iguana iguana*); (2) nonnative
 754 amphibians were greenhouse frogs (*Eleutherodactylus planirostris*), Cuban treefrogs (*Osteopilus*
 755 *septentrionalis*), and cane toads (*Rhinella marina*); and (3) nonnative mammals were feral cats (*Felis catus*)
 756 and hogs. The most observed (1) native amphibians were southern toads (*Anaxyrus terrestris*) and green
 757 treefrogs (*Hyla cinerea*); (2) native reptiles were cottonmouths (*Agkistrodon conanti*), ribbon snakes
 758 (*Thamnophis sauritus*), and garter snakes (*Thamnophis sirtalis*); and (3) native mammals were Virginia
 759 opossums (*Didelphis virginiana*), white-tailed deer (*Odocoileus virginianus*), and raccoons (*Procyon*
 760 *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).

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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 gekko*), 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.

782 In FY2025, EIRAMP continued to increase focus on detecting and removing priority species, including
 783 adapting established EIRAMP survey routes to address emerging EDRR needs. Future EIRAMP activities
 784 will continue to explore and implement additional methods, such as environmental DNA (eDNA)
 785 biosurveillance, to increase detection and removal of invasive species.

876 Python Removal Contractor Program

877 In spring 2017, SFWMD and FWC began collaboration to develop
878 independent—but parallel—incentivized python removal programs.
879 Both agencies developed programs to encourage public participation in
880 removing invasive pythons. The new program was built from previous
881 use of volunteers working with SFWMD and UF as a component of
882 EIRAMP, which demonstrated that skilled, motivated python removal
883 experts (**Figure 7-11**) can be an effective means of locating and
884 removing giant constrictors in accessible areas such as levees and canal
885 banks, while reliably collecting data. The objectives of both programs
886 are to deploy experienced python removal experts to specific areas and
887 compensate them for conducting surveys, collecting useful data on
888 search efforts, and removing as many large, nonnative constrictors as
889 possible from public lands.

890 Both agencies agreed to a multi-tiered compensation structure.
891 Contractors receive \$14.00 per hour for time spent in the field
892 surveying for pythons, up to 10 hours daily. Both agencies also
893 compensate contractors at the rate of \$20.00 per hour and \$30.00 per
894 hour in specific locations on the fringe of the known python range, or
895 in sensitive native habitats, to increase survey effort in areas searched less frequently. For successfully
896 capturing a target species, the contractor receives additional compensation based on the animal’s length:
897 \$50 for the first four feet (ft) and an additional \$25 per foot above four ft. SFWMD and FWC also
898 compensate their contractors \$200 for each verified, viable python nest found and \$50 for a verified picture
899 of a research scout snake.

900 As of September 30, 2025, SFWMD and FWC program’s contractors have conducted a combined
901 **158,989** survey hours, resulting in the removal of **15,273** pythons (**Figure 7-12**), with an average of
902 **10.41 hours** of surveying per python caught. The mean body length of pythons removed by SFWMD and
903 FWC contractors is **1.7 m (5.77 ft)**, with the largest python being **5.72 m (18.75 ft)**. Currently, there are
904 **105** active contractors between both agency’s programs. (**Updated numbers to be provided in the final**
905 **version of the chapter.**)

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



Figure 7-11. SFWMD python removal contractor Megan De Angelis with a captured Burmese python (photo by SFWMD).

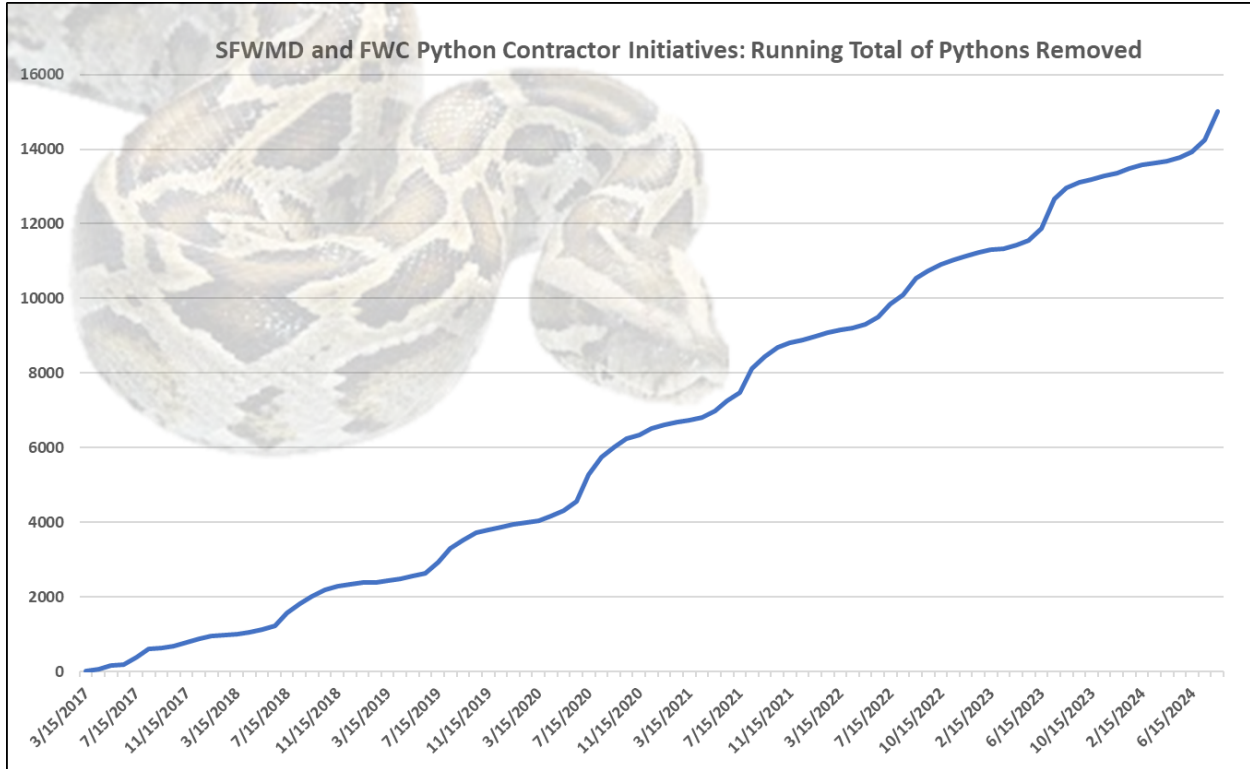


Figure 7-12. Running total of Burmese pythons removed from the Everglades region by SFWMD and FWC python removal contractors between March 25, 2017, and September 30, 2025. (Graph will be updated in the final version.)

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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.

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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.

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852 Burmese python research continues to build upon work completed over the last decade (see Guzy et al.
853 2023 for a review). Early trials of traps resulted in low python capture rates (Reed et al. 2011) but the
854 development of a pheromone (or other) attractant may improve the utility of traps. James Madison
855 University, USDA, and NPS have collaborated to test the effectiveness of pheromones in luring pythons,
856 and their work has shown when male Burmese pythons are presented with a conspecific female scent trail,
857 male snakes consistently follow the female scent trail and exhibit sex-specific behaviors (Richard et al.
858 2019). However, preliminary assessments of estradiol-implanted radio-telemetered male pythons did not
859 show a significant increase in attractance compared to non-implanted pythons (Guzy et al. 2023). The UF,
860 USDA, and USFWS collaborated on testing a patented large reptile trap specifically designed to avoid
861 capture of non-target species (Gati et al. 2020). While the traps were successful at reducing capture of non-
862 target species, no pythons were captured during the study despite numerous pythons having been removed
863 from the study site during visual surveys. The lack of python captures in this study, and the low capture
864 rates of pythons in traps in general, likely reflect the foraging behavior of pythons where they primarily sit
865 and wait for prey and to a lesser extent, actively forage to seek out prey, the latter of which would be a
866 prerequisite for entering baited traps. However, these traps, particularly when paired with an automated
867 wireless camera network, show promise for reducing resources necessary to trap large invasive reptiles
868 (e.g., Nile monitors) and allow for implementation in remote, hard to access areas or biologically sensitive
869 locations where daily trap checks are undesired.

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

895 Impacts of Burmese pythons on native wildlife continue to be documented. Previous work on Burmese
896 python diet reveals they are generalist predators (Snow et al. 2007a, Dove et al. 2011) and stable isotope
897 research by USGS and UF indicates pythons consume prey across a broad isotopic niche in saline and
898 freshwater habitats and feed across several trophic levels (B. Smith, USGS/UF, personal communication).
899 Road surveys in the past were useful in providing evidence for dramatic declines in mammal populations

900 as pythons increased their presence (Dorcas et al. 2012). Recent work using camera traps to surveil
901 mammals across the Greater Everglades ecosystem found populations of prey species decreased within the
902 python invasion front and mammal populations within the core of the python's distribution did not
903 demonstrate resilience to python predation over time (Taillie et al. 2021). Research also shows chronic,
904 direct depredation of marsh rabbits by pythons (McCleery et al. 2015). The effect of python predation on
905 native fauna can result in trophic cascades impacting Florida's ecosystems (Willson 2017). Pythons have
906 been implicated in altering parasite and pathogen dynamics within their invasive range. Studies of
907 Everglades virus have shown that with reduced diversity of mammalian host species due to python
908 predation, the virus has become more prevalent (Hoyer et al. 2017). Pythons have also introduced a
909 nonnative lung parasite, the pentastome *Raillietiella orientalis*, to Florida that has spilled over to infect at
910 least 18 species of native snakes (Miller et al. 2018, 2020, Metcalf et al. 2019, Palmisano et al. 2025).
911 Native snakes are highly susceptible to infection, which has facilitated the spread of this parasite to native
912 snakes outside the python's native range (Miller et al. 2020). This parasite can now be found in native
913 snakes as far north as the Florida panhandle and is expected to expand its range outside of the state in the
914 near future (Palmisano et al. 2025). While additional study is needed to assess the impact of this pentastome
915 on native snake populations, it has been anecdotally linked to adverse effects on host health and survival
916 (Farrell et al. 2019, Bogan et al. 2022). Burmese pythons have also been documented to carry a
917 serpentovirus in their invasive Florida range. While the virus does not appear to have spread to native
918 snakes, further examination of the potential for spillover is warranted (Tillis et al. 2022).

919 Improving detection of Burmese pythons is of critical importance since they are widely established in
920 the region and notoriously difficult to detect. A study by UF and USGS estimated the probability of
921 detecting a Burmese python in the wild to be less than 0.05 (Nafus et al. 2020). Several studies have focused
922 on refining our ability to detect pythons including detector dogs, Irla tribesmen from India, eDNA,
923 mammalian lures, and multispectral cameras. Detector dogs have been proven to successfully locate
924 Burmese pythons, with an initial collaboration among Auburn University, NPS, and SFWMD
925 demonstrating detection of 20 pythons, 19 of which were able to be captured, during searches for free-
926 ranging pythons on federal, state, and tribal lands (Romagosa et al. 2011). Subsequent use of detector dogs
927 worked on Key Largo to find Burmese pythons by scent and dogs were used in the Bird Drive Basin to
928 search for northern African pythons. They found at least one python on Key Largo and many points of
929 interest there and in the Bird Drive Basin. Multiple agencies and organizations, including SFWMD, FWC,
930 USFWS, and the Miccosukee Tribe of Indians of Florida continue exploring detector dogs' utility in python
931 removal. Yet, as dogs can be limited in search duration and efficiency in extreme heat and humidity
932 (Romagosa et al. 2011), the most effective use of detector dogs may be for rapid response efforts and
933 attempts to delineate presence/absence of a target species within a location (i.e., aiding delineation of an
934 invasion front or incipient population). Future studies exploring use of detector dog teams as a control tool
935 for rapid response efforts to detect and remove pythons, as well as other priority invasive species, are
936 warranted to fully understand the utility of detection dogs for invasive species management. A study
937 conducted by UF and funded by FWC and SFWMD demonstrated live domestic rabbits placed in pens will
938 attract pythons to localized areas, where they may remain for extended periods of time with an increased
939 chance for detection (McCampbell et al. 2024). McCampbell et al. (2024) detected 21 pythons using game
940 cameras placed near the rabbit pens over the course of the study; however, as care for live rabbits is resource
941 intensive, it may prohibit the wide use of this method as a means to increase python detection. To address
942 this challenge, these researchers, along with funding from SFWMD, are currently examining use of robotic
943 rabbits, capable of movement and containing a heating device to mimic real rabbits, to explore if robotic
944 rabbits can attract pythons, and thus be easier to deploy in the field. This strategy may be especially effective
945 in environmentally sensitive areas that are not easily accessible to removal contractors or otherwise under
946 surveyed. A study using eDNA successfully detected Burmese pythons in five sites, including one where
947 pythons were not yet documented (Piaggio et al. 2014). Orzechowski et al. (2019) utilized eDNA to identify
948 the adverse impact of pythons on wading bird breeding aggregations. Recent advancements in eDNA
949 sampling include development of a multiplex digital polymerase chain reaction (PCR) assay that is capable

950 of simultaneously detecting the presence of Burmese pythons, as well as other large invasive snakes (i.e.,
951 northern African pythons, boa constrictors, and Brazilian rainbow boas), from the same environmental
952 sample (Miller et al. 2024). This can increase efficiency of eDNA surveillance as natural resource managers
953 can monitor for multiple target species within a sample, instead of only testing for one target species per
954 sample, which may reduce costs associated with eDNA sampling.

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

967 Argentine black and white tegus received extensive attention from researchers during the last five years
968 although they are not as well studied as pythons. Studies have primarily focused on tegu life history and
969 spatial ecology, with an emphasis on their capacity for range expansion; however, more recent work has
970 explored increasing detection of tegus through eDNA. Adverse impacts of tegus on native wildlife,
971 including at-risk species, have been documented. In a study of tegu diet, hatchling gopher tortoises
972 (*Gopherus polyphemus*) were recovered from five tegus (Offner et al. 2021) and tegus have been observed
973 consuming the eggs of an American alligator (*Alligator mississippiensis*) nest (Mazzotti et al. 2015). As
974 omnivorous predators of a diversity of prey taxa, uncontained growth and expansion of tegu populations
975 may be a risk to many native wildlife species. Tegus have also been observed utilizing gopher tortoise
976 burrows (Offner et al. 2021) and therefore may compete with native wildlife for these resources as well. In
977 addition, tegus have been documented as competent hosts of an invasive pentastome (*Raillietiella*
978 *orientalis*) introduced by Burmese pythons (Miller et al. 2018), indicating tegus may play a role in increased
979 transmission of this parasite (Goetz et al. 2021).

980 Early radio telemetry work was conducted using VHF transmitters and showed tegus spread readily in
981 altered landscapes such as linear habitats and areas where water does not restrict movement (Klug et al.
982 2015). GPS tracking and modeling show tegus are most active in warmer temperatures (Mason et al. 2024).
983 This suggests removing tegus during the hottest months and surveying for them during the hottest parts of
984 the day may increase detection and maximize removal. Tegus are often in more open habitats than pythons
985 and, consequently, GPS tags on tegus are generally more successful than those used with pythons
986 (F. Mazzotti, UF, unpublished data). Several agencies trapped tegus extensively and used a wide variety of
987 designs. Using chicken eggs as bait, Tomahawk® and Havahart® traps are the most effective tools for
988 removing tegus, although use of artificial baits are being explored, and drift fences in conjunction with
989 minnow traps successfully capture hatchling tegus (Nestler et al. 2017). The goal of this multi-agency effort
990 is to contain and reduce tegu populations in South Florida. Analysis of data obtained by UF from the 2021
991 trapping season in the core of the tegu distribution in Miami-Dade County yielded fewer tegus relative to
992 2019 supporting temporal consistency of a trending decline, demonstrating the effectiveness of long-term
993 trapping efforts as a tool for tegu containment. However, trapping efforts must be robust and sustained to
994 reduce tegu populations. Live trapping is currently being used to manage tegu populations in four Florida
995 counties: St. Lucie, Miami-Dade, Charlotte, and Hillsborough. In addition, researchers are examining the
996 potential for using conspecific chemical cues to increase trap efficacy. Results are promising with both
997 sexes demonstrating the ability to follow the scent trail of a conspecific, with female tegus particularly
998 excelling at this task (Richard et al. 2020). UF continues to evaluate the use of automated AI smart traps

999 designed to selectively capture tegus while eliminating bycatch of non-target species for removal of tegus
1000 (M. Miller, UF, unpublished data). Smart traps are solar powered and are operated remotely through a web
1001 application. A user receives a real-time alert message through the application when a tegu is captured;
1002 therefore, smart traps eliminate the need for in-person trap checks required for traditional trapping methods.
1003 A comparison study conducted by UF, Wild Vision Systems, and USDA, of AI smart traps and traditional
1004 (i.e., non-smart) traps showed that use of smart traps significantly increased trap efficiency, reduced capture
1005 rates of non-target species by 94%, and reduced costs to operate traps by 87% (Miller et al. in prep).

1006 Tegus have demonstrated the ability to withstand climates much cooler than South Florida indicating
1007 physiological and behavioral constraints are not likely to limit spread of this invasive lizard throughout the
1008 state and to other states with suitable climates within the United States (Jarnevich et al. 2018, Haro et al.
1009 2020, Currylow et al. 2021, Goetz et al. 2021). A study examining the ability of tegus to overwinter in
1010 outdoor semi-natural enclosures in Alabama found 9 of 12 tegus were able to withstand winter temperatures
1011 and upon necropsy, sperm was found within the testes of males and females displayed previtellogenic or
1012 early vitellogenic follicles indicating both sexes were capable of reproduction (Goetz et al. 2021). Recently,
1013 established populations of tegus are suspected in two counties in Georgia (Haro et al. 2020) and climate
1014 models further support tegus may be capable of successfully establishing beyond South Florida (Jarnevich
1015 et al. 2018).

1016 A localized population of Northern African pythons was first detected in 2001 in Miami-Dade County.
1017 Between 2018 and 2021, captures of Northern African pythons were down to zero. In December 2021
1018 confirmed reports of this species prompted an increase in research and control efforts. In addition to
1019 previously mentioned detector dog work, UF utilized surveys of refuges to search for remaining African
1020 pythons and estimate detection probability. Because northern African pythons were not detected during
1021 those surveys, Cole et al. (2017) estimated detection probability for northern African pythons using
1022 Burmese pythons as a surrogate. Detection probability of Burmese pythons was 0.0064 during EIRAMP
1023 surveys on Main Park Road in ENP, 0.00257 on C-110, and 0.0149 for surveys conducted by volunteer
1024 python hunters outside ENP. Using these detection probabilities, the minimum number of surveys needed
1025 to infer absence with a 95% confidence interval is 467 on Main Park Road and 1,164 on C-110. Increasing
1026 the detection probability to 0.0166 drops the number of surveys required to 179.

1027 In December 2021, five Northern African pythons were captured in the Bird Drive Basin by a member
1028 of the public. Additional Northern African pythons have been captured since December 2021 and in
1029 response to these removals, FWC increased efforts to inform the local community about the presence of
1030 this species and canvassed nearby residential neighborhoods with outreach information on how to report
1031 observations. Initial gut content analysis of these recently captured pythons found remains of raccoon, rat,
1032 birds, and an unidentified canid. Two large females were discovered to have developing follicles indicating
1033 there could still be reproduction occurring in this area. Initiation of a scout telemetry program for Northern
1034 African pythons to increase our understanding of their movement patterns, habitat preferences, and
1035 behaviors could improve our ability to detect these pythons while concurrently removing individuals from
1036 the population. To date, 49 Northern African pythons have been removed from the Bird Drive Basin since
1037 the population was discovered in 2001.

1038 Monitoring and removal of Nile monitors, a large-bodied carnivorous lizard of African origin,
1039 continued in 2023 and 2024 by FWC. Habitat assessment was the central research focus and will result in
1040 maps to visualize and monitor habitat quality. Scobel et al. (2017) reported trap success of 25.0%, similar
1041 to the success of trapping efforts in Cape Coral, Florida, where success averaged 29.2% (K. Hankins, City
1042 of Cape Coral, unpublished data). Sample size was too small to assess the best trap design but the highest
1043 catch per unit effort (CPUE) in the study was 0.167 monitors per trap day for a Tomahawk S50 trap baited
1044 with chicken (Scobel et al. 2017). No Nile monitors were removed by FWC in the last year from Palm
1045 Beach County. However, Nile monitor observations continue to be reported sporadically across the C-51
1046 Basin area. Recent work utilizing species distribution models to assess habitat for monitors found low

1047 habitat suitability and predicted the spread of Nile monitors beyond Central Florida is unlikely (Bevan et
1048 al. 2024). A study by UF examined use of targeted outreach to increase detection and reporting of Nile
1049 monitors within the C-51 Basin and found that their efforts to relay a specific message to a targeted audience
1050 significantly increased reports of monitors within the basin (Mazzotti et al. 2024).

1051 Spectacled caiman were introduced to South Florida in the 1970s and 321 caiman have been removed
1052 from populations established within CERP project lands. Caiman are dietary generalists (Godfrey et al.
1053 2025) and may pose a threat to native wildlife due to predation. As caiman are found in habitats also shared
1054 by American alligators and American crocodiles (*Crocodylus acutus*), they pose a risk to these native
1055 species through competition. A UF study by Godfrey et al. (2023) examined a long-term caiman removal
1056 data set to assess the potential for extirpation of caiman from CERP projects. Analysis of removal data
1057 collected during 2012–2021 found that maximum control (removal of most individuals from the population
1058 with continued monitoring required to remove stragglers or new introductions) of caiman was possible and
1059 eradication of the species, with continued sustained removal efforts, was likely (Godfrey et al. 2023). An
1060 understanding of caiman movement patterns and nesting sites could increase our ability to detect and
1061 remove this species. A molecular study of caiman genetics by Parks et al. (2024) identified two distinct
1062 lineages of caiman in Florida, with caiman populations originating from either Columbian or Brazilian
1063 origins. These results raise concerns of hybrid vigor if mixing should occur among caiman populations of
1064 different origins as this interbreeding could increase genetic diversity and thus increase the ability of caiman
1065 to adapt to their nonnative range.

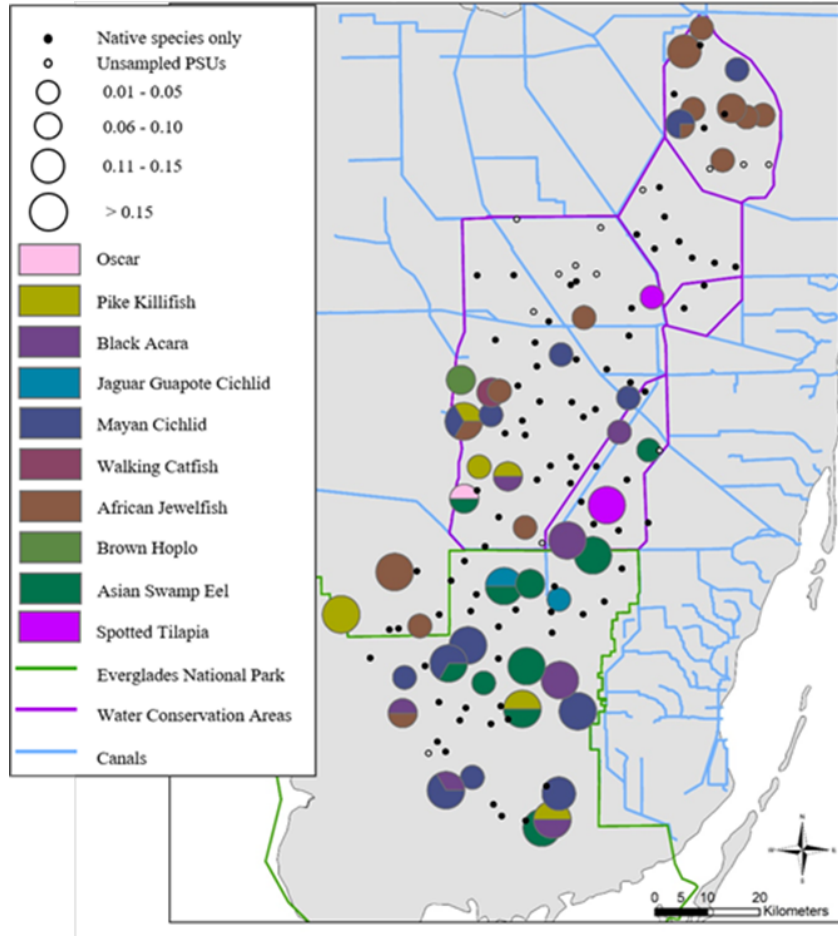
1066 **Invasive Freshwater Fishes**

1067 The spread of invasive fishes may be the most directly linked to water management features and actions
1068 of all nonnative species issues in South Florida. Canals, which are unnaturally deep aquatic habitats, are a
1069 refuge and a conduit for aquatic invasive species to colonize and persist in Everglades marshes (Harvey et
1070 al. 2011). The invasion of nonnative freshwater fishes into ENP coincided spatially and temporally with
1071 both the increasing number of reproducing nonnative fish species in Florida and water management actions
1072 and infrastructure that increased the connectivity of marshes with canals (Kline et al. 2014). Mayan cichlids
1073 (*Mayaheros urophthalmus*) dispersed into the marsh from canals more readily at shallower marsh depths
1074 than largemouth bass (*Micropterus salmoides*) with individual cichlids observed moving > 20 km into the
1075 marsh from the canal (Parkos and Trexler 2014). Mayan cichlids recolonized the marsh/mangrove
1076 ecosystem south of Taylor Slough downstream of nearby canals much more rapidly following the cold
1077 weather and drought events in 2010 and 2011 than in mangrove creeks in southern Shark River Slough,
1078 more distant from the nearest canals (Rehage et al. 2016). New nonnative species continue to spread into
1079 the Everglades. Nile tilapia (*Oreochromis niloticus*), a species that has been spreading throughout Central
1080 and South Florida since the mid-2000s (Shafland et al. 2008), has been found in the Everglades STAs
1081 (J. Goeke, Florida International University, personal communication), was collected from BCNP in 2017
1082 (USGS Nonindigenous Aquatic Species [NAS] database specimen ID 1396492), and were a new species
1083 to ENP in 2019 (Naja et al. 2022). In addition, a credible observation of an individual hornet/zebra tilapia
1084 (*Tilapia buttikoferi*) in ENP (Early Detection and Distribution Mapping System [EDDMapS] Record ID
1085 11289274) suggests this species continues to spread west from the locations of first collections in the
1086 Tamiami Canal in 2005 (Shafland et al. 2008). The eDNA of the goldline snakehead (*Channa aurolineata*;
1087 previously identified as the bullseye snakehead), a prohibited nonnative species in Florida, was detected
1088 within the Everglades Protection Area (EPA; Hunter et al. 2019) and a population of these snakeheads is
1089 now present upstream of the S-9 structures that pump from the C-11 Canal to the west into the Everglades
1090 (K. Gestring, FWC, personal communication). The Midas cichlid (*Amphilophus citrinellus*) continues to be
1091 observed in the canals and management areas adjacent to ENP (EDDMapS Record IDs 10510277,
1092 11487510, and 7813826). The Asian swamp eel (*Monopterus albus*) was originally recorded in the CERP
1093 footprint in 1998 (NAS Database). It is now firmly established throughout the footprint, and is spreading
1094 rapidly outward, reaching the northern boundaries of the Everglades and beyond. The proximity of these

1095 nonnative species to Everglades marshes demonstrates the threat of future invasions and uncertainty for
1096 what influence those species may have on Everglades trophic ecology.

1097 Once in the Everglades, nonnative fishes have established populations across various habitats and
1098 management areas. Prior to the 2010s, the largest relative abundances of nonnative fish in the Everglades
1099 occurred within canals, solution hole habitats of the Rocky Glades, and in the mangrove/marsh/estuarine
1100 creek areas of the southern Everglades, however the ridge and slough habitats maintained a relative
1101 abundance often much less than < 1% of the total catch in quantitative throw trap samples (Trexler et al.
1102 2000, Kline et al. 2014). Also, in general, ENP tended to have a higher relative abundance of nonnative fish
1103 than the WCAs (Trexler et al. 2000). It was thought the vulnerability of many of the nonnative fish to
1104 seasonal cold and possibly the occasional drought may have limited their abundance in the sloughs (Trexler
1105 et al. 2000). It was because of the traditionally low relative abundance in the quantitative fish density
1106 samples from the slough/*Eleocharis* marsh habitats that an arbitrary threshold of 2% of the total catch was
1107 considered a “red stoplight” indicator of “substantial deviations from restoration targets, creating severe
1108 negative condition that merits action” (Doren et al. 2008). However, in Water Year 2015 (WY2015; May 1,
1109 2014–April 30, 2015) and WY2016, due to a surge in the African jewelfish (*Hemichromis letourneuxi*)
1110 population, Shark River Slough exceeded the 2% threshold, and in WY2016 nonnative fish exceeded the
1111 2% threshold in Taylor Slough due to Mayan cichlids and the surge of Asian swamp eels (Brandt et al.
1112 2016). In WY2022, the overall relative abundance of nonnative fish was 2.5% in the CERP’s Restoration
1113 Coordination and Verification Program’s (RECOVER’s) Monitoring and Assessment Plan (MAP) aquatic
1114 fauna sampling from WCA-1 down through ENP, the highest relative abundance observed over the previous
1115 16 years of the study (**Figure 7-13**) and exceeded thresholds for the first times in WCA-3 in WY2021 and
1116 WY2022 (Brandt et al. 2022). Non-native fish relative abundance and spatial spread were higher for
1117 WY2018–WY2024 than the baseline WY2005–WY2017 of the RECOVER aquatic fauna data set do to
1118 both increases in density and more frequent catches in WCA-3 (N. Dorn from the 2024 *System*
1119 *Status Report*, [RECOVER 2024]).

1120 The impact of nonnative fishes in Florida and the Everglades has not often been studied with rigor
1121 (Schofield and Loftus 2015); however, recent studies have predicted or observed impacts of nonnative
1122 fishes in the Everglades. Abundant Mayan cichlid populations appear to reduce the abundance of some
1123 small native fish species in southern Taylor Slough mangrove creek and marsh flat habitats likely through
1124 predation (Harrison et al. 2013). African jewelfish reduced the abundance of some aquatic invertebrates
1125 and a small fish species in mesocosm experiments simulating Everglades marshes (Schofield et al. 2014).
1126 Invasive fishes, including African jewelfish, can dominate solution hole habitats of the karst landscape and,
1127 in combination with the overdried conditions and extended time isolated in the pools without surface water,
1128 results in the Rocky Glades being considered a possible population sink for native marsh fishes (Rehage et
1129 al. 2014). Certain small fishes were missing restoration targets from assessment in Shark River Slough
1130 when African jewelfish were particularly abundant (Brandt et al. 2016). Jewelfish reduced the density of
1131 some small native fishes when they were particularly abundant, but when the jewelfish population declined,
1132 the small native fishes began recovery, and those impacts attributable to jewelfish appear to have been
1133 smaller and more temporary than the impacts attributed to the Asian swamp eel (Pintar et al. 2023a).
1134 Crayfishes and some small fish species known to be vulnerable to predators and to benefit from drying
1135 events that knock back predators (e.g., Dorn and Cook 2015) have almost disappeared from long-term
1136 monitoring plots after Asian swamp eels spread from adjacent canals, established throughout Taylor
1137 Slough, and attained high abundance. The Asian swamp eel’s ability to persist through drying events may
1138 break the typical hydrological control drying causes by reducing the abundance of all other large fishes in
1139 Everglades marshes (Pintar et al. 2023b). Maintaining the consistency of long-term monitoring programs
1140 will be very important to assess the potential influence of Asian swamp eels now that the species has
1141 recently spread throughout much of WCA-3 and ENP (Pintar et al. 2023a, 2024).



1142
1143
1144
1145

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.

1146 Agency staff use natural waters surveys to
1147 proactively determine the distribution and abundance
1148 of established species and, if a new species is
1149 detected, to implement management strategies to
1150 eradicate or minimize potential negative impacts.
1151 FWC staff are conducting electrofishing surveys and
1152 removing invasive fish—primarily tilapia
1153 (*Oreochromis* sp.) and sailfin catfish
1154 (*Pterygoplichthys* sp.) from selected natural water
1155 bodies (**Figure 7-14**). FWC used experimental
1156 gillnets to remove tilapia from several springs in
1157 Central Florida with little success. Based off their
1158 results, they developed a custom gillnet with a single
1159 mesh opening and heavier lead line with plans to do
1160 removal surveys during the winter months when fish
1161 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).

1162 **Species Profile: Sailfin Catfish**

1163 FWC contracted with UF to generate bioprofiles
 1164 and complete Aquatic Species Invasiveness Screening
 1165 Kit (AS-ISK) risk screens for 4 species of sailfin catfish
 1166 (*Pterygoplichthys anisitsi*, *P. disjunctivus*, *P. multi-*
 1167 *radiatus*, and *P. pardalis*) (Figure 7-15) with native
 1168 ranges in the Orinoco and Amazon River basins, or
 1169 rivers in Paraguay. These species are large-bodied,
 1170 heavily armored fish commonly referred to as sailfin
 1171 catfish due to an elongated dorsal fin. The international
 1172 aquaculture industry trade these *Pterygo-plichthys*
 1173 catfishes and collectively this group of fish (16 species)
 1174 is within the top five traded species by trade volume
 1175 annually. Aquarists use them to clean algae from their
 1176 tanks and to eat surplus fish food. Florida is a major
 1177 producer of these species with an estimated production
 1178 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.



1179 **Figure 7-15.** Sailfin catfish (photo by FWC).

1186 **Species Profile: Asian Swamp Eel**

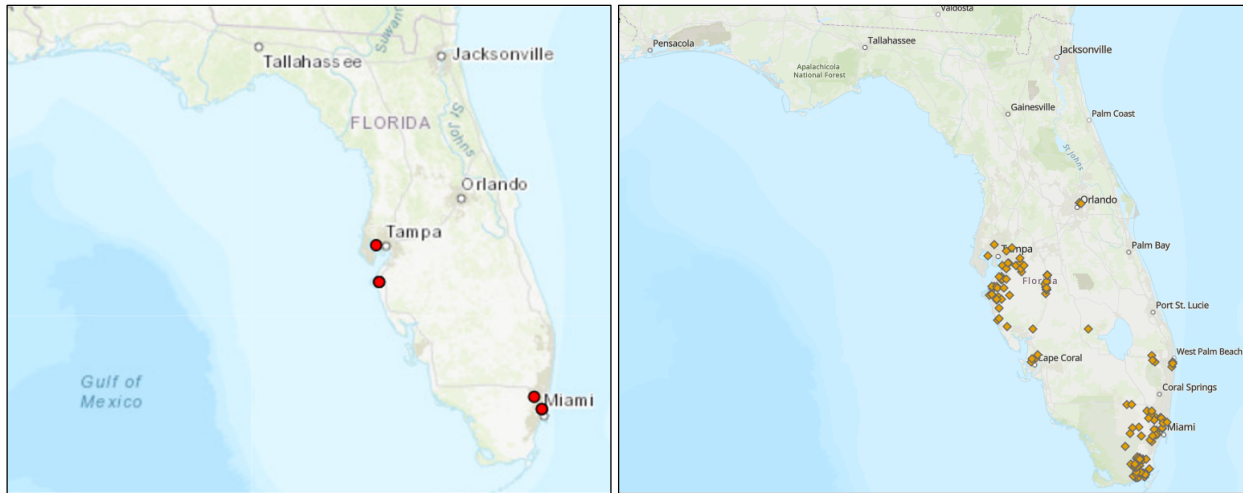


1199 **Figure 7-16.** Asian swamp eel
 (photo by USACE).

1200 The Asian swamp eel (*Monopterus albus*), an aquatic invasive
 1201 species native to Asia, was recorded within the CERP footprint as
 1202 early as 1998 (Figure 7-16). It is thought to have been introduced by
 1203 way of aquarium release or from live fresh fish market releases. It is
 1204 morphologically similar to several native Florida species, like the
 1205 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).

1206 A study on both wild-caught and imported *Monopterus*, the occurrence of internal parasites in wild-
 1207 caught Asian swamp eels was found to be nearly 100%, making their potential as a vector for disease very
 1208 high (Nico et al. 2011). The Asian swamp eel was originally thought to be a single species, but further study
 1209 has shown some genotypic distinctions, which indicates they may have originated from several locations

1210 throughout Asia (Collins et al. 2002). If this species persists and continues its spread throughout Florida,
 1211 the potential for ecological harm only grows larger. The maps below show its spread from 1998 to 2025
 1212 (Figure 7-17).



1213
 1214 **Figure 7-17.** Maps of Florida displaying Asian swamp eel sightings
 1215 in a pre-CERP environment in 1998 (left panel) and 2025 (right panel).

1216 **Priorities Moving Forward**

1217 As management of invasive animals in the Everglades restoration footprint continues, gaps in
 1218 knowledge are increasingly filled. But important questions and the need for critical resources remain.
 1219 Identifying and prioritizing future needs are important steps to move forward effectively and increase our
 1220 likelihood of managing invasive fauna successfully. This section outlines future priorities.

1221 The most consistent and important resource identified by most invasive species management experts is
 1222 a steady and substantial source of dedicated funding. Resources for invasive animal research and
 1223 management are much less substantial than funding for invasive plant work. Identifying a source capable
 1224 of delivering sufficient and sustainable resources, developing a pathway to acquire them, and successfully
 1225 executing that plan is vital to the success of managing invasive fauna.

1226 Preventing introduction of new species or of existing species in new locations is the easiest and most
 1227 cost-effective method of keeping the landscape free of nonnative species. Outreach, education, and risk
 1228 assessment are important tools to achieve prevention. These tools are beginning to gain momentum in
 1229 management efforts and the value of these programs should be reinforced. Creating regulations and patterns
 1230 of responsible ownership to limit the introduction and spread of many nonnative species has occurred after
 1231 species have been introduced but would be more effective if set in place proactively to prevent
 1232 future introductions.

1233 EDRR is the next best tool after prevention. Successful EDRR efforts have prevented the establishment
 1234 and/or spread of several species such as sacred ibis (*Threskiornis aethiopicus*), Nile crocodiles, Asian water
 1235 monitor (*Varanus salvator*), red swamp crayfish (*Procambarus clarkii*), and one population of panther
 1236 chameleons (*Furcifer pardalis*). Maintaining a readily available response team with expertise across taxa
 1237 is critical to success in extirpating a nonnative species quickly after its introduction.

1238 Burmese pythons remain a priority species due to their ability to impact native wildlife. Increasing
 1239 detection of this cryptic predator is a high priority. Many avenues exist to pursue this goal. Work will
 1240 continue with detector dogs, eDNA, and AI, in addition to pheromone and mammalian lures. Currently,
 1241 technologies such as sophisticated cameras capable of scanning wavelengths outside human visible

1242 spectrum have been developed and continue to be tested. Analyses of ideal conditions for python detection
 1243 are nearly complete but should continue to be refined as data collection continues. Most control tools used
 1244 for Burmese pythons also apply to Northern African python eradication efforts. While this species’
 1245 population is thought to be extremely limited geographically in South Florida, it should remain a key focus
 1246 of invasive animal specialists. Scout snakes, captured snakes that are radio-tagged and released back into
 1247 the wild to find conspecifics, may be an effective tool for northern African pythons and should be deployed
 1248 if possible. Continued monitoring of pythons will help in evaluation of control efforts.

1249 Control of Argentine black and white tegus should continue, and current declines are encouraging in
 1250 suggesting that removal efforts may impact the population in local areas. Additional research on diet, body
 1251 condition, and phenology of tegus is underway and will continue to shed light on the species, potentially
 1252 leading us to weaknesses to exploit in removal efforts.

1253 While Nile monitors are relatively confined geographically, they are another species needing aggressive
 1254 control efforts. Exploratory surveys and public outreach may provide important information on
 1255 undiscovered metapopulations. Researchers and managers likely have an incomplete picture of where they
 1256 occur and how they use the areas in which we already know they occur. Currently, a GPS telemetry study
 1257 is ongoing to determine how monitors are using the landscape in Cape Coral. Nile monitor diet and body
 1258 condition research is currently underway.

1259 Several species have emerged as candidates for increased control measures. Spectacled caimans are
 1260 sparsely distributed throughout the landscape of South Florida. Several agencies (FWC, SFWMD, and
 1261 USACE), and UF have bolstered removal programs to extirpate local populations or even eradicate the
 1262 species entirely from Florida, and at present, maximum control of this species is thought to be achieved
 1263 (Godfrey et al. 2023). Green iguanas cause economic damage through crop damage, aircraft strikes on
 1264 runways, and structure damage (Falcón et al. 2013). For these reasons, FWC, UF, and SFWMD have begun
 1265 pilot programs to test iguana control methods from the Florida Keys through Palm Beach County.

1266 **INVASIVE SPECIES MANAGEMENT CASE STUDIES**

1267 This section presents five case studies that highlight the diversity of invasive species management
 1268 efforts in the region. Together, these case studies showcase integrated approaches—biological, mechanical,
 1269 chemical, and sociological—tailored to the invasive species’ biology and program objectives. They also
 1270 underscore two recurring themes: collaboration among partner agencies and stakeholders, and the
 1271 importance of sustained, science-based control strategies. Each example offers transferable lessons for
 1272 invasive species programs throughout the South Florida ecosystem.

1273 **Inundative Releases of Biocontrol Agents of Water Hyacinth**

1274 Classical biological strategies typically involve initial mass releases of approved agents to encourage
 1275 establishment, after which time agents are left to reproduce in the field without frequent additional releases.
 1276 This can be effective but is dependent on the unique circumstances of the target species, agent species, and
 1277 the environment in which the agents are released. In many cases, and particularly for invasive aquatic plants,
 1278 eutrophication in the water systems acts as a strong bottom-up force driving high rates of plant growth and
 1279 reproduction, and achieving maintenance control through biological control can be challenging, since one
 1280 is required to overwhelm such high rates of plant growth. To counteract this challenge, inundative releases
 1281 of insects can be conducted to create a strong top-down force, but this requires the production of large
 1282 numbers of insects to be released frequently. In South Africa, researchers have achieved promising results
 1283 using inundative releases of the water hyacinth planthopper (*Megamelus scutellaris* Berg [Delphacidae]) to
 1284 manage water hyacinth populations in a highly eutrophic system without the use of herbicides (Coetzee et
 1285 al. 2022). Hence, there is interest in determining if the same effect can be achieved in Florida using
 1286 inundative releases of *M. scutellaris*.

1287 *M. scutellaris* is established in Florida after it was initially released in the early 2010s, but abundances
 1288 in the field are far lower than those in South Africa. This lower abundance may be the result of lower release
 1289 efforts/rates compared to the South African researchers, climatic differences between Florida and South
 1290 Africa, presence of difference species of parasitoids, and several other factors. Additionally, the source
 1291 populations of the *M. scutellaris* in Florida and South Africa are different. A *M. scutellaris* population from
 1292 Argentina was originally imported to the USDA-ARS quarantine facility before being released and exported
 1293 to South Africa after host specificity tests. Subsequently, a population from Paraguay was also imported
 1294 and released in Florida, and future release efforts continued with this species. Currently, the dominant
 1295 population found in Florida originates from Paraguay, and the dominant population used in South Africa
 1296 originates from Argentina (*N. Salinas* and *A. Sosa*, personal comm.). Therefore, it is possible that each
 1297 population has differing abilities to survive and reproduce as biological control agents.

1298 In this study, researchers' goals were threefold:

- 1299
- Establish mass rearing facilities for *M. scutellaris*.
 - 1300 • Conduct crossbreeding experiments to determine if there are differences in the number of
 - 1301 offspring produced by each population and their hybrids.
 - 1302 • Conduct frequent releases of *M. scutellaris* from both populations at select sites and compare
 - 1303 abundances and management of waterhyacinth.



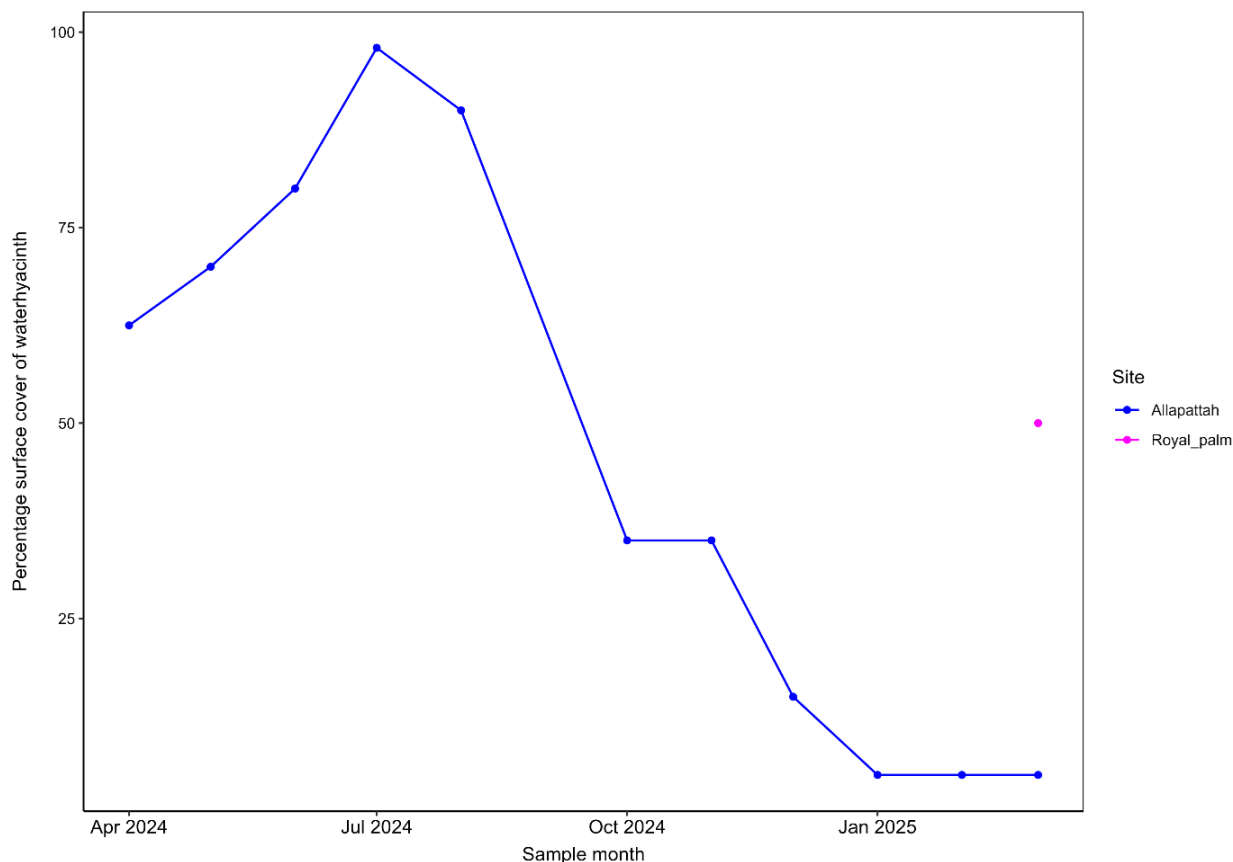
Figure 7-18. Mass rearing facility using troughs and insect netting to grow colonies of *M. scutellaris* (photo by Megan Reid).

1320

1321 enclosed male and female from each population to compare “pure” Argentina and Paraguay populations, as
 1322 well as hybrids created by mating females from the Paraguay population with males from the Argentina
 1323 population (hybrid 1) and mating males of the Paraguay population with females from the Argentina
 1324 population (hybrid 2). Preliminary results indicated that similar abundances of offspring were produced for
 1325 each crossbreeding treatment, but that there were slightly elevated numbers of offspring for the hybrid 1
 1326 treatment. Experiments are still being conducted, but it is possible that increasing the genetic diversity of
 1327 *M. scutellaris* by crossbreeding populations could have beneficial (or minimally beneficial) effects.

1328 Frequent field releases of the Paraguay population of *M. scutellaris* began in April 2024 at a selected
 1329 site near Indiantown, Florida, during which time water hyacinth coverage and average biomass, as well as
 1330 abundances of *M. scutellaris* and *Nechoetina eichhorniae* (another well-established biological control agent
 1331 for water hyacinth released in the 1970s) were measured once a month following monthly releases of 1,000
 1332 to 2,000 *M. scutellaris*. Coverage was reduced from 95% water body coverage to under 5% coverage by

1333 January 2025 (**Figure 7-19**), and coverage has remained low to date. However, abundances of *M. scutellaris*
 1334 did not increase substantially, but populations of *N. eichhorniae* exploded, resulting in high levels of
 1335 feeding damage on the leaves. Currently, the water body is covered in water lettuce, with only a few heavily
 1336 damaged water hyacinth plants present. Another site was selected to begin releases of the Argentina
 1337 population, but extremely low water levels have hindered surveys and releases. Additional sites are being
 1338 selected to conduct releases and aim to include releases of *N. eichhorniae*. Rearing capacity has recently
 1339 been improved to include indoor colonies with grow lights to counter the deleterious effects of high summer
 1340 temperatures on insect colonies. It is expected that releases of both species of biological control agents will
 1341 achieve promising results, and experiments will continue to be conducted to compare the two populations
 1342 of *M. scutellaris* and determine if one or the other performs better through mass releases. In addition,
 1343 experiments are being conducted to test integrated pest management (IPM) through inundative releases and
 1344 the use of different herbicides to measure effects on biological control agents and develop improved
 1345 techniques to manage water hyacinth with minimum cost. This research is supported by funding from (and
 1346 collaboration with) FWC and the USDA-ARS Areawide Management program.



1347
 1348 **Figure 7-19.** Water hyacinth coverage over time during monthly surveys and mass
 1349 releases of *M. scutellaris*. Rapid decrease in cover after July is likely the result of an
 1350 explosion in populations of *N. eichhorniae* in addition to releases of *M. scutellaris*.

1351 **Picayune Strand Invasive Fish Project**

1352 In partnership with FWC, USACE participated in an operational invasive fish project in Picayune
 1353 Strand in 2025. The purpose of the project is to assess fish biodiversity in both the Miller and Faka Union
 1354 restored canal systems. This information will help biologists extrapolate fish biodiversity patterns
 1355 throughout the surrounding regions of the Everglades.

1356 The first phase of this project began in early 2025. Biologists surveyed both the Faka Union and Miller
 1357 canal systems using electrofishing. All identifiable species—both native and nonnative—were recorded to
 1358 allow comparisons with species observed during phase 2 of the project. A mark/recapture study was also
 1359 incorporated to estimate fish populations within each canal segment and to determine electrofishing
 1360 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 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**.

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1393

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

1394

1395

Table 1. Continued.

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

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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

1400

1401 **Melaleuca Maintenance Control Program**

1402 Melaleuca (*Melaleuca quinquenervia*), a fast-growing invasive tree from Australia, was widely planted
1403 across South Florida in the early 20th century. By the 1990s, it had infested nearly 200,000 ha (Ferriter
1404 1999), including major wetlands such as the WCAs, BCNP, and ENP. In response, melaleuca was listed as
1405 a federal noxious weed, and the Melaleuca Task Force formed a regional plan of attack.

1406 SFWMD, in collaboration with federal, state, and local partners, launched a three-phase melaleuca
1407 control strategy:

- 1408 1. Eliminate major infestations of all mature and seedling trees.
- 1409 2. Revisit previously treated sites to control previously missed trees and/or to remove new
1410 seedlings.
- 1411 3. Conduct surveillance and inspections of those previously treated areas to monitor and to
1412 maintain minimal reinfestation levels.

1413 This integrated approach combined aerial and ground-based herbicide applications, biological controls
1414 (e.g., melaleuca weevil, psyllid, and stem-gall midge), and consistent surveillance.

1415 **Comparison of Control Efforts Under Maintenance Control and Heavy Infestation**

1416 WCA-2B was historically one of the most heavily infested areas within the Everglades, with up to 30%
1417 canopy coverage. WCA-3B also contained substantial infestations, while the Pennsuco Wetlands Area, east
1418 of WCA-3B along the urban fringe, experienced varying levels of invasion with some areas containing
1419 dense single species stands.

1420 Decades of coordinated treatment in the WCAs have yielded dramatic results. WCA-2A, WCA-2B,
1421 WCA-3A, and WCA-3B are now considered under maintenance control (**Figure 7-21**) and areas once
1422 dominated by melaleuca have been restored to native marsh habitat. The sustained efforts to systematically
1423 remove dense infestations while preventing reinfestations through diligent monitoring and follow up
1424 treatments has resulted in significant reductions in the management costs and herbicide utilization. In 2024,
1425 the SFWMD's melaleuca removal contractors swept the entire 94,452-acre WCA-3B at a cost of just \$1.24
1426 per acre, with melaleuca occupying less than 1% of the area. Only 3.18 pounds (lb) of imazapyr and 6.3 lb
1427 of glyphosate were applied—virtually negligible when distributed over the entire management area.
1428 Likewise, in 2025, WCA-2B's 26,844 acres were gridded for maintenance treatments, with less than 1%
1429 infested and herbicide inputs similarly minimal (1.8 lb imazapyr and 3.7 lb glyphosate total, or near-zero
1430 per acre).

1431 By contrast, the 2025 control effort at a Pennsuco Wetlands site with inconsistent past melaleuca
1432 management covered 4,867 acres, with 97.7 acres of dense infestation requiring far higher herbicide use—
1433 89.4 lb of imazapyr and 496.3 lb of glyphosate. Treatment costs were \$134.63 per acre due to higher plant
1434 density and more intensive labor requirements. Unlike the WCAs, parts of the Pennsuco Wetlands Area are
1435 still in initial or overdue maintenance phases and suffer from reinvasion from neighboring properties.

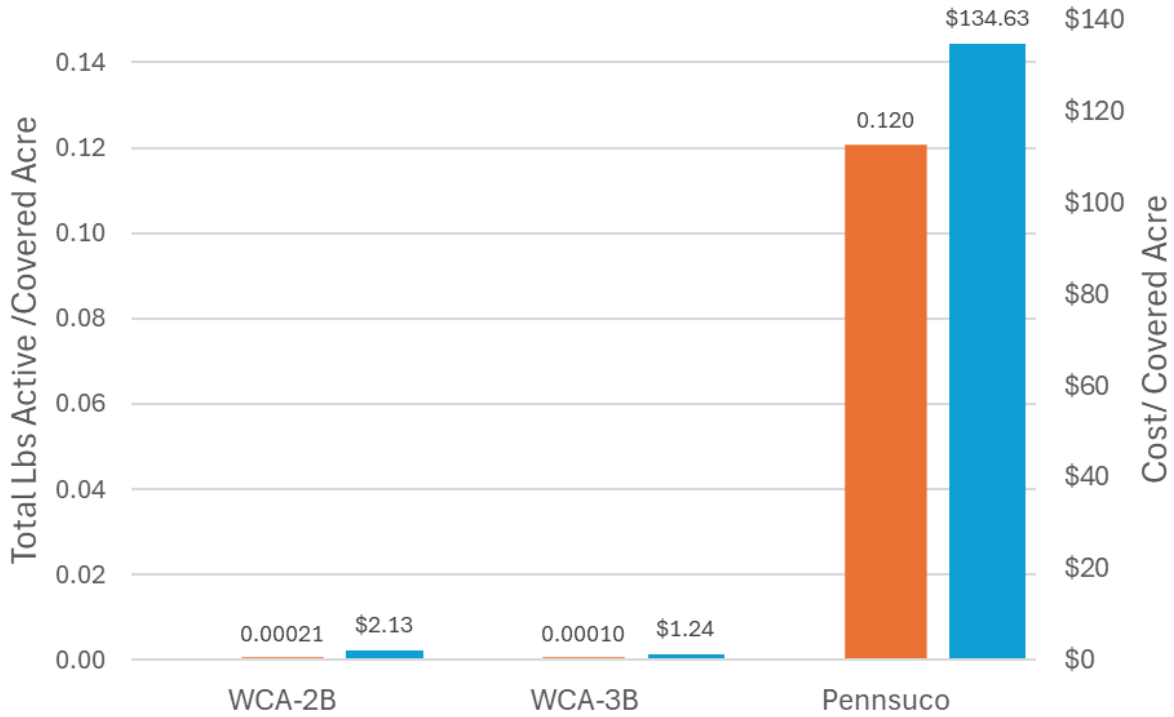


Figure 7-21. Comparison of per acre herbicide use and control costs for melaleuca management in two areas under maintenance control (WCA-2B and WCA-3B) and an initial melaleuca treatment in the Pennsuco Wetlands Area.

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Long-Term Strategy and Outcomes

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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

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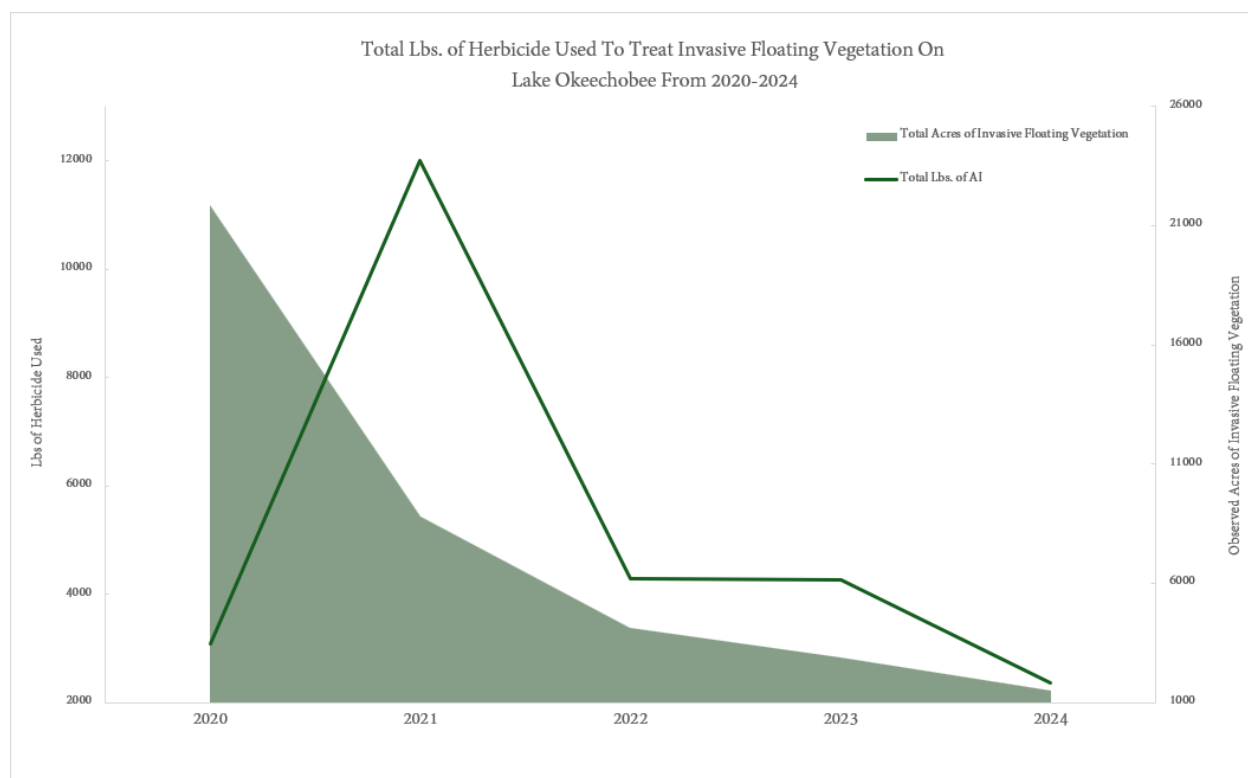
Invasive floating plants, particularly water hyacinth (*Pontederia crassipes*) and water lettuce (*Pistia stratiotes*), pose persistent challenges in Lake Okeechobee even after 105 years of management. Maintenance control, which is a proactive strategy focused on keeping plant populations at the lowest 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.

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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

1462 maintaining low levels of invasive plants through integrated management techniques, not only reduces
 1463 herbicide use but also limits muck accumulation and long-term costs.

1464 Today, FWC and USACE continue to employ maintenance control tactics on Lake Okeechobee. These
 1465 efforts have shown measurable success after the statewide 2019 three-month spray pause, which caused
 1466 floating plants to quickly get out of hand (**Figure 7-22**). By 2025, floating plant levels were reduced to just
 1467 three acres of infestation that could be identified during interagency helicopter surveys, which is the lowest
 1468 levels since 1989. Additionally, since reestablishing maintenance control post 2019, the agencies have
 1469 achieved significant gains: a 27.5% reduction in spending, a 44% reduction in treated acres, and a 80%
 1470 reduction in pounds of active ingredient use per year and a 93% reduction in the amount of acres of invasive
 1471 floating plants observed throughout the lake (**Figure 7-22**).



1472 **Figure 7-22.** The relationship between yearly observed acres of invasive floating vegetation and the
 1473 yearly pounds (Lbs) of active ingredients used to treat invasive floating vegetation throughout Lake
 1474 Okeechobee since the 3-month spray pause of 2019 caused a disruption in maintenance control.
 1475

1476 However, the greatest threat to the sustainability of this program is not biological, but public perception.
 1477 When plant levels are low and visible impacts diminish, stakeholders may question the need for continued
 1478 treatment. This misunderstanding has led to repeated shifts from proactive to reactive management. For
 1479 example, in 1989 after “Operation Clean Sweep” by USACE, plant levels were well controlled, prompting
 1480 public outcry over continued herbicide use. A resulting three-month spray pause allowed hyacinth and
 1481 lettuce populations to rebound dramatically, leading to increased herbicide use and costs.

1482 A similar scenario unfolded in 2019 when public pressure caused FWC to halt herbicide applications
 1483 statewide. This pause resulted in more than 3,500 acres of floating plants on Lake Okeechobee, disrupted
 1484 boat navigation, and forced the closure of the Julian Keen Jr. federal navigation lock for two weeks. Moored
 1485 boats were surrounded overnight as drifting mats of hyacinth spread across the lake. Once treatment

1486 resumed, efforts had to intensify to regain control, reversing earlier gains in cost savings and
1487 ecological stability.

1488 As of May 2025, Lake Okeechobee’s invasive plant levels are under control, and management is more
1489 efficient than it has been in decades. Yet, the risk remains that shifting public perception and political
1490 pressure may once again undermine progress.

1491 Ultimately, the success of invasive plant management on Lake Okeechobee hinges not just on science
1492 and strategy, but also on effective communication and public education. The lesson is clear that proactive,
1493 sustained intervention works but only if it is allowed to continue, regardless of whether the threat is
1494 immediately visible.

1495 **A Termite Tale: The Significance of Public Outreach for Early Detection and** 1496 **Rapid Response and Eradication Programs**

1497 While the importance of public outreach for early detection and rapid response (EDRR) is likely a well
1498 understood concept in invasive species management, a recent example of success in the detection, reporting
1499 and quick action taken to prevent establishment of a novel termite species discovered on Florida soil is
1500 highlighted here.

1501 The Florida Department of Agriculture and Consumer Services (FDACS) has been working for over a
1502 decade to eradicate the conehead termite (*Nasutitermes corniger*) from Broward County. The Conehead
1503 Termite Eradication Program is both a management and education program whose focus is on awareness
1504 of the dangers of this invasive species as well as on the high potential likelihood of new introductions from
1505 abroad or unintentional human spread of this species across the state. While the currently known
1506 populations in Florida are limited to a small area of southeast Broward County, FDACS places a high
1507 priority on spreading awareness via both targeted and broad outreach opportunities to identify any potential
1508 unknown populations that may exist in other areas.

1509 It can often be difficult to assess if an outreach program is successful, especially if the target species
1510 population is not widespread. However, the Conehead Termite Eradication Program received a report in
1511 late April 2024 that proved the years of outreach and education shared by the program was indeed
1512 succeeding.

1513 A discovery by staff at the Port of Palm Beach in Riviera Beach, Florida, of a large and strange looking
1514 insect nest prompted a quick call to their contracted pest control company. While the port staff may not
1515 have known what they were seeing, the termite experts from the pest control company knew right away that
1516 this was not something they had previously encountered. A quick best guess of species by the termite team
1517 told them that this may be a conehead termite, which they knew, by way of those years of FDACS’ targeted
1518 outreach to the pest control industry, was a species of high concern, and under eradication from the state.
1519 The pest control company also knew how to contact the program and quickly completed both an online
1520 reporting form and a phone call to the program lead.

1521 Once contacted, and after seeing the initial photographs, FDACS conehead termite staff knew that this
1522 needed to be addressed immediately. Not only was this location over 50 miles removed from the current
1523 known infestation of conehead termites, but it was days away from what is considered the beginning of
1524 swarming season. They knew that if this nest were to swarm, that the new kings and queens that would
1525 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

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1549 removed from its crane pad substrate, destroyed to the best ability, and treated with pesticide. While it was
 1550 full of worker and soldier termites, there was no sign of any ongoing reproduction within the nest structure.
 1551 No immature termites, no kings or queens, and no alate reproductives ready to swarm were found. A follow
 1552 up survey of the entire port also did not locate any additional signs of ongoing *N. acajutlae* activity.

1553 Because of the cryptic nature of young termite colonies, it is premature to say that this one treatment
 1554 event completely removed this species from Florida shores, however the lack of colony reproductive
 1555 activity and no additional sightings in the past year make this an optimistic EDRR success story. It
 1556 especially highlights the collaboration between government biologists who are tasked with protecting the
 1557 state from invasive species threats, and the industry workers who are often the first line of discovery when
 1558 unusual species are spotted. The public outreach efforts of FDACS’ Conehead Termite Eradication Program
 1559 had reached the audience that it needed with a message that highlighted the importance of quick action and
 1560 best reporting procedures. Without this knowledge network built of trust and urgency, successful EDRR
 1561 events such as this would not be possible.

1562 **INTERAGENCY COORDINATION**

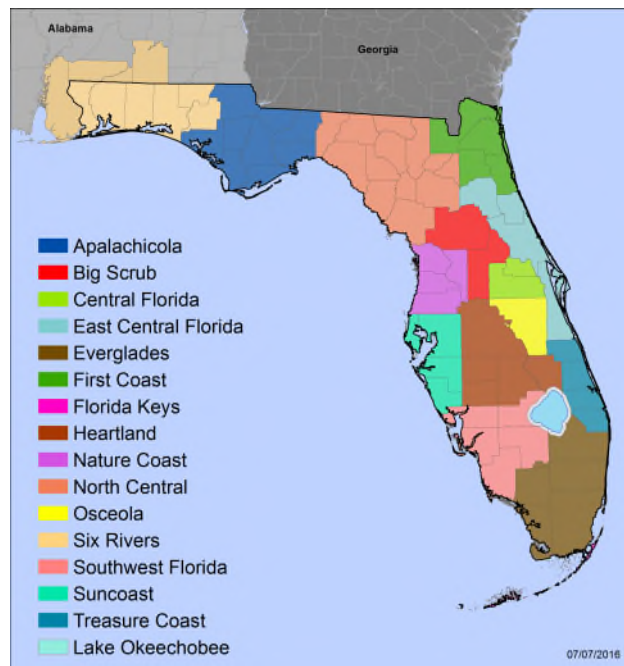
1563 This section provides updates on key interagency coordination activities pertaining to invasive species
 1564 in South Florida during FY2025. To be successful, regional management of invasive species requires
 1565 strategic integration of a broad spectrum of control measures across multiple jurisdictions. As such,
 1566 numerous groups and agencies are necessarily involved with invasive species management in Florida. More
 1567 information on agency roles and responsibilities pertaining to invasive species in Florida is in the document
 1568 *Filling the Gaps: Ten Strategies to Strengthen Invasive Species Management in Florida* (Environmental
 1569 Law Institute 2004) available online at <http://www.eli.org/sites/default/files/eli-pubs/fillingthegaps.pdf>.

1570 **Florida Invasive Species Council**

1571 Recognizing the need to standardize terminology (Iannone et al. 2021), the Florida Exotic Pest Plant
 1572 Council (FLEPPC) formally changed its name to the Florida Invasive Species Council (FISC) in 2022. As
 1573 with FLEPPC, FISC’s primary mission is to reduce the impacts of invasive plants in Florida through the
 1574 exchange of scientific, educational, and technical information. The organization accomplishes this by
 1575 hosting an annual symposium, compiling an invasive plant species list every two years (FISC 2025), and
 1576 developing invasive species management plans and outreach materials. In addition to its name change,
 1577 FISC formerly merged with the Florida Invasive Species Partnership (FISP) in 2023. FISP was a
 1578 collaborative effort between local, state, and federal agencies, as well as non-governmental organizations,
 1579 to connect private and public landowners with professional expertise and assistance programs. FISP played
 1580 an important role in helping coordinate cooperative invasive species management areas (CISMAs) at the
 1581 state level. With the organizational merger, FISC formally established a CISMA committee, which will
 1582 provide similar functions as FISP. Finally, following the trend of other invasive species coordinating
 1583 groups, FISC has integrated invasive animals into its mission.

1584 **Cooperative Invasive Species Management Areas**

1585 Florida has a long history of invasive species organizational cooperation including FISC, Noxious
 1586 Exotic Weed Task Team, Florida Invasive Animal Task Team, and the Florida Invasive Species Working
 1587 Group. At more local levels, land managers and invasive species scientists have informally coordinated
 1588 across the fence line for many years. These regional groups began formalizing their partnerships into
 1589 cooperative invasive species management areas (CISMAs) to further enhance collaboration and
 1590 coordination. CISMAs are local organizations defined by a geographic boundary that provide a mechanism
 1591 for sharing invasive plant and animal management information and resources across jurisdictional
 1592 boundaries to achieve regional invasive species prevention and control (MIPN 2011). To date, there are
 1593 16 CISMAs in Florida covering roughly 98% of the state (**Figure 7-24**). Of these 16 CISMAs, seven occur
 1594 either wholly or partially within the CERP footprint.



1595 **Figure 7-24.** Locations of Florida’s CISMAs.
 1596 (Note: this map was produced by the Center for Invasive
 1597 Species and Ecosystem Health at the University of Georgia.)
 1598

1599 Everglades CISMA

1600 The Everglades Forever Act of 1994 directed SFWMD to coordinate invasive species management
1601 between public agencies with jurisdiction in the EPA. To formalize this coordination, invasive species
1602 scientists and Everglades land managers formed the Everglades Cooperative Invasive Species Management
1603 Area (ECISMA) in 2006 to improve cooperation and information exchange related to invasive species
1604 management. The ECISMA partnership was formalized in 2008 (renewed in 2023) with a memorandum of
1605 understanding (MOU) among SFWMD, USACE, FWC, NPS, and USFWS. The MOU recognizes the need
1606 for cooperation in the fight against invasive species and affirms the commitment of signatories to a common
1607 goal. Currently, the ECISMA consists of 18 cooperators and partners, spanning the full spectrum of
1608 jurisdictions, including tribal, federal, state, local, and nongovernmental conservation organizations. The
1609 geographic extent of ECISMA includes all state and federal lands within the EPA and Everglades
1610 Agricultural Area (EAA), Miccosukee and Seminole lands, and Broward, Palm Beach, and Miami-Dade
1611 counties. ECISMA has achieved much progress toward improved coordination and cooperation among
1612 those engaged in invasive species management in the Everglades. These accomplishments include
1613 development of regional monitoring programs, completion of numerous rapid response initiatives, and
1614 enhanced coordination of management and research activities. During FY2025, partner agencies continued
1615 quarterly coordination meetings to share progress and challenges. In addition, ECISMA partners
1616 participated in ongoing rapid response workdays to eradicate invasive black mangrove (*Lumnitzera*
1617 *racemosa*) from mangroves adjacent to Fairchild Tropical Botanic Gardens in Miami-Dade County.
1618 ECISMA partners also organized several invasive species workdays focused on outreach and small-scale
1619 invasive plant removal. Workdays were held at Galaxy Scrub and Juno Dunes natural areas in Palm Beach
1620 County as well as within the Biscayne Bay Coastal Wetlands project footprint in Miami-Dade County. A
1621 northern African python removal survey was also conducted during National Invasive Species Awareness
1622 Week. ECISMA also hosted its annual Everglades Invasive Species Summit on July 22 and 23, 2025. This
1623 two-day meeting provided a forum for exchanging updates on invasive species management activities, new
1624 research, and outreach efforts as well as planning workshops to organize future collaborations and projects.
1625 More information about ECISMA is available online at <http://www.evergladescisma.org/>.

1626 Treasure Coast CISMA

1627 The Treasure Coast CISMA (TC-CISMA) is a regional partnership established in 2007 to cooperatively
1628 address the threats of invasive plants and animals. The partnership extends from Indian River County south
1629 through St. Lucie, Martin, and northern Palm Beach counties and includes representatives and land
1630 managers from local, state, and federal governments as well as non-governmental organizations. Current
1631 active participants include SFWMD, USFWS, FWC, FDEP-Florida Park Service, Martin County, The
1632 Nature Conservancy, Treasure Coast Resource Conservation and Development Council, Natural Resources
1633 Conservation Service, Palm Beach County Environmental Resources Management, UF's Institute of Food
1634 and Agricultural Sciences (IFAS), St. Lucie County, Indian River County, Aquatic Vegetation Control Inc.,
1635 Habitat Specialists Inc., The Florida Native Plant Society, and several private citizens.

1636 In 2025, TC-CISMA hosted an annual planning meeting where the previous year's activities were
1637 reviewed, and new projects and events were proposed. In addition to the annual meeting, sub-committee
1638 meetings for private lands, cooperative workdays, and EDRR species were held throughout the year. The
1639 Treasure Coast CISMA has largely been focused on outreach and community-driven workdays. The group
1640 engaged in nine local outreach events geared towards educating the public about issues with invasive flora
1641 and fauna in natural and suburban areas, in addition to the planning and participation of 12 workdays which
1642 involved actively surveying for and removing invasive species within the region. TC-CISMA and partners
1643 hosted a workshop offering continued education units to participants with Restricted Use Pesticide licenses,
1644 covering common invasives within the CISMA and two hands on workshops discussing management,
1645 identification and capture techniques of the invasive Burmese python and redhead agama (*Agama agama*).
1646 The continued focus of TC-CISMA is planning and providing opportunities for managers and citizen

1647 scientists to learn how to identify and manage invasive species that are less well known can aid in preventing
1648 their spread and distribution across the landscape. More information about TC-CISMA is available online
1649 at <http://www.floridainvasives.org/treasure/>.

1650 **Southwest Florida CISMA**

1651 The Southwest Florida CISMA (SWFLCISMA), founded in 2008, is a partnership between the
1652 SFWMD, Florida Forest Service, FWC, FDEP-Florida Park Service, USFWS, Lee County, Conservation
1653 Collier, Audubon of Florida, Conservancy of Southwest Florida, Naples Zoo, and others. The boundary of
1654 this CISMA encompasses five counties: Collier, Lee, Charlotte, Hendry, and Glades. Both the Weed
1655 Wrangle and Invasive Fish Roundup, two seminal events for the CISMA, are held in conjunction with the
1656 annual SWFLCISMA Invasive Species Symposium to engage members of the CISMA and the public in
1657 invasive species removal efforts and local research and management efforts. CISMA members learn to
1658 identify and treat a variety of invasive plant species and put their knowledge to work at annual Weed
1659 Wrangle events. The Invasive Fish Roundup incentivizes participant anglers to target nonnative and/or
1660 invasive fish for removal with the chance of earning prizes for their catch.

1661 **Other CISMAs**

1662 In addition to ECISMA, TC-CISMA, and SWFLCISMA, there are four other CISMAs either wholly
1663 or partially within the footprint of the Greater Everglades ecosystem: Florida Keys Invasive Species Task
1664 Force, Heartland CISMA, Osceola County CISMA, and Central Florida CISMA. These CISMAs have also
1665 recognized many successes that have benefited the Everglades ecosystem by furthering the concept of a
1666 landscape-level approach to invasive species management.

1667 **Lake Okeechobee Aquatic Plant Management Interagency Task Force**

1668 Invasive plant management on Lake Okeechobee is coordinated according to policy contained in the
1669 *Corps of Engineers Letter of Operating Procedures for Aquatic Plant Management on Lake Okeechobee*
1670 (USACE 1989) which was adopted by the involved agencies: USACE, SFWMD, Florida Department of
1671 Natural Resources, now FDEP, and FWC, along with state universities. Representatives from partner
1672 agencies in the group have conducted semi-monthly helicopter flights since 1987 to estimate the lake's
1673 coverage of water lettuce and water hyacinth and now conduct aerial surveys every month. At bi-monthly
1674 meetings, interagency representatives present ongoing and planned invasive plant management projects for
1675 review. The group considers all aspects of the project including presence of endangered species,
1676 conservation of quality fish and wildlife habitat, flood control, and navigation. A newsletter is prepared
1677 each month to provide updates on ongoing and upcoming projects from FWC, SFWMD, USACE, and
1678 FDEP. Public stakeholders and nongovernmental organizations are encouraged to attend and provide input.
1679 In recent years, greater emphasis has been put on integrated management of floating aquatic plants
1680 incorporated within the lake. More information about this task force is available online at
1681 <https://www.floridainvasives.org/okeechobee>.

1682 **Kissimmee River and Greater Kissimmee** 1683 **Chain of Lakes Watershed Coordination**

1684 Invasive plant treatment priorities on the Kissimmee River and Greater Kissimmee Chain of Lakes
1685 Watershed are planned at interagency meetings, though these groups do not have a formal agreement such
1686 as the *Corps of Engineers Letter of Operating Procedures for Aquatic Plant Management on Lake*
1687 *Okeechobee* (USACE 1989). Funding from the Florida Aquatic Plant Management Trust Fund and the Land
1688 Acquisition Trust Fund, administered by FWC, is used for much of the aquatic plant management in these
1689 waters. The primary lakes within the Kissimmee Chain of Lakes are given high state priority for large-scale
1690 aquatic plant management treatments, particularly for hydrilla, water lettuce, water hyacinth, Cuban bulrush
1691 (*Cyperus blepharoleptos*), and creeping water primrose (*Ludwigia* spp.). The primary lakes are large

1692 (1,620–13,800 ha) and interconnected with flood protection canals, which are navigable with boat locks
1693 along the system.

1694 Invasive plant management on the Kissimmee River includes the river channel and floodplain and is
1695 strategically implemented to align with restoration efforts. With the completion of construction for the
1696 Kissimmee River Restoration Project, invasive plant management activities have predominantly been focused
1697 within the restoration project footprint, in areas where high quality habitat exists or in areas where
1698 restoration is expected to have the greatest impact. The highest priority species for management in the river
1699 and floodplain include Old World climbing fern, Brazilian pepper, and a suite of invasive grasses. Effective
1700 control methods and management strategies are known for the two former species and managers are
1701 working with researchers to investigate efficient and sustainable options for controlling invasive grasses in
1702 the river and floodplain. SFWMD and UF have partnered on a research project investigating optimal control
1703 options for the most abundant and challenging invasive grasses on the floodplain; West Indian marsh grass
1704 (*Hymenachne amplexicaulis*) and para grass (*Urochloa mutica*). The goal of the research is to determine
1705 the influence of treatment timing, the habitat response post treatment, and the monitoring and retreatment
1706 intervals needed to maintain control of these species while promoting desirable native vegetation.
1707 Operational treatments are being conducted on a larger scale that mirror the experiments and data and results
1708 from these experiments are expected to be published in 2027.

1709 **South Florida Ecosystem Restoration Task Force**

1710 Authorized by the United States Congress in the Water Resources Development Act (WRDA) of 1996,
1711 the South Florida Ecosystem Restoration Task Force (SFERTF) brings together federal, state, tribal, and
1712 local agencies involved in restoring and protecting America’s Everglades. The critical role of the
1713 intergovernmental SFERTF is to facilitate the coordination of the numerous conservation and restoration
1714 efforts being planned and implemented. It also provides a forum for the participating agencies to share
1715 information about their restoration projects, resolve conflicts, and report on progress. SFERTF is chaired
1716 by the Secretary of the United States Department of the Interior or their appointed designee. It is staffed
1717 and supported in the accomplishment of its mission and duties by the United States Department of the
1718 Interior's Office of Everglades Restoration Initiatives.

1719 SFERTF recognizes the significant threat invasive species pose to the goals and objectives of ecosystem
1720 restoration programs in South Florida. To address this, the Invasive Exotic Species Strategic Action
1721 Framework began in 2013. The initial framework was completed in 2015 (SFERTF 2015) and helped to
1722 improve invasive species coordination and boost the effectiveness of existing programs. The framework
1723 was updated in 2020 (SFERTF 2020) and includes a set of complimentary resources, which can be found
1724 online at <https://www.evergladesrestoration.gov/invasive-exotic-species-archive>.

1725 In 2020, section 528 of WRDA 1996 was amended to add specific duties to SFERTF’s mission related
1726 to invasive species. WRDA 2020 directs SFERTF to develop a priority list of invasive species that
1727 significantly impact the structure and function of ecological communities, native species, or habitats within
1728 the South Florida ecosystem. SFERTF member agencies are directed to manage those species through
1729 coordination and collaboration, develop innovative strategies and tools, guide applied research, and
1730 facilitate improved management, control, eradication, and prevention efforts. SFERTF, its Working Group,
1731 the Science Coordination Group, and the Office of Everglades Restoration Initiatives, have established an
1732 Invasive Species Team of experts to help implement the SFERTF’s WRDA 2020 duties.

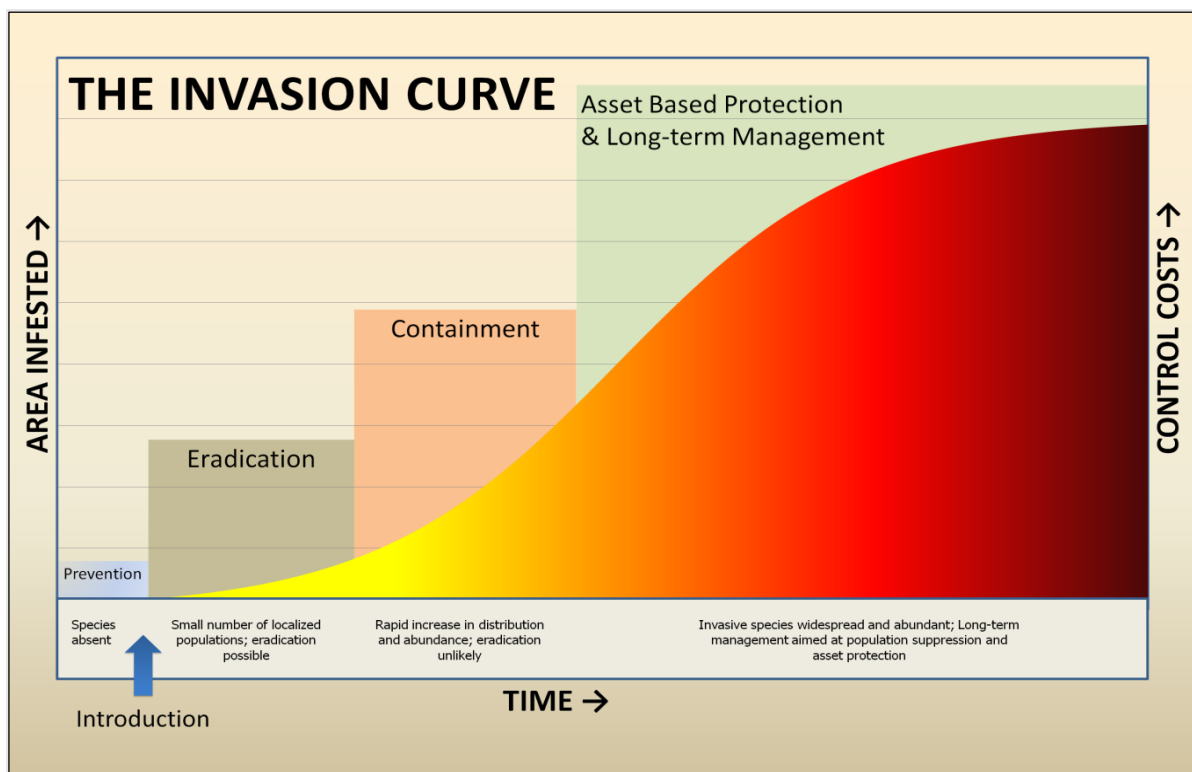
1733 An initial list of priority species was developed for those species not yet within the South Florida
1734 ecosystem and of highest concern for prevention. This effort identified 19 species as high priority
1735 prevention species. This initial list and associated recommended actions were presented to SFERTF at their
1736 June 1, 2023, meeting. The recommended actions include regulation, outreach, and response planning if
1737 prevention efforts are not successful. To help communicate the priority species and recommendations, a
1738 summary document was prepared and is available at the link provided above.

1739 Ongoing work by the Invasive Species Team includes developing an invasive species prioritization tool
1740 and assessing needs and gaps for early detection monitoring. Currently, efforts are underway through an
1741 effort led by UF and USGS to develop a web-based prioritization tool for species all along The Invasion
1742 Curve (see **Figure 7-25** in the *Invasive Species Status Updates* section). The web-based prioritization tool
1743 is intended to provide a repeatable, science-based method of evaluating risk of invasive species to the South
1744 Florida ecosystem. A workshop process for the tool’s development, sponsored by USGS and the Center for
1745 Environmental Studies at Florida Atlantic University, is designed to be inclusive and scientifically based,
1746 incorporating expert options from the Invasive Species Team and input from managers, technical taxonomic
1747 experts, and stakeholders. The first of two workshops was conducted in April 2024; the second was held in
1748 September 2024. Currently, the draft web-based tool is undergoing testing by taxonomic experts. The team
1749 is also conducting an inventory of invasive species detection programs and tools currently being utilized by
1750 agencies and the Seminole and Miccosukee Tribes. This inventory will help identify any gaps or needs with
1751 the goal of optimizing the detection of incipient populations of invasive species.

1752 **INVASIVE SPECIES STATUS UPDATES**

1753 This section provides a summary of invasive species that threaten the success of SFWMD’s mission.
1754 Regional invasive species scientists and land managers have adopted The Invasion Curve (**Figure 7-25**) as
1755 an organizing graphic to communicate the status, impacts, and management strategies for biological
1756 invaders. The curve depicts, at a glance, the ability to combat invasive species in terms of time, resources,
1757 and likelihood of eradication or containment. The left-hand side of the invasion curve represents the best
1758 chance for long-term success. Since eradication of widely established invasive species is rarely achieved, a
1759 long-term commitment to controlling established species is required to protect vulnerable natural resources.
1760 Long-term suppression of established species is challenging and costly. Thus, early detection and control
1761 of new invasive species results in lower overall environmental impact and economic cost along with a
1762 higher likelihood for eradication.

1763 In this section, each of the priority species is summarized in a one-page synopsis that highlights key
1764 management issues and provides general distribution information. Species are presented in three sections
1765 following principles of The Invasion Curve. The three sections group species according to the management
1766 strategies for long-term suppression or containment/eradication. Species managed by regional land
1767 managers for long-term suppression typically have wide distribution ranges and are assumed to be beyond
1768 regional containment or eradication. Species targeted for containment or eradication generally have
1769 regionally limited or highly localized distributions and are thought to have the potential for containment or
1770 eradication due to limited distributions and/or sufficient control tools and resources. A third group includes
1771 nonnative species considered highly invasive in the South Florida ecosystem but are not actively managed
1772 due to insufficient control tools or management resources. These species may be the focus of monitoring
1773 and research on ecosystem- and species-level impacts. Omitting specific mention of other invasive species
1774 in the following priority summaries does not imply the species are not problematic or that control is not
1775 important. On the contrary, the need is urgent for distribution and biological data for many of these
1776 organisms. In addition, numerous nonnative freshwater fishes with known or suspected impacts to native
1777 fauna are not included in this report. Ongoing monitoring and research regarding many of these fish species
1778 is beginning to elucidate the scope of the problem.



1779
1780
1781
1782




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.

1783 For each one-page synopsis, county distribution maps are provided. Plant species distribution is
1784 determined by presence of a species in each county. Animal distribution is based on establishment of a
1785 species, which is determined by the presence of all sexes and age classes, or other evidence of breeding.
1786 Distribution data were compiled from a variety of resources including herbarium records and documented
1787 and verified sightings by citizen scientists, and in only a few cases are data used from systematic, statewide
1788 monitoring efforts. As such, these maps should be viewed as provisional and only intended to give general
1789 instruction on species' distribution. Primary data sources for the distribution maps and the module
1790 occurrence table found in Appendix 7-1 of the *2014 South Florida Environmental Report – Volume I*
1791 (Rodgers and Black 2014) include EDDMapS, ECISMA, FWC Florida's Nonnative Species, USGS
1792 Nonindigenous Aquatic Species, and the University of South Florida Atlas of Florida Vascular Plants. More
1793 photographs and general information about these and other invasive species can be found online at the
1794 following websites:

- 1795
- Early Detection and Distribution Mapping System (EDDMapS) –
1796 www.eddmaps.org/distribution/
 - 1797 • ECISMA – www.evergladescisma.org/
 - 1798 • FWC Florida's Nonnative Fish and Wildlife – myfwc.com/wildlifehabitats/nonnatives/
 - 1799 • USGS Nonindigenous Aquatic Species – nas.er.usgs.gov/
 - 1800 • University of South Florida Atlas of Florida Vascular Plants –
1801 <https://florida.plantatlas.usf.edu/>
 - 1802 • UF IFAS Center for Aquatic and Invasive Plants – <https://plants.ifas.ufl.edu/>

1803 Additionally, each species synopsis includes an indicator-based stoplight table that gauges the status of
 1804 the species in each of SFWMD’s land management regions, as well as Lake Okeechobee, Florida Bay, and
 1805 the Florida Keys. These regions closely align with the CERP RECOVER modules but are more inclusive
 1806 of all conservation and project lands within SFWMD’s boundary. The stoplight table technique was
 1807 established through coordination among the Science Coordination Group, Noxious Exotic Weed Task
 1808 Team, and Florida Invasive Animal Task Team of the SFERTF (Doren et al. 2009). Like its application in
 1809 previous reports, the indicator table assesses each species by region per the following questions: (1) How
 1810 many hectares within the module does this species occur in? (2) Is the distribution of the species in the
 1811 module documented to be increasing, decreasing, or static? and (3) If the species is decreasing in coverage,
 1812 is it a direct result of an active biocontrol or chemical/mechanical control program?

1813 A brief explanation of stoplight indicators provided for each priority species in the following species
 1814 summaries is as follows:

- 1815  Red – Severe negative condition, or expected in near future, with out-of-control situation
 1816 meriting serious attention.
- 1817  Yellow – Situation is improving due to control program and is stable or moving toward
 1818 stabilizing, or species is localized but expected to spread if sufficient resources or actions
 1819 are not provided.
- 1820  Green – Situation is under control and has remained under control for several years or in
 1821 some cases, is not yet present.

1822 **SPECIES MANAGED FOR LONG-TERM SUPPRESSION**

1823 Fourteen established plant species were selected by invasive species biologists from SFWMD and
 1824 partner agencies for long-term suppression based on potential and current implications to SFWMD’s
 1825 infrastructure and ecological concerns (Table 7-3). The three established invasive animal species presented
 1826 in this section are in close alignment with the species identified by regional invasive species experts as
 1827 priorities for long-term suppression and have active management programs in place. These species are
 1828 generally presented with a “SFWMD-centric” justification for listing, and priority plant species may differ
 1829 for other agencies depending on regional factors and agency priorities and goals.

1830 **Table 7-3.** Priority species currently managed within the South Florida ecosystem for
 1831 long-term suppression and/or asset protection (e.g., endangered species), ranked by
 1832 taxonomic group and then alphabetically by common name.

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

1833

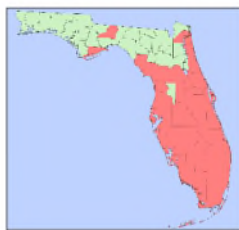
1834 **Australian Pine (*Casuarina* spp.)**

1835 **SUMMARY:** Three invasive species in Florida are
 1836 collectively referred to as Australian pine: *Casuarina*
 1837 *equisetifolia*, *C. glauca*, and *C. cunninghamiana*. Australian
 1838 pine is a large, fast-growing tree that readily colonizes coastal
 1839 and inland habitats (Morton 1980). Mature plants produce thick
 1840 litter mats containing plant growth inhibiting compounds
 1841 (**Figure 7-26**; Batish et al. 2001), making the plant particularly
 1842 destructive to native plant communities. Australian pine can
 1843 interfere with sea turtle and American crocodile nesting (Klukas
 1844 1969), and small mammal populations are lower in habitats
 1845 dominated by this invader (Mazzotti et al. 1981).



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

1846 **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.

1855 **Control Tools:** Herbicide control methods are well established for this species although access to
 1856 remote infestations makes control challenging. Mechanical removal is often used to remove trees when
 1857 access by heavy equipment is feasible. There are no biological control agents approved for *Casuarina* spp.
 1858 in Florida. Aminocyclopyrachlor has been shown to be highly effective in a reduced hack and squirt
 1859 application, with similar results to triclopyr. This method reduces the quantity of herbicide applied and is
 1860 faster than a cut stump treatment (Enloe et al 2025).

1861 **Monitoring:** Agencies monitor for this species in high priority public lands regionwide. Monitoring is
 1862 conducted within the Greater Everglades and on most SFWMD-owned lands.

1863 **Interagency Coordination:** Agency-sponsored control efforts are ongoing and gaining public support
 1864 through education. However, local opposition to control efforts, especially on beaches, can sometimes
 1865 complicate efforts.

1866 **Regulatory Tools:** *Casuarina* species are designated as Florida Prohibited Aquatic Plants.
 1867 *C. equisetifolia* and *C. glauca* are designated as Florida Noxious Weeds. Florida law allows plantings of
 1868 male *C. cunninghamiana* for windbreaks in commercial citrus groves in some counties.

1869 **Critical Needs:** State and local restrictions on planting and maintaining Australian pine. Numerous
 1870 potential biological control agents have been identified but support for research into their development and
 1871 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

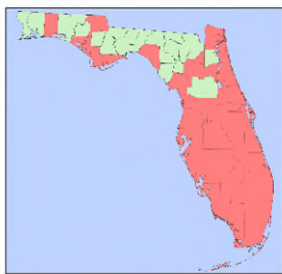
1872 **Brazilian Pepper (*Schinus terebinthifolia*)**

1873 **SUMMARY:** Brazilian pepper (Figure 7-27) is a fast-
 1874 growing tree that rapidly invades disturbed areas then
 1875 expands into adjacent natural areas. Brazilian pepper reduces
 1876 native plant and animal diversity (Campello and Marsaioli
 1877 1974, Morton 1978, Curnutt 1989) and alters fire regimes
 1878 (Stevens and Beckage 2009). The invasiveness of this plant
 1879 is partly explained by hybrid vigor. Florida's Brazilian pepper
 1880 originated from multiple genetic strains (Mukherjee et al.
 1881 2012). The Florida hybrids have greater fitness relative to
 1882 their progenitors (Geiger et al. 2011).



Figure 7-27. Brazilian pepper produces large quantities of viable seeds (photo by NPS).

1883 **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).

1893 **Control Tools:** Managers typically use chemical, mechanical, and cultural controls. UF and SFWMD
 1894 scientists are developing new treatment techniques that result in lower volumes of herbicide required to
 1895 control this species. A reduced hack-and-squirt method with aminocyclopyrachlor or aminopyralid have
 1896 shown similar effectiveness to triclopyr applications, with the benefit of decreased herbicide volume (Enloe
 1897 et al. 2025). One biological control agent, a thrip (*Pseudophilothrips ichini*) that targets Brazilian pepper
 1898 has been released since 2019; another is in development. With Brazilian pepper dominating so many
 1899 hectares of private lands, biological control agents are an important tool we can use to reduce the
 1900 reintroduction of seed to maintained natural areas.

1901 **Monitoring:** Agencies monitor for this species in high priority public lands regionwide. Monitoring is
 1902 conducted within the Greater Everglades and on all SFWMD-owned lands.

1903 **Interagency Coordination:** ECISMA partners coordinate control efforts on adjacent lands in the
 1904 Everglades. Although there is some coordination by local agencies and partner groups, increased
 1905 coordination between major landholders is needed.

1906 **Regulatory Tools:** Brazilian pepper is designated a Florida Noxious Weed and Florida Prohibited
 1907 Aquatic Plant. There are no federal regulations regarding this species. It is listed as a FISC Category I
 1908 species.

1909 **Critical Needs:** Development and implementation of statewide private lands initiatives are needed to
 1910 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

1911

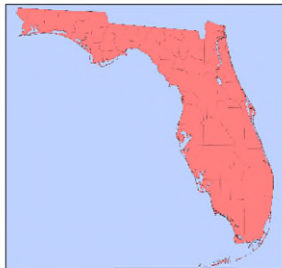
1912 **Cogongrass (*Imperata cylindrica*)**

1913 **SUMMARY:** Cogongrass (**Figure 7-28**) is among the worst
 1914 invasive plants globally (Holm et al. 1977). Originally from
 1915 Southeast Asia, Australia, and East Africa, this fast-growing grass
 1916 was widely planted for forage in the 1900s and is now documented
 1917 in every county in Florida. Cogongrass invades numerous habitats
 1918 where it displaces plant communities and alters ecosystem
 1919 processes, such as fire regimes (Lippincott 2000) and
 1920 biogeochemical cycling (Daneshgar and Jose 2009, Holly et al.
 1921 2009). Experimental evidence supports concerns that ornamental
 1922 cultivars may hybridize with invasive biotypes of cogongrass
 1923 resulting in increased cold tolerance and range expansion
 1924 (MacDonald 2009).



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

1925 **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,

1934 fluazifop-P-butyl, may provide control of cogongrass alone when mixed with desirable species, allowing
 1935 for accelerated native plant recovery after repeat applications (Hinkson et al. 2024). Two potential
 1936 biological control candidates have been identified and were brought to the United States to observe their
 1937 veracity at the USDA-ARS Invasive Plant Research Lab in Fort Lauderdale, Florida (Gazdick et al. 2024).

1938 **Monitoring:** Agencies monitor for this species in high priority public lands regionwide.

1939 **Interagency Coordination:** Interagency inspectors continue to monitor the plant and recommend
 1940 control areas. SFWMD works to reduce the spread of this species when working with contractors,
 1941 maintaining levees, roads, and other infrastructure with heavy equipment or mowers through outreach,
 1942 coordination, and decontamination practices.

1943 **Regulatory Tools:** Cogongrass is designated as both a federal and Florida noxious weed and is a FISC
 1944 Category 1 species.

1945 **Critical Needs:** Development of biological control agents would improve regional control of this
 1946 species. Regulatory pressure is needed to encourage increased control efforts on rights-of-way where this
 1947 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

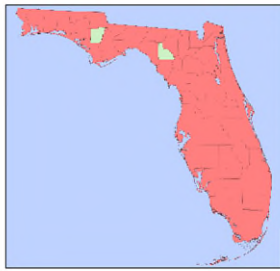
1948 **Water Primroses (*Ludwigia* spp.)**

1949 **SUMMARY:** Numerous invasive aquatic *Ludwigia* species native
 1950 to South and Central America have become widely established in
 1951 Florida. These species include *L. grandiflora*, *L. hexapetala* (**Figure 7-**
 1952 **29**), *L. peruviana*, and *L. peploides*. Genetic analysis is often the only
 1953 method to identify some of these species, and the taxonomy remains
 1954 unclear. *L. grandiflora* is often used as a “catch all” species name for
 1955 plants in the creeping water primrose complex. Creeping water
 1956 primrose initially spread horizontally across the water surface, easily
 1957 overtaking other plants. When mature, emergent plants grow up to two
 1958 meters tall, and dense rhizome mats fill the water column (Jacono
 1959 2014). In the Kissimmee River Watershed, creeping water primrose
 1960 overwhelms populations of emergent native plants. Allelopathic effects
 1961 further contribute to the plant’s invasiveness (Dandelot et al. 2008,
 1962 Drexler et al. 2024).



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

1963 **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

1972 imazamox, though with limited success. Herbicides tend to be more effective in spring when water levels
 1973 are low, just before the rainy season (Enloe et al. 2020b). USDA-ARS is evaluating South American insects
 1974 for biocontrol potential but the number of native *Ludwigia* species in Florida make this development
 1975 unlikely.

1976 **Monitoring:** There is no comprehensive monitoring program for this species.

1977 **Interagency Coordination:** The Florida Aquatic Plant Management and Land Acquisition trust funds,
 1978 as administered by FWC, fund control of these species in waters designated as Waters of the State.
 1979 Interagency plant managers working on the Kissimmee and Alligator Chains of Lakes, Kissimmee River,
 1980 and Lake Okeechobee allocate available funding towards managing this species through a coordinated
 1981 effort to improve habitat for native species and reduce tussock formation.

1982 **Regulatory Tools:** There are no regulatory tools in place for this species.

1983 **Critical Needs:** State-wide documentation and reporting of population location, status, and control
 1984 methods for dense populations are lacking for this complex. Continued funding and effort are essential to
 1985 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

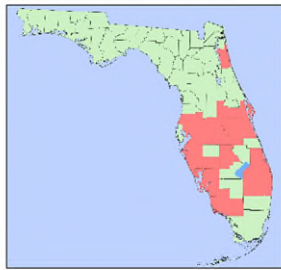
1986 **Downy Rose Myrtle (*Rhodomyrtus tomentosa*)**

1987 **SUMMARY:** Downy rose myrtle is an ornamental shrub of Asian
 1988 origin. Introduced to Florida in the late 1800s, the plant now occurs in
 1989 natural areas throughout South and Central Florida. This fast-growing
 1990 shrub spreads into pine flatwoods and drained cypress strands, even in
 1991 the absence of disturbance, and can form dense thickets that crowd out
 1992 native vegetation (**Figure 7-30**). Downy rose myrtle recovers quickly
 1993 from fire. Successful control of downy rose myrtle with herbicides is
 1994 being accomplished where adequate resources are available. The high
 1995 cost per hectare to clear advanced invasions demonstrates the value of
 1996 detecting and eliminating downy rose myrtle before it dominates a
 1997 natural area. Often this plant can be hard to differentiate from some other
 1998 pineland woody shrubs leading to missed plants or nontarget mortality.
 1999 Downy rose myrtle is characterized by leaves with 3 distinct veins, short
 2000 hairs on the underside of the leaf, and rose pink flowers in the spring to
 2001 early summer.



Figure 7-30. Downy rose myrtle displaces understory plant communities in pine flatwoods (photo by USDA-ARS).

2002 **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

2011 care is taken to ensure excellent coverage; these can be time consuming and labor-intensive treatments in
 2012 dense infestations. Every stem is required to be cut and have herbicide applied for effective control. Often
 2013 times, repeated applications are necessary due to heavy seed production and the tendency to resprout.
 2014 Multiple candidate biological control agents have been evaluated and rejected as they are not specific to the
 2015 species.

2016 **Monitoring:** Because downy rose myrtle is difficult to detect from the air, monitoring is currently
 2017 limited to observations by land managers on the ground and can be more effective in spring and early
 2018 summer when flowers are present.

2019 **Interagency Coordination:** TC-CISMA makes this species a priority for regional coordination.

2020 **Regulatory Tools:** Downy rose myrtle is designated a Florida Noxious Weed.

2021 **Critical Needs:** Statewide private lands initiatives to reduce propagule pressure on conservation lands;
 2022 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

2023

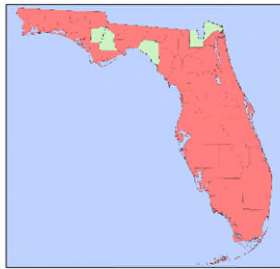
2024 **Hydrilla (*Hydrilla verticillata*)**

2025 **SUMMARY:** Hydrilla is a rooted submerged plant that
 2026 often forms dense monotypic stands through the water
 2027 column, competitively excluding native aquatic plant
 2028 communities (**Figure 7-31**). It is native to the Old World and
 2029 Indo-Pacific and was likely first introduced to Florida in the
 2030 1950s as an aquarium plant. Hydrilla is now the dominant
 2031 submerged plant in much of the state, forming large
 2032 infestations that can obstruct flood control structures and
 2033 hinder navigation. Hydrilla also supports the growth of a
 2034 cyanobacterial epiphyte, *Aetokthonos hydrillicola*, which
 2035 produces a toxin affecting waterbirds and their avian
 2036 predators (e.g., coots [*Fulica americana*] and bald eagles
 2037 [*Haliaeetus leucocephalus*]; Wilde 2005, Martin 2015,
 2038 Wilde et al. 2014) and a broad range of wildlife, including
 2039 amphibians, reptiles, and fish (Breinlinger et al. 2021).



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

2040 **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

2049 leaf-mining fly *Hydrellia pakistanae* and the stem-boring weevil *Bagous hydrelliae* established in South
 2050 Florida ecosystems. Unfortunately, the beetle remains rare in the landscape. The fly’s impacts, although
 2051 occasionally impressive, are largely ephemeral and unpredictable.
 2052

2053 **Monitoring:** FWC monitors hydrilla throughout Florida’s public waters and ranks these waters
 2054 according to environmental and societal factors to prioritize management.

2055 **Interagency Coordination:** FWC allocates funds from the Florida Invasive Plant Management Control
 2056 Trust Fund to local agencies for coordinated management of hydrilla.

2057 **Regulatory Tools:** Hydrilla is designated a Federal Noxious Weed and a Florida Prohibited Aquatic
 2058 Plant.

2059 **Critical Needs:** Continued research on effective systemic herbicides and foreign exploration to locate
 2060 potential biological control agents in China and Korea are needed. In addition, integrated management with
 2061 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

2062

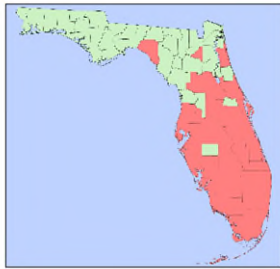
2063 **Melaleuca (*Melaleuca quinquenervia*)**

2064 **SUMMARY:** Before organized state and federal invasive plant
 2065 control operations were initiated in 1990, melaleuca (**Figure 7-32**)
 2066 was widely distributed throughout the WCAs, ENP, BCNP, and Lake
 2067 Okeechobee. Overall, agency efforts to control melaleuca are
 2068 succeeding in containing and reducing its footprint. However,
 2069 melaleuca remains widely distributed on private lands throughout
 2070 South and Central Florida, but the successful biological control
 2071 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).

2072 **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.

2082 **Control Tools:** Chemical, mechanical, physical, and biological controls are all used as part of an
 2083 integrated management technique that has resulted in the maintenance control over large areas of public
 2084 lands. Three biological control agents are now established and have demonstrated they reduce flower and
 2085 seed production and biomass (Tipping et al. 2008, 2016). A fourth insect was approved in 2022 and has
 2086 been released into natural areas infested with melaleuca where populations will be monitored to ensure
 2087 successful establishment and spread.

2088 **Monitoring:** Agencies monitor for this species in high priority public lands regionwide. Monitoring is
 2089 conducted within the Greater Everglades and on all SFWMD-owned lands.

2090 **Interagency Coordination:** Interagency coordination has proven successful for this species.

2091 **Regulatory Tools:** Melaleuca is listed as a Federal Noxious Weed, Florida Noxious Weed, and Florida
 2092 Prohibited Aquatic Plant.

2093 **Critical Needs:** Private land initiatives are needed to reduce remaining infestations near conservation
 2094 lands. Consistent funding is important to ensure the current level of control does not reverse due to irregular
 2095 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

2096

2097 **Old World Climbing Fern (*Lygodium microphyllum*)**

2098 **SUMMARY:** Perhaps no other plant species poses a greater threat to
 2099 South Florida’s mesic upland and wetland ecosystems than Old World
 2100 climbing fern. This highly invasive fern smothers native vegetation severely
 2101 compromising plant species composition, destroying tree island canopy cover,
 2102 and dominating understory communities (**Figure 7-33**). Without active control
 2103 measures, this species could potentially overtake most of South Florida’s mesic
 2104 and hydric forested plant communities (Lott et al. 2003, Volin et al. 2004).

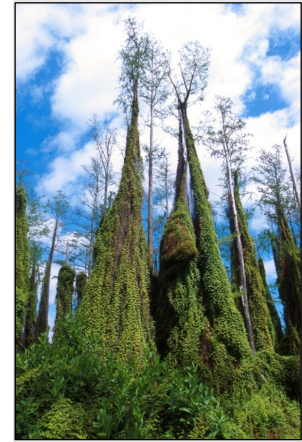
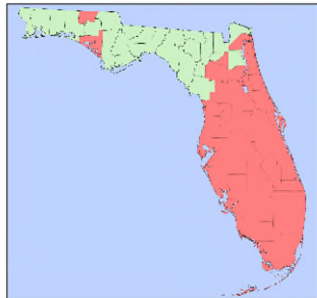


Figure 7-33. Old World climbing fern overtaking a cypress swamp (photo by USDA-ARS).

2105 **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.

2116 **Control Tools:** Herbicides are used to control Old World climbing fern, but rapid reestablishment
 2117 makes chemical control costly and unlikely to succeed alone. Recent herbicide evaluations confirm that
 2118 triclopyr is a suitable alternative to glyphosate in wetland ecosystems (Glueckert et al. 2023). Biological
 2119 control is a critical component to effective long-term management of this plant. Three agents have been
 2120 released in Florida; two have established: the brown lygodium moth and lygodium gall mite. The USDA-
 2121 ARS continues to mass-rear and release the gall mite. Three additional agents are in the regulatory pipeline
 2122 for approval. Prescribed fire can provide effective short-term reductions in biomass and regrowth (Richard
 2123 et al. 2020) and may encourage establishment of biological controls (David et al. 2020), though care should
 2124 be taken given documented impacts to native plant canopies from fire laddering on Old World climbing
 2125 fern (Hutchinson et al. 2006).

2126 **Monitoring:** Agencies monitor for this species in high priority public lands regionwide. Aerial
 2127 mapping is conducted on a 5-year cycle within the Greater Everglades and on a 2-year cycle within WCA-
 2128 1 (LNWR).

2129 **Interagency Coordination:** An interagency management plan (FLEPPC 2006) was developed for this
 2130 species and agencies are coordinating management efforts. Research investigating new herbicides,
 2131 biological controls, and integrated pest management strategies for this species is ongoing.

2132 **Regulatory Tools:** Old World climbing fern is a Federal Noxious Weed and Florida Noxious Weed.

2133 **Critical Needs:** Greater understanding of the natural history of Old World climbing fern may improve
 2134 development of management strategies. Successes in biological control, ground-based monitoring
 2135 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

2136

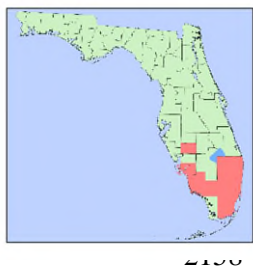
2137 **Dwarf Rotala (*Rotala rotundifolia*)**

2138 **SUMMARY:** Dwarf rotala (**Figure 7-34**) is a submersed
 2139 aquatic plant native to India and Southeast Asia. It was
 2140 introduced into Florida systems through the aquarium trade
 2141 (Gettys and Della Torre 2014). Dwarf rotala was first
 2142 collected in Florida in 1996 in Broward County and can now
 2143 be found in numerous other counties in South Florida (UF
 2144 IFAS 2025/EDDMapS). In South Florida, dwarf rotala grows
 2145 year-round and can alter its growth habit to suit the changing
 2146 water levels of the region. This, along with its ability to
 2147 reproduce from seeds and fragmentation, contributes to its
 2148 invasive advantage. Once introduced, proliferations of dwarf
 2149 rotala lead to the accretion of thick vegetative clumps that can
 2150 block waterways and alter water flows.



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

2151 **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). Florypyrauxifen-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

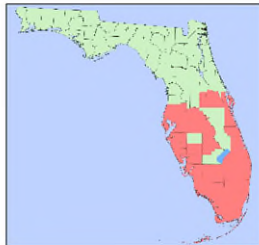
2174 **Shoebuttan Ardisia (*Ardisia elliptica*)**

2175 **SUMMARY:** Shoebuttan ardisia (**Figure 7-35**) was imported from
 2176 southeast Asia as an ornamental shrub in the early 1900s (Gordon and
 2177 Thomas 1997). This species has since invaded certain South Florida
 2178 natural areas where it will form dense monospecific stands, resulting in
 2179 the displacement of native plants (Potter et al. 2023). There is a tendency
 2180 for reinvasion by shoebuttan ardisia or other invasive plants following
 2181 removal of dense thickets of this species (Pascarella and Horvitz 1999).
 2182 Early infestations may go unnoticed due to this species’ morphological
 2183 similarity to the common native marlberry (*Ardisia escallonioides*).



Figure 7-35. Shoebuttan ardisia seedlings often create dense carpets in the mangrove understory (photo by SFWMD).

2184 **KEY MANAGEMENT ISSUES**



2192

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

2193 denser infestations and is typically only employed in sensitive wetland habitats where other removal
 2194 methods are not feasible. Applying triclopyr amine or acid as a basal application can be more cost effective
 2195 for lighter infestations. The ester formulation of triclopyr can only be applied when no water is present. A
 2196 mix of aminocyclopyrachlor and metsulfuron methyl can be used as a low volume foliar spot treatment.
 2197 However, the most efficient approach for dense infestations is mechanical shredding followed by a foliar
 2198 herbicide application of a low rate triclopyr product. Follow up treatments are required to control plants
 2199 germinating from the seedbank (Pascarella and Horvitz 1999). There are currently no biological controls or
 2200 feasibility studies for potential agents for this species.

2201 **Monitoring:** Shoebuttan ardisia is difficult to detect from aerial reconnaissance. Monitoring is
 2202 currently limited to ground-based observations by land managers.

2203 **Interagency Coordination:** While there is no regionwide strategic coordination for this species,
 2204 biologists from SFWMD, Miami-Dade County, and ENP are working closely to address major infestations
 2205 in the Southern Glades and Biscayne Bay regions.

2206 **Regulatory Tools:** Shoebuttan ardisia is listed as a Florida Noxious Weed and a FISC Category 1
 2207 species.

2208 **Critical Needs:** A comprehensive feasibility study on the potential for biological control is needed.
 2209 Increased funding to remove dense infestations in the eastern Everglades, improved revegetation methods
 2210 after shoebuttan ardisia removal, and more efficient means of monitoring to identify new populations are
 2211 also needed.

2025 Status of Shoebuttan Ardisia by Management Region

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

2212

2213 **Torpedograss (*Panicum repens*)**

2214 **SUMMARY:** Torpedograss (**Figure 7-36**), a perennial
 2215 rhizomatous grass native to parts of Africa and Eurasia, was
 2216 introduced to Florida for cattle forage during the early 1900s (Sperry
 2217 et al. 2023). By 1992, it was reported in over 70% of the state’s public
 2218 water ways (MacDonald et al. 2008). Robust, partitioned rhizomes,
 2219 where the plant stores the majority of its biomass, enable this plant to
 2220 recover from fire, drought, herbicide application, frost, and
 2221 mechanical disturbance. One study found that 87% of the total
 2222 torpedograss biomass was within the rhizomes (Busey 2003). This
 2223 carbon reservoir allows the plant to quickly rebound following a
 2224 disturbance and then form dense, homogenous mats that can
 2225 outcompete native plants (Langeland et al. 1998). Although seed
 2226 originating from Florida has shown to have very low viability,
 2227 torpedograss readily spreads vegetatively to new sites (Khamare et
 2228 al. 2021). Torpedograss represents a significant management challenge in restoration projects where it
 2229 aggressively invades and hampers native plant colonization and survival.



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

2230 **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).

2237 **Control Tools:** Torpedograss is one of the most difficult weeds for land managers
 2238 in South Florida to control. Mowing and grazing can marginally impact torpedograss,
 2239 while disking and fire can increase its abundance if not utilized in concert with additional management
 2240 tools (Khamare et al. 2021). Repeated herbicide treatments are currently the best method for long-term
 2241 control. In mixed vegetative communities, selective graminicides such as fluazifop-p-butyl and sethoxydim
 2242 have proven effective, though repeated treatments are needed (Enloe and Netherland 2017). When
 2243 selectivity is not a concern, non-selective herbicides such as imazapyr and glyphosate have been shown to
 2244 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.

2245 **Monitoring:** Torpedograss monitoring on Lake Okeechobee, begun in the 1980s by SFWMD and
 2246 FWC, demonstrates that control efforts here have been successful, though populations remain.

2247 **Regulatory Tools:** There are no federal or state prohibitions for this species, however, torpedograss is
 2248 listed as a FISC Category I species.

2249 **Critical Needs:** Strategies proven successful in reducing torpedograss rhizomes differ significantly
 2250 from other weed management strategies. Because of this, proper education, including a comprehensive
 2251 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

2252

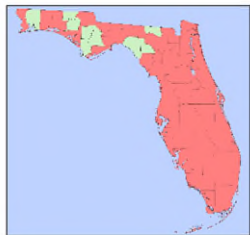
2253 **Water Lettuce (*Pistia stratiotes*)**

2254 **SUMMARY:** Water lettuce is a free-floating aquatic plant
 2255 that is heavily managed in South Florida. However, the recent
 2256 discovery of macrofossil seeds has raised questions about the
 2257 plant's origin and the possibility of its nativity to the region,
 2258 although the invasion of non-native genotypes appears likely
 2259 (Evans et al. 2024). Water lettuce primarily spreads through
 2260 rapid production of vegetative daughter plants, although new
 2261 plants are also readily produced from seed which are found to be
 2262 up to 80% viable (Dray and Center 1989). Water lettuce was first
 2263 reported by William Bartram in 1765 as forming dense mats on
 2264 the St. Johns River. These mats continue to occur, clogging
 2265 waterways and water management structures (**Figure 7-37**).



Figure 7-37. Water lettuce clogging a canal in Palm Beach County (photo by SFWMD).

2266 **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.

2275 **Control Tools:** Water lettuce is readily controlled by herbicides, but rapid reestablishment of this
 2276 species in some water bodies necessitates frequent retreatments. Two biocontrol agents, the South American
 2277 weevil *Neohydronomous affinis* and the Thai moth *Spodoptera pectinicornis* were released in Florida to
 2278 suppress water lettuce. The moth failed to persist and despite encouraging early success on Lake
 2279 Okeechobee, the weevil has become ephemeral in the field. Mechanical harvesting or shredding for water
 2280 lettuce can be practical when it forms a dense mat.

2281 **Monitoring:** FWC monitors water lettuce in all public waters and SFWMD routinely monitors its
 2282 canals for large populations. Interagency aerial surveys are conducted monthly to document floating plant
 2283 coverage on Lake Okeechobee.

2284 **Interagency Coordination:** FWC coordinates interagency management of water lettuce and other
 2285 aquatic plants allocating funds from the FWC Invasive Plant Management Control Trust Fund to
 2286 cooperating local agencies.

2287 **Regulatory Tools:** Water lettuce is listed as a Florida Prohibited Aquatic Plant.

2288 **Critical Needs:** Development of additional biological controls is needed. Development of remote
 2289 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

2290

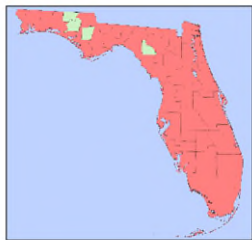
2291 **Water hyacinth (*Pontederia crassipes*)**

2292 **SUMMARY:** Water hyacinth (**Figure 7-38**), a floating
 2293 aquatic plant native to tropical South America, was brought to
 2294 Florida in 1884. Shortly after its introduction, it quickly spread
 2295 and clogged the St. Johns River, hindering navigation. The
 2296 severity of this infestation caused the United States to initiate
 2297 its first aquatic plant management program under of the Rivers
 2298 and Harbors act of 1899 (Center 1996). Vegetative
 2299 reproduction occurs rapidly during all but the coolest months.
 2300 New plants are also produced from seed, which germinate
 2301 copiously on exposed moist soils (Perez et al. 2011). Low
 2302 nutrient needs and wide tolerance for water conditions enable
 2303 its persistence and spread throughout Florida water bodies.



Figure 7-38. Dense floating mat of water hyacinth (photo by USACE).

2304 **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).

2312
 2313 are suspended to accommodate research plots, public events, or Everglade snail kite (*Rostrhamus sociabilis*)
 2314 nesting. The newly labeled auxin herbicide, ProcellaCOR (florpyrauxifen-benxyl) has shown effective
 2315 control of water hyacinth at low rates (Mudge et al. 2021). USDA has released and established four water
 2316 hyacinth biocontrol insects in Florida, including two weevils of the genus *Neochetina*. These agents reduce
 2317 biomass by up to 58% and flower production by up to 97% in mesocosm studies (Tipping et al. 2014a) but
 2318 do not reduce surface coverage enough to meet management standards. Herbivory by these agents can make
 2319 the plant more susceptible to herbicides. In 2010, a water hyacinth-feeding insect, *Megamelus scutellaris*,
 2320 was released in Florida. This planthopper is now established in Florida and can be more readily integrated
 2321 with herbicides than the previously released agents (Goode et al. 2020).

2322 **Monitoring:** FWC monitors water hyacinth in all Florida public waters. SFWMD routinely monitors
 2323 and treats its canals for populations of this and other floating aquatic weeds.

2324 **Interagency Coordination:** FWC coordinates interagency management of water hyacinth via
 2325 allocated funds from the FWC Invasive Plant Management Control Trust Fund.

2326 **Regulatory Tools:** Water hyacinth is listed as a Florida Prohibited Aquatic Plant.

2327 **Critical Needs:** Continued development of biological controls and continued research into augmented
 2328 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

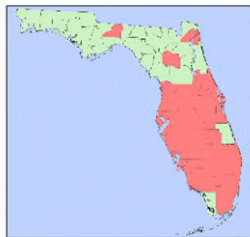
2329 **West Indian Marsh Grass (*Hymenachne amplexicaulis*)**

2330 **SUMMARY:** West Indian marsh grass is native to Central and South
 2331 America and the West Indies. It was first collected in North America in
 2332 1957 (Bair 1957) but began expanding in Florida natural areas in the 1990s
 2333 (Langeland et al. 2008). This robust grass grows in freshwater marshes
 2334 where it often forms large, dense monospecific stands and displaces native
 2335 marsh species. The plant is well adapted to disturbed habitats and
 2336 fluctuating water levels (Kibbler and Bahnisch 1999) and appears to spread
 2337 during seasonal flooding and via surface water ditches (Bouchard
 2338 et al. 2020).



Figure 7-39. Dense stand of West Indian marsh grass on the Kissimmee River floodplain (photo by SFWMD).

2339 **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

2348 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.

2349 **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.

2360 **Monitoring:** Interagency partners continue to monitor the plant and recommend priority control areas.

2361 **Interagency Coordination:** While there is no regionwide strategic coordination for this species, ECISMA partners are actively monitoring for new infestations within the Everglades region.

2363 **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.

2365 **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

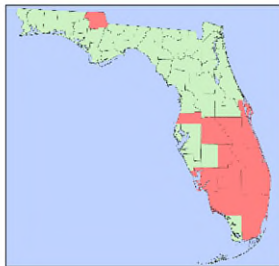
2366 **Wright’s Nutrush (*Scleria lacustris*)**

2367 **SUMMARY:** Wright’s nutrush is a robust annual, aquatic
 2368 sedge, considered native throughout the Caribbean, northern South
 2369 America, and originating in parts of Africa (Jacono 2001). The first
 2370 recorded occurrence in Florida is from 1988, but large populations
 2371 were not documented until 2001. Wright’s nutrush prefers open
 2372 sunny habitats with reduced competition from taller shading trees
 2373 and shrubs and is typically found invading seasonally dry wetlands
 2374 but once established, can tolerate occasional drought or prolonged
 2375 flooding due to its persistent seedbank (Jacono et al. 2011).
 2376 Sawgrass and graminoid marshes, cypress strands, and floodplain
 2377 basins are all vulnerable to invasion by Wright’s nutrush, where it
 2378 readily outcompetes the native graminoid species (**Figure 7-40**).



Figure 7-40. Dense stand of Wright’s nutrush (photo by SFWMD).

2379 **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

2388 across multiple acres. Land managers often find treatment timing and the intensive monitoring effort
 2389 necessary for effective management challenging. When treatment occurs too early in the season, late
 2390 flowering plants are missed and if seeds are clipped from early seeding plants, they will flower again. Late
 2391 season treatments risk allowing viable seeds to enter the system. Annual treatments are necessary to control
 2392 the persistent seedbank.
 2393

2394 **Monitoring:** Land managers survey for this species each spring when water levels begin to rise, and
 2395 the sedge is actively growing. Interagency surveys and management of Wright’s nutrush occur in WCA-3A
 2396 and WCA-1.

2397 **Interagency Coordination:** There is no formal rapid response plan or regionwide containment
 2398 strategy, but informal treatment coordination and information sharing occurs among partners.

2399 **Regulatory Tools:** Wright’s nutrush is not a regulated or Prohibited Species but it is listed as a FISC
 2400 Category I species.

2401 **Critical Needs:** Expanded surveys and control efforts for Wright’s nutrush including private lands,
 2402 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

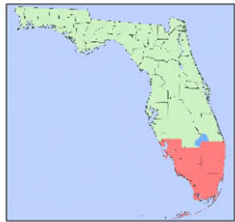
2403 **Burmese Python (*Python molurus bivittatus*)**

2404 **SUMMARY:** The Burmese python (Figure 7-41) is widely
 2405 established in the southern Everglades (Snow et al. 2007b) and
 2406 increased sightings in the central Everglades indicate it is spreading.
 2407 This large constrictor is a top predator known to prey upon more than
 2408 60 native Florida species and is implicated in substantial mammal
 2409 declines in ENP (Dorcas et al. 2012, McCleery et al. 2015). Control
 2410 of this species is a top priority among agencies. See the *Invasive*
 2411 *Animal Management* subsection above for more detailed updates on
 2412 monitoring and removal efforts.



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

2413 **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.

2421 **Control Tools:** Control options for this species are limited, primarily due to
 2422 very low detectability (Nafus et al. 2020). Potential controls include visual
 2423 searching, traps, detection dogs, scout snakes, pheromone attractants, and
 2424 multispectral or near infrared camera imaging. Research and development for these and other tools is
 2425 ongoing or in the early stages of development. Python contractor programs are ongoing with SFWMD and
 2426 FWC, but an NPS volunteer program was suspended because of COVID-19. Collectively, these programs have removed over 15,272 pythons between 2017 and October 2024. Statewide, more than 17,000 Burmese pythons have been removed as of August 2025 (FWC, unpublished data). (Numbers to be updated in the final version.)

2427 **Monitoring:** A regional python monitoring network continues to develop and expand in South Florida.
 2428 Pythons are regularly reported by members of the public to the 888-IVE-GOT1 hotline, EDDMapS
 2429 reporting website (<https://www.eddmaps.org/>), and IveGot1 smartphone app. UF conducts monitoring
 2430 surveys as a major component of EIRAMP.

2431 **Interagency Coordination:** FWC and partner organizations completed an interagency python control
 2432 strategy (*Florida Python Control Plan*; FWC et al. 2021) to align management goals and leverage resources
 2433 among partners. SFWMD and FWC python contractor programs are closely aligned with the cooperation
 2434 of NPS, USFWS, and FDEP. Additionally, USGS has headed up coordination of the python synthesis, a
 2435 document detailing python life history, research, and control efforts in South Florida (Guzy et al. 2023).

2436 **Regulatory Tools:** The State of Florida lists the Burmese python as a Prohibited Species, which
 2437 prevents public ownership. A federal ban on importation and interstate trade was instated in January 2012
 2438 but subsequently lifted in 2017.

2439 **Critical Needs:** Critical needs include the development of technologies to improve detection in the
 2440 field, research into methods to improve population estimates, and protection of vulnerable resources such
 2441 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

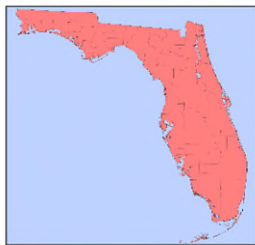
2442 **Feral Hog (*Sus scrofa*)**

2443 **SUMMARY:** Feral hogs (**Figure 7-42**) have existed on the
 2444 Florida landscape since their introduction by Spanish explorers four
 2445 centuries ago. Feral hogs consume a variety of vegetation,
 2446 invertebrates, insects, reptiles, frogs, bird eggs, rodents, small
 2447 mammals, and carrion (Laycock 1966, Baber and Coblentz 1987). This
 2448 invasive mammal is also known to prey on sea turtles, gopher tortoises,
 2449 and other at-risk wildlife (Singer 2005). Rooting by feral hogs can
 2450 damage plant communities and may facilitate establishment of
 2451 invasive plant species (Belden and Pelton 1975, Duever et al. 1986).
 2452 Feral hog damage to rangeland pasture is estimated to result in at least
 2453 \$2 million in losses to Florida cattle production (Bankovich et al.
 2454 2016). Plans are to document these impacts more fully in future work
 2455 (Wisely 2016). \$1.5 billion is conservatively estimated as the annual
 2456 United States costs of feral swine damage (Mississippi State
 2457 University Extension Service 2020).



Figure 7-42. A pair of feral hogs at Lake Okeechobee (photo by FWC).

2458 **KEY MANAGEMENT ISSUES**



2466

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.

2467 **Monitoring:** There is no regional, coordinated monitoring program for wild hogs. Monitoring is limited
 2468 to efforts associated with removal programs.

2469 **Interagency Coordination:** The Florida Feral Hog Working Group was established in 2018 to better
 2470 coordinate feral hog policy, research, outreach, control, hunting, and other stakeholder services between
 2471 agency/non-governmental organization (NGO) partners to best serve Florida stakeholders and natural
 2472 resource management.

2473 **Regulatory Tools:** Hunting regulations could be modified to better control hog populations.

2474 **Critical Needs:** Development of target specific toxicants or contraceptives and initiatives for control
 2475 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

2476

2477 **Green Iguana (*Iguana iguana*)**

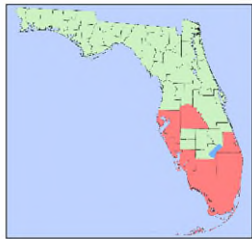
2478 **SUMMARY:** The green iguana (**Figure 7-43**) is a large,
 2479 predominantly herbivorous lizard native to South and Central
 2480 America and some Caribbean islands. The species was introduced
 2481 to Florida through the pet trade in the 1960s (King and Krakauer
 2482 1966) and is now firmly established in human-modified habitats
 2483 throughout South Florida. Although they occupy some natural areas
 2484 where they consume native vegetation and displace native animals
 2485 such as burrowing owls (*Athene cunicularia*), green iguanas are
 2486 primarily a threat to SFWMD infrastructure. Green iguanas directly
 2487 impact stakeholders as a pest species because they destroy
 2488 ornamental vegetation and deface property with feces, which may contain *Salmonella* bacteria.



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

2489 **KEY MANAGEMENT ISSUES**

2490 **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.
 2491 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.



2492

2493 **Control Tools:** Manual removal, firearms, and trapping are all effective
 2494 control tools, and many iguana control companies are in operation.

2500 **Monitoring:** The UF EIRAMP program monitors green iguanas throughout the Greater Everglades.
 2501 They have conducted removal/monitoring in certain urban areas, but most metropolitan monitoring is
 2502 through reports from the public.

2503 **Interagency Coordination:** SFWMD has funded EIRAMP monitoring and removal since 2011, as
 2504 well as special projects focused on levee damage assessments. FWC contracted UF and independent
 2505 contractors for iguana management and encourages the public to remove iguanas whenever possible. Green
 2506 iguanas are a priority species for management in ecologically sensitive systems or where infrastructure is
 2507 threatened.

2508 **Regulatory Tools:** Green iguanas are listed as a Prohibited Species under Chapter 68-5 of the Florida
 2509 Administrative Code, which restricts pet ownership and commercial sales with some limited exceptions. In
 2510 May 2025, FWC implemented a rule change to allow for increased capture and out-of-state sale of invasive
 2511 green iguanas by authorized entities.

2512 **Critical Needs:** Research on the economic impacts of green iguanas is needed, as is a greater
 2513 understanding of the ecology of this species in Florida and an evaluation of the effectiveness and long-term
 2514 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

2515 **SPECIES MANAGED FOR CONTAINMENT OR ERADICATION**

2516 Four invasive plant species were identified as priorities for regional containment or eradication by
 2517 invasive species biologists from SFWMD and partner agencies (**Table 7-4**). Two graminoid species—
 2518 tropical American watergrass and tropical nutrush (*Scleria microcarpa*)—are well established in the
 2519 northern reaches of SFWMD. Land managers are working to contain the spread of these species and prevent
 2520 further expansion in the southern reaches of the Everglades and elsewhere. The eight established invasive
 2521 animal species presented in this section are also targeted for containment or eradication (**Table 7-4**). Species
 2522 with numerous population cores, such as the Nile monitor, are actively managed for regional containment
 2523 while others with still limited geographic distributions (e.g., northern African python) remain candidates
 2524 for eradication from Florida.

2525 **Table 7-4.** Priority species currently managed within the South Florida ecosystem for geographic
 2526 containment or eradication, ranked by taxonomic group and then alphabetically by common name.

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

2527

2528 **Asian Black Mangrove or Lumnitzera (*Lumnitzera racemosa*)**

2529 **SUMMARY:** Lumnitzera, the Asian black mangrove (**Figure 7-**
 2530 **44**), is native to Asia and Australia. It escaped cultivation from
 2531 Fairchild Tropical Botanic Garden in Miami-Dade County. The plant
 2532 was discovered to be rapidly proliferating in neighboring Matheson
 2533 Hammock Preserve in 2009. Lumnitzera aggressively out-competes
 2534 native mangrove species, however the full effects of a major invasion
 2535 of this species on Florida mangrove swamp diversity and function are
 2536 difficult to predict. Given the important contributions of mangroves to
 2537 marine productivity and South Florida’s economy, ECISMA and
 2538 Fairchild Tropical Botanic Garden launched a rapid response effort
 2539 almost immediately after the invasion was detected.



Figure 7-44. Asian black mangrove (photo by SFWMD).

2540 **KEY MANAGEMENT ISSUES**



2541

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.

2542 Annual removals from the 8-ha area have steadily declined and now mostly consist
 2543 of seedlings and saplings, suggesting the seedbank is shrinking. However, after 15 years of annual removal
 2544 efforts, new lumnitzera saplings still appear.

2550 **Monitoring:** Biologists at Fairchild Tropical Botanic Gardens, with the support of ECISMA
 2551 collaborators, conduct annual monitoring for this species.

2552 **Interagency Coordination:** In the absence of a formalized, regional rapid response program, the 15-
 2553 year eradication effort led by ECISMA is a model for grassroots coordination between agency resource
 2554 managers. Cooperative annual workdays continue the efforts to pull seedlings and survey outlying areas for
 2555 new plants. In FY2025, Fairchild Tropical Botanic Gardens and ECISMA coordinated three interagency
 2556 workdays.

2557 **Regulatory Tools:** There are no federal or state prohibitions for this species, however, lumnitzera is
 2558 listed as a FISC Category I invasive species.

2559 **Critical Needs:** Continued annual efforts to monitor and remove remaining established plants. State
 2560 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

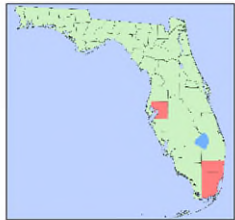
2561 **Mile-a-minute (*Mikania micrantha*)**

2562 **SUMMARY:** Mile-a-minute (**Figure 7-45**) is a federally
 2563 listed noxious weed first documented in South Florida in 2008.
 2564 This South American vine has turned into a serious weed where
 2565 it was introduced in Asia, Australia, and Africa (Holm et al.
 2566 1977, Zhang et al. 2004). Research shows that mile-a-minute
 2567 invasion changes soil nutrients, microbial community
 2568 composition, and metabolic function in subtropical forests,
 2569 creating more favorable growth conditions for the vine,
 2570 potentially forming a positive feedback invasion process (Zhao
 2571 et al. 2023). Upon discovery of this species near Homestead,
 2572 an aggressive eradication effort began immediately.
 2573 Controlling the plant is challenging, in part due to infestations
 2574 on private lands (Dozier 2012), although the threat of FDACS
 2575 quarantine is an incentive for nursery owners to eliminate the
 2576 plant. Eradication from Florida seems unlikely, but
 2577 containment and suppression remain a priority to prevent it
 2578 from colonizing large natural areas like the South Dade
 2579 Wetlands and ENP.



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

2580 **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.

2588 **Control Tools:** This plant is readily controlled by herbicides. Many population cores of the plant may
 2589 be eradicated but annual maintenance work on county properties is necessary and limited monitoring access
 2590 and treatment on private land hinders control efforts. The growth rate of mile-a-minute can be decreased
 2591 using a rust fungus (*Puccinia spegazzinii*) as a biological control agent (Zhang et al. 2023).

2592 **Monitoring:** There is not currently an active monitoring program for this species.

2593 **Interagency Coordination:** Coordination is limited to ad hoc rapid response efforts conducted
 2594 by ECISMA.

2595 **Regulatory Tools:** Mile-a-minute is designated a Federal Noxious Weed.

2596 **Critical Needs:** Continued annual efforts to monitor and remove remaining established plants,
 2597 particularly on private lands and outreach to and education of Florida nurseries that may spread this species
 2598 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

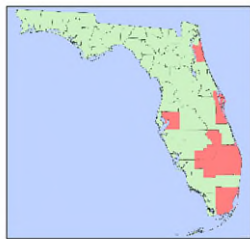
2599 **Tropical American Watergrass (*Luziola subintegra*)**

2600 **SUMMARY:** Tropical American watergrass (**Figure**
 2601 **7-46**) was first discovered in North America in 2007 in Lake
 2602 Okeechobee (Kunzer and Bodle 2008). This perennial South
 2603 American grass grows floating or emergent with prostrate
 2604 creeping culms that form dense mats. UF researchers found
 2605 plants annually produce hundreds of fertile seeds that remain
 2606 viable for long periods. Plants decline in winter; new spring
 2607 and summer growth occurs from seed and surviving
 2608 rhizomes. On Lake Okeechobee, higher water levels seem to
 2609 help with control. Significant increases in *L. subintegra* on
 2610 the lake in 2025 coincided with low water levels during the
 2611 dry season. Managers aim to treat the plants before the onset
 2612 of fall flowering.



Figure 7-46. Dense monospecific stands of tropical American watergrass (photo by USACE).

2613 **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.

2621 **Control Tools:** Herbicides are the only control tool currently available.
 2622 Commonly used herbicides to control *L. subintegra* include glyphosate and imazypr. Contact herbicides,
 2623 e.g., diquat and flumioxazin, have been known to fragment *L. subintegra* furthering its spread. There is
 2624 currently no research on biological control development because tropical American watergrass is in the rice
 2625 tribe (Oryzaceae) and the discovery of a species-specific parasitoid is unlikely.

2626 **Monitoring:** Interagency inspectors continue to monitor the plant and recommend control areas.
 2627 Treatment funding is available from the Florida Invasive Species Management Trust Fund.

2628 **Interagency Coordination:** Within the Lake Okeechobee Watershed, large property owners have been
 2629 contacted to look out for the plant. Also, the Sanibel-Captiva Conservation Foundation was asked to look
 2630 for the plant in their role as Caloosahatchee River Riverkeeper.

2631 **Regulatory Tools:** Tropical American watergrass is not a federal or Florida Noxious Weed, but it is
 2632 an FISC Category I species.

2633 **Critical Needs:** Additional herbicide research and funding for monitoring and rapid response efforts
 2634 are needed. Trials with several newly labeled aquatic herbicides, separately and in combinations, may
 2635 provide more control options and prevent development of herbicide resistance to commonly
 2636 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

2637

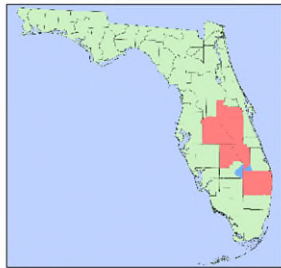
2638 **Tropical Nutrush (*Scleria microcarpa*)**

2639 **SUMMARY:** Tropical nutrush is perennial sedge with a
 2640 neotropical distribution. This species was first identified in 2016
 2641 shortly after it established dense stands in the understory of
 2642 swamps bordering several lakes in the Kissimmee Chain of Lakes
 2643 (Figure 7-47). This species prefers dappled or indirect light and is
 2644 typically found in the understory of bald cypress (*Taxodium*
 2645 *distichum*) forests where it thrives. Tropical nutrush outcompetes
 2646 and displaces native plant populations and is the target of ongoing
 2647 containment monitoring and control efforts within several
 2648 CISMAs in the central and southern regions of SFWMD as its
 2649 spread into the Greater Everglades region could negatively impact
 2650 forested wetlands and swamps.



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

2651 **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.

2660 **Control Tools:** Recent unpublished studies suggest glyphosate and
 2661 imazamox provide effective control of this species. Additional trials determined herbicide is most effective
 2662 for this species when applied under dry conditions (Onisko 2020). Although consecutive treatments reduce
 2663 tropical nutrush density, seed production may still occur. Increased treatment frequency is being
 2664 investigated as it may be needed for achieving maintenance control.

2665 **Monitoring:** This species must be detected from the ground since it thrives under canopy. Heartland,
 2666 TC-, and Osceola CISMAs have provided outreach to engage land managers in the region in detection,
 2667 reporting, and management of this species.

2668 **Interagency Coordination:** Heartland and TC-CISMAs makes this species a priority for regional
 2669 reporting and control coordination. UF IFAS’ Assessment of Nonnative Plants in Florida’s Natural Areas
 2670 website (<https://assessment.ifas.ufl.edu/>) concluded this species to be invasive in Central Florida. TC-
 2671 CISMA lists this species as an EDRR priority.

2672 **Regulatory Tools:** Tropical nutrush is not a regulated or Prohibited Species but it is listed as a FISC
 2673 Category I species.

2674 **Critical Needs:** Expanded surveys for tropical nutrush including private lands and information about
 2675 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

2676

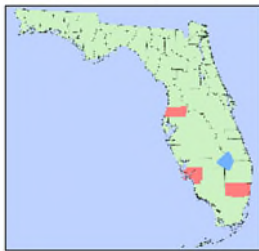
2677 **Giant African Land Snail (*Lissachatina fulica*)**

2678 **SUMMARY:** The giant African land snail (**Figure 7-48**) is
 2679 known to eat a great variety of vegetation, including crop plants,
 2680 horticultural plants, and environmentally valuable plants. This
 2681 species has invaded other places outside its native range in Africa,
 2682 often causing substantial damage. It is an intermediate host of the rat
 2683 lungworm (*Angiostrongylus cantonensis*), which can infect humans
 2684 and cause meningitis (Cowie 2013). A previous infestation of this
 2685 snail occurred in Miami in 1966. The Florida state eradication effort
 2686 took 10 years at a cost of \$1 million (USDA 2020). The State of
 2687 Florida has requested federal resources to help control outbreaks in
 2688 currently affected counties.



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

2689 **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).

2698 **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).

2702 **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.

2705 **Interagency Coordination:** The USDA-FDACS eradication program is a model for collaborative rapid response efforts.

2707 **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.

2711 **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

2713

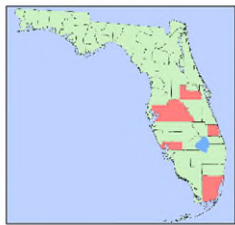
2714 **Argentine Black and White Tegu (*Salvator merianae*)**

2715 **SUMMARY:** The Argentine black and white tegu (**Figure 7-49**)
 2716 is a large, omnivorous lizard that is known to eat eggs. In its native
 2717 range, it prefers open grassy areas and nests in burrows (Winck and
 2718 Cechin 2008). This species may impact Everglades restoration by
 2719 increasing predation on threatened and endangered species, including
 2720 the American crocodile and the Cape Sable seaside sparrow
 2721 (*Ammodramus maritimus mirabilis*) (Kevin Enge, FWC, unpublished
 2722 data) and ecologically important species such as the American alligator
 2723 (Mazzotti et al. 2015). Eradication from Florida is now considered
 2724 unlikely.



Figure 7-49. Argentine black and white tegu (photo by FWC).

2725 **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 Lingenfelter, 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

2734 in local tegu abundance observed over time in this area (UF, unpublished data). Statistical assessment of
 2735 trapping data collected from multiple sites in South Florida corroborate systematic trapping efforts,
 2736 particularly with a high density of traps and a low rate of immigration, can significantly reduce tegu
 2737 populations (Udell et al. 2022).

2738 **Control Tools:** Trapping with baited traps and/or drift fences and removal by firearms may be effective
 2739 control tools. Automated AI smart traps designed to capture tegus were examined by UF and were found
 2740 to significantly increase detection and removal of tegus while reducing resources needed to operate trap
 2741 lines. As of October 1, 2024, over 811 traps have been deployed by FWC, SFWMD, NPS, UF, and FPL for
 2742 FY2025 (number to be updated for the final version of this chapter).

2743 **Monitoring:** Interagency collaborators have conducted regional monitoring for tegus in Miami-Dade County
 2744 since 2011. Monitoring methods include camera surveillance, visual surveys, detector dogs, and eDNA.

2745 **Interagency Coordination:** There is interagency monitoring and trapping coordination for tegus.
 2746 However, funding is needed for expanded current removal efforts and support use of innovative tools if
 2747 containment is to be achieved.

2748 **Regulatory Tools:** As of April 29, 2021, tegus (genera *Salvator* and *Tupinambis*) are listed as a
 2749 Prohibited Species per Chapter 68-5, Florida Administrative Code.

2750 **Critical Needs:** Needs include research on severity of impacts; utilizing a model to predict optimal
 2751 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

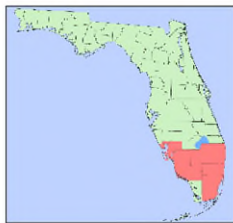
2752 **Chameleons (*Furcifer oustaleti* and *Chamaeleo calypttratus*)**

2753 **SUMMARY:** The Oustalet's chameleon (*Furcifer oustaleti*) is a
 2754 large chameleon native to a variety of habitats in Madagascar (D'Cruze
 2755 et al. 2007). In Florida, their diet includes moth larvae, other insects,
 2756 snails, and brown anoles (Krysko et al. 2012). The veiled chameleon
 2757 (*Chamaeleo calypttratus*; **Figure 7-50**) naturally occurs in mountain and
 2758 coastal regions of the Arabian Peninsula. The veiled chameleon is also
 2759 known to utilize a wide range of habitats. Florida populations of both
 2760 species are suspected to have been established through intentional
 2761 releases by reptile enthusiasts. While chameleons are not particularly
 2762 vagile, intentional introduction by humans must be considered when
 2763 assessing their potential for reaching natural areas. Eradication of newly
 2764 established populations is justified because of their unknown ecological
 2765 impacts and high likelihood of eradication success.



Figure 7-50. A veiled chameleon (photo by UF).

2766 **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).

2774 **Control Tools:** Nighttime searches using flashlights and telescopic poles are generally the best way to
 2775 detect and remove chameleons. Between July 2011 and July 2017, biologists removed 601 Oustalet's
 2776 chameleons from a 49-ha site (Mike Rochford, UF, personal communications). Beginning December 2020,
 2777 efforts lead by UF, SFWMD, and USACE began to eradicate a population of veiled chameleons in Palm
 2778 Beach County, Florida. A total of 1,117 chameleons were removed from Palm Beach County during
 2779 December 2020 to April 2023.

2780 **Monitoring:** An interagency team, led by FWC, began a rapid assessment monitoring project in July
 2781 2011 for Oustalet's chameleons.

2782 **Interagency Coordination:** FWC and partnering agencies coordinate response efforts for these species
 2783 but efforts to implement controls are constrained by limited resources and few control tools.

2784 **Regulatory Tools:** There are no federal or state prohibitions for these species. However, chameleons
 2785 used for public exhibition or commercial sales require authorization from FWC.

2786 **Critical Needs:** Research on ecological and economic impacts of chameleons, as well as the life history
 2787 of chameleons in Florida, are needed. An outreach strategy to discourage hobbyists from releasing
 2788 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

2789

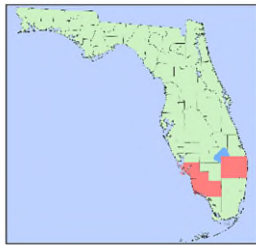
2790 **Nile Monitor (*Varanus niloticus*)**

2791 **SUMMARY:** The Nile monitor (**Figure 7-51**) is a
 2792 large predatory lizard known for its intelligence and
 2793 adaptability (Bennett 1998). It is a generalist feeder (Losos
 2794 and Greene 1988) that commonly preys on crocodile eggs
 2795 and hatchlings in Africa (Lenz 2004). The impact of Nile
 2796 monitors on Florida fauna is unclear but their potential to
 2797 impact native species through competition and predation
 2798 is high (Enge et al. 2004). This species threatens many
 2799 endangered species (Meshaka 2006, Hardin 2007). Diet
 2800 studies found 94% of Nile monitors had food in their
 2801 gastrointestinal tracts with insects, snails, and reptiles
 2802 most consumed.



Figure 7-51. Nile monitors grow to 1.5 meters in length (photo by UF).

2803 **KEY MANAGEMENT ISSUES**



2811

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.

2812 **Control Tools:** Snares, traps, and firearm hunting are the only available
 2813 control tools for this species. City of Cape Coral and FWC biologists respond to
 citizen reports in Lee County, and FWC and UF conduct regular removal surveys
 in Palm Beach County. **The total number of Nile monitors that have been removed from Palm Beach County and Lee County are 135 and over 639, respectively (numbers to be updated in the final version).**

2814 **Monitoring:** FWC is currently monitoring, and when possible, removing Nile monitors in Palm Beach
 2815 County. Based on FWC data, the number of Nile monitors in Palm Beach County appears to be declining.
 2816 Between 2010 and 2018, the number of Nile monitors removed per year averaged nearly 15. Between 2018
 2817 and 2024, that number dropped to less than 3 per year. Nile monitors continue to be observed on game
 2818 cameras, but canal bank vegetation removal, road construction, and boat-based iguana hunters have likely
 2819 contributed to fewer observations and subsequently, fewer removal efforts during boat surveys.

2820 **Interagency Coordination:** Higher-level coordination was moved forward by a Nile monitor
 2821 workshop organized by FWS in May 2016. A formal interagency control program is needed.

2822 **Regulatory Tools:** On April 29, 2021, the Nile monitor was listed as a Prohibited Reptile by the State
 2823 of Florida. Federal regulations are needed to further curtail releases of this invasive species.

2824 **Critical Needs:** Dedicated funding for aggressive control measures and federal regulations to restrict
 2825 possession of this species to avoid additional releases are needed. An understanding of the ecology of Nile
 2826 monitors concerning movement and habitat use, particularly in the C-51 Basin, is needed to increase our
 2827 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

2828 **Northern African Python (*Python sebae*)**

2829 **SUMMARY:** Since 2001, over 46 northern African pythons
 2830 (**Figure 7-52**) have been removed from Miami-Dade County
 2831 (McKayla Spencer, FWC, personal communication) (number to
 2832 be updated in the final version). This giant constrictor shares
 2833 many natural history traits with the Burmese python and is
 2834 considered a high risk for expansion beyond its established
 2835 population in Miami-Dade County throughout South Florida
 2836 (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.

2844

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.

2848 **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.

2854 **Interagency Coordination:** There is excellent interagency coordination for this species but efforts to implement controls, or develop new tools, are constrained by limited resources.

2856 **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.

2859 **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

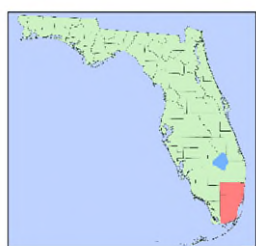
2865 **Spectacled Caiman (*Caiman crocodilus*)**

2866 **SUMMARY:** Spectacled caiman (**Figure 7-53**) from the
 2867 exotic pet trade were first reported in canals at the Homestead Air
 2868 Reserve Base as early as 1960 (Ellis 1980). Native to Central and
 2869 South America, this secretive crocodilian can reach up to
 2870 2.4 meters total length. In Florida, spectacled caiman primarily
 2871 occupies ditches, canals, and disturbed wetlands but are
 2872 occasionally found in undisturbed marshes. This crocodilian
 2873 feeds primarily on fish, mammals, waterbirds, and snails in its
 2874 native range (Thorbjarnarson 1993). Breeding populations are
 2875 documented in localized areas of Miami-Dade and Broward
 2876 counties.



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

2877 **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

2886 freshwater flow may encourage that population to expand into Biscayne National Park, and changes to flow
 2887 in the canal may lead to a similar expansion into ENP. Determining the extent that immigration or additional
 2888 releases of caiman are occurring is key to assessing the potential for maximum containment, or eradication
 2889 of this species in the Greater Everglades ecosystem.

2890 **Control Tools:** Spectacled caimans are controlled primarily by visual searching and removal. This is
 2891 done by trained experts to ensure native crocodilians are not harmed. **Efforts by FWC, SFWMD, USACE,**
 2892 **and UF have resulted in the removal of approximately 300 caimans since 2011 (to be updated in final).**

2893 **Monitoring:** Caiman observations have continually declined in all survey areas despite an increase in
 2894 survey effort in 2017. Results of removal efforts suggest maximum control of caiman within survey areas
 2895 indicating extirpation may be possible (Godfrey et al. 2023).

2896 **Interagency Coordination:** There is excellent interagency coordination for this species but efforts to
 2897 implement controls are constrained by limited resources.

2898 **Regulatory Tools:** Spectacled caiman are regulated as Class II Wildlife by FWC, requiring a permit
 2899 for public exhibition, sale, or personal possession.

2900 **Critical Needs:** Continued efforts to monitor and remove remaining populations need to continue to
 2901 sustain maximum control of caiman populations. An understanding of the extent of potential immigration
 2902 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

2903 **Gambian Pouched Rat (*Cricetomys gambianus*)**

2904 **SUMMARY:** The Gambian pouched rat is a large,
 2905 omnivorous rodent of African origin (**Figure 7-54**). Once
 2906 popular in the pet trade, the United States Center for
 2907 Disease Control banned their importation in 2003 because
 2908 they are a carrier of monkey pox. Prior to this ban,
 2909 numerous Gambian rats escaped captivity in the Florida
 2910 Keys (Grassy Key) and established a reproducing
 2911 population. This species is considered likely to invade the
 2912 Florida mainland and is viewed as a significant threat to
 2913 endangered rodents and other fauna, agriculture, and
 2914 human health (Engeman et al. 2006). These concerns
 2915 prompted rapid response measures in 2005, which appeared
 2916 to have been successful. In 2009, FWC biologists
 2917 cautiously declared the population was eradicated while
 2918 continuing periodic monitoring for the rodent. Then in
 2919 2011, the Gambian pouched rat was again reported on Grassy Key. USDA and FWC biologists reinitiated
 2920 trapping efforts in early 2011 and removed 31 rats to date. The last removal and sighting occurred in 2012.
 2921 Though unconfirmed, in August 2017, a picture surfaced of an American crocodile with what could be a
 2922 Gambian pouched rat in its mouth.



Figure 7-54. Gambian pouched rat (photo by USDA).

2923 **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.

2929 **Interagency Coordination:** USDA, FWC, and the Florida Keys Invasive Exotic Task Force coordinate
 2930 closely on early detection and rapid response efforts for this species.

2931 **Regulatory Tools:** The United States Center for Disease Control banned the importation of the
 2932 Gambian pouched rat in 2003. The Gambian pouched rat is listed as a Prohibited Species by the State of
 2933 Florida.

2934 **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

2935

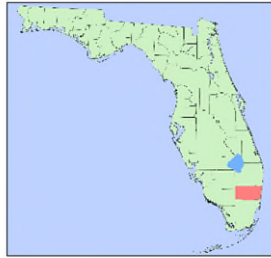
2936 **Conehead Termite (*Nasutitermes corniger*)**

2937 **SUMMARY:** Conehead termites were first discovered in Dania Beach,
 2938 Florida in 2001 (Figure 7-55). While control efforts were conducted previously,
 2939 an official eradication program was established by FDACS in 2012. The termites,
 2940 which are native to South America, Central America, and much of the Caribbean
 2941 islands, have been shown to thrive in South Florida but have been kept mostly
 2942 contained to a small region of Broward County by the eradication
 2943 program’s efforts.



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

2944 **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.

2953 **Control Tools:** Control of this species is conducted with detailed visual surveys to locate all active nest
 2954 sites and colonies. Treatment of a termite colony includes physical destruction of the nest and chemical
 2955 termiticides. Proximity to surface water of many current populations limits chemical treatment capabilities.
 2956 In some cases, nesting habitat, such as dead trees or debris piles, are removed and treated with termiticide
 2957 or fumigation. While officially an arboreal termite, meaning nests are typically located aboveground and
 2958 often in trees, the conehead termites in Broward County have recently been found with increasing frequency
 2959 in, or just below, the ground surface. This has complicated the surveying and treatment efforts as subsurface
 2960 nests can be more difficult to locate and remove.

2961 **Monitoring:** FDACS Conehead Termite Eradication Program conducts all current monitoring.
 2962 However, outreach efforts to the general public, land managers, and local biologists extend surveillance as
 2963 much as possible.

2964 **Interagency Coordination:** The program is managed by FDACS but is often assisted by Broward
 2965 County and/or other local biologists via volunteer workdays and events coordinated through the ECISMA
 2966 network.

2967 **Regulatory Tools:** Conehead termites and all *Nasutitermes sp.* are on the USDA’s Regulated Plant
 2968 Pest List.

2969 **Critical Needs:** Additional funding to support survey efforts, treatments, and removal of nesting and
 2970 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

2971

2972 **ESTABLISHED INVASIVE SPECIES WITHOUT CONTROL PROGRAMS**

2973 The final group of invasive species are well established in the Everglades ecosystem and are known or
 2974 presumed to exert significant negative impacts on Florida ecosystems or native species populations but are
 2975 not currently the focus of active management (**Table 7-5**). Common reasons for the limited management
 2976 of these species are inadequate control tools, limited resources for project implementation, and/or limited
 2977 risk assessment information. Most of these species are the focus of ongoing monitoring and research to
 2978 better understand their impacts to the South Florida environment or to develop control tools. While there
 2979 are many other species that may warrant inclusion in this section, particularly freshwater fishes, the included
 2980 species represent some of the most concerning organisms for South Florida.

2981 **Table 7-5.** Priority species not currently managed within the South Florida ecosystem for
 2982 geographic containment, ranked by taxonomic group and then alphabetically by common name.

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

2983

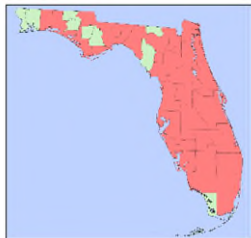
2984 **Island Applesnail (*Pomacea maculata*)**

2985 **SUMMARY:** The island applesnail (**Figure 7-56**) is a large (up to
 2986 10 centimeters) South American freshwater mollusk now established in
 2987 Florida. It was introduced through intentional releases from aquaria and as
 2988 a food crop. Likely impacts include destruction of native vegetation,
 2989 competition with native fauna, and disease transmission. The island
 2990 applesnail may out compete the native applesnail, *P. paludosa*, the primary
 2991 food of the endangered Everglade snail kite. Juvenile kites have difficulty
 2992 handling larger island applesnails and experience lower net daily energy
 2993 balances when feeding on them (Cattau et al. 2010). Also, a recently
 2994 described cyanobacterium (*Aetokthonos hydrillicola*) found in the
 2995 Kissimmee Chain of Lakes is associated with a lethal neurologic disease,
 2996 vacuolar myelinopathy (VM), which affects avifauna in the southeastern United States (Wilde et al. 2005).
 2997 Research confirms island applesnail bioaccumulation of a neurotoxin produced by *A. hydrillicola* and 100%
 2998 development of VM in laboratory birds fed affected snails (Dodd et al. 2016), suggesting a significant risk
 2999 to the snail kite and other avifauna.



Figure 7-56. The island applesnail (photo by FWC).

3000 **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)

3008 **Control Tools:** No control tools exist with applicability in large natural areas. State and federal
 3009 agencies should dedicate resources to develop control strategies.

3010 **Monitoring:** State and federal monitoring programs are either limited to small geographic areas or
 3011 participatory monitoring through outreach.

3012 **Interagency Coordination:** Limited interagency coordination has yielded little information and few
 3013 attempts to understand this species' distribution, potential impacts, and possible control.

3014 **Regulatory Tools:** This species is widely sold in the aquarium trade. Additional regulations are needed
 3015 to curb the release of this and other nonnative *Pomacea* species.

3016 **Critical Needs:** Development of control tools; research to better understand impacts of this species;
 3017 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

3018

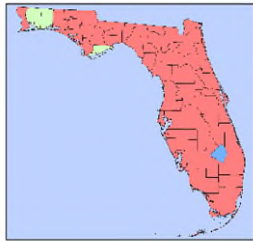
3019 **Laurel Wilt (*Raffaelea lauricola*)**

3020 **SUMMARY:** Laurel wilt (**Figure 7-57**) is a lethal fungal disease of
 3021 red bay (*Persea borbonia*) and other members of the Laurel family
 3022 (Lauraceae). The disease is caused by the fungus (*Raffaelea lauricola*)
 3023 introduced into trees by the wood-boring redbay ambrosia beetle
 3024 (*Xyleborus glabratus*) (Fraedrich et al. 2008). This Asian beetle was
 3025 introduced into the United States via infested wood used for shipping
 3026 crates with Taiwanese origin (Harrington et al. 2011, Dreaden et al.
 3027 2019). Once infected, susceptible trees rapidly succumb to the pathogen
 3028 and die. The disease also impacts other members of the Lauraceae family
 3029 (Hanula et al. 2009) including swamp bay (*P. palustris*), an important
 3030 species of many Everglades plant communities. Since its introduction
 3031 into the United States, the fungus is now vectored by several native and
 3032 nonnative ambrosia beetles (Carrillo et al. 2014). Documented reductions in abundance of Palamedes
 3033 swallowtail butterflies (*Papilio palamedes*) in laurel wilt infested stands raises serious concerns for this and
 3034 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).

3035 **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

3044 areas is impractical (Mayfield et al. 2008). Research to identify ambrosia beetle repellents for use in
 3045 agrosystems is showing promising results (Cloonan et al. 2023)

3046 **Monitoring:** State and federal agencies are monitoring the spread of laurel wilt disease through the
 3047 Cooperative Agricultural Pest Survey Program. Recent monitoring studies suggest variability of red bay
 3048 survivorship, with higher sapling survival and growth in proximity to mature survivors, suggesting disease
 3049 tolerance in some individuals (Eicholtz et al. 2024).

3050 **Interagency Coordination:** Due to lack of feasible control strategies in natural areas, there’s
 3051 interagency support for research into effective management options.

3052 **Regulatory Tools:** The redbay ambrosia beetle is considered a plant pest.

3053 **Critical Needs:** Critical research areas needed include continued evaluation of *Persea* resistance,
 3054 *Persea* seed/germplasm conservation efforts, potential chemical or biological control tools, discovery of
 3055 chemical attractants for *X. glabratus*, and impacts on native flora, ecological processes, and native fauna
 3056 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	

3057

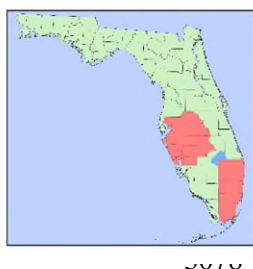
3058 **Asian Swamp Eel (*Monopterus albus*)**

3059 **SUMMARY:** Asian swamp eels (**Figure 7-58**) are versatile
 3060 animals, capable of living in a broad spectrum of hydrology and
 3061 salinity. They can travel over flooded land when necessary and burrow
 3062 into mud to survive periods of drought. Populations in Florida likely
 3063 originated as escapes or deliberate releases. The eels are generalist
 3064 predators, but it is their ability to survive periods of drought that make
 3065 this species unique to the large fishes of the Everglades. Since first
 3066 documented in the Everglades in 2007, the species attained high
 3067 abundance throughout Taylor Slough and subsequently, species known
 3068 to be vulnerable to fish predators virtually disappeared from the
 3069 wetlands (Pintar et al. 2023a,b).



Figure 7-58. Asian swamp eel (photo by NPS).

3070 **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

3079 discovered in Lake Underhill in Orange County. While currently not documented in the wild in South
 3080 Florida, it is sold in live food markets in Florida suggesting a possible vector for introduction into new areas.

3081 **Control Tools:** Given the abundance and wide distribution of swamp eels in Florida’s canals,
 3082 eradication is probably impossible.

3083 **Monitoring:** Existing long-term monitoring programs have proven invaluable to track the spread of
 3084 Asian swamp eels and assess their influence in the Everglades (e.g. Pintar et al. 2023a,b). FWC monitors
 3085 Asian swamp eel numbers in select urban canals through routine electrofishing sampling.

3086 **Interagency Coordination:** No significant interagency coordination presently aims to manage
 3087 this species. However, an interagency Swamp Eel Summit hosted by USACE will provide a venue to
 3088 exchange information on swamp eel distribution and spread, brainstorm and evaluate control methods, and
 3089 coordinate efforts between agencies with the goal of mitigating the ecological and economic impacts of
 3090 swamp eels. A USACE-funded literature review is currently in progress.

3091 **Regulatory Tools:** There are currently no regulations that prohibit the importation or possession of this
 3092 species or other species of swamp eels in Florida.

3093 **Critical Needs:** Maintaining long-term quantitative monitoring to evaluate distribution and impacts;
 3094 research to determine potential species’ impacts and spread; research and development of control
 3095 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

3096

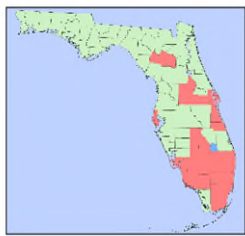
3097 **Grey-headed Swamphen (*Porphyrio porphyrio*)**

3098 **SUMMARY:** The grey-headed swamphen (**Figure 7-59**) is a rail native
 3099 to Australia, Europe, Africa, and Asia. Its introduction was likely due to
 3100 escapes from the Miami Zoo and private aviculturists in Broward County.
 3101 This invasive rail feeds on shoots and reeds, invertebrates, small mollusks,
 3102 fish, snakes, and waterfowl eggs and young (Pranty et al. 2000). Highly
 3103 aggressive and territorial, the grey-headed swamphen could impact native
 3104 waterbirds through competition, destruction of habitat, and direct predation.
 3105 Rapid response efforts between 2006 and 2009 did not successfully reduce
 3106 the abundance or distribution of this species. The management goal for this
 3107 species has shifted from eradication to monitoring (Hardin et al. 2011) and
 3108 preventing spread or establishment in new areas through EDRR.



Figure 7-59. The grey-headed swamphen (photo by SFWMD).

3109 **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

3117 within known established areas, but FWC coordinates rapid response to sightings in new areas to prevent
 3118 spread and establishment of new populations.

3119 **Monitoring:** Agencies rely on reports from the public and agency personnel to track the spread of
 3120 this species.

3121 **Interagency Coordination:** Local and state agencies have attempted to analyze this species’
 3122 population and implement control. However, efforts to date have not halted the further spread of this species
 3123 and eradication is no longer considered feasible. FWC staff have removed over 3,000 grey-headed
 3124 swamphens to date, mostly from Lake Okeechobee, STAs, and WCA-2B (Johnson and McGarrity 2009,
 3125 Hardin et al. 2011). Florida Atlantic University scientists studied habitat use and diets of grey-headed
 3126 swamphens to assess impacts this species may have on the Greater Everglades ecosystem (Callaghan and
 3127 Gawlik 2016)

3128 **Regulatory Tools:** There are currently no regulations that prohibit import or possession of this species
 3129 in Florida. Regulations to restrict possession of this species would help avoid new releases.

3130 **Critical Needs:** Additional monitoring to assess population expansion; additional information
 3131 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

3132

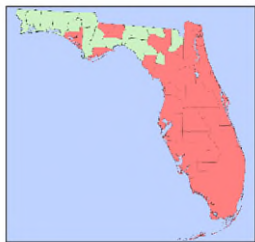
3133 **Cuban Treefrog (*Osteopilus septentrionalis*)**

3134 **SUMMARY:** The Cuban treefrog (**Figure 7-60**) is native to
 3135 Cuba, the Cayman Islands, and the Bahamas. It was first reported
 3136 in Florida in the 1920s and was likely transported in cargo or
 3137 ornamental plant shipments. Cuban treefrogs consume a variety
 3138 of invertebrates and native treefrog species (Maskell et al. 2003).
 3139 Native green (*Hyla cinerea*) and squirrel (*Hyla squirella*) tree
 3140 frogs are less likely to be found when Cuban treefrogs are present
 3141 (Waddle et al. 2010), and when Cuban treefrogs are removed
 3142 from an area, the abundance of native treefrogs increases (Rice et
 3143 al. 2011). Recent work has shown snakes that consume Cuban
 3144 tree frogs endure a cost to fitness as Cuban tree frogs contain a
 3145 noxious chemical that can hinder growth and exert energetic costs for digestion in snakes consuming this
 3146 species relative to native tree frogs (Goetz et al. 2018). Additionally, Cuban treefrog populations in Florida
 3147 are hosts to rat lungworm, a parasitic nematode capable of infecting humans and animals with a deadly
 3148 disease (Chase et al. 2022). Given the Cuban treefrog’s wide distribution and habitat tolerances, mounting
 3149 evidence of direct impacts to native species, and the lack of management programs, the status of this species
 3150 is red in all management regions.



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

3151 **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).

3159 **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.

3161 **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.

3165 **Interagency Coordination:** No significant interagency coordination presently aims to manage this species.

3167 **Regulatory Tools:** There are currently no regulations that prohibit the importation or possession of this species in Florida.

3169 **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

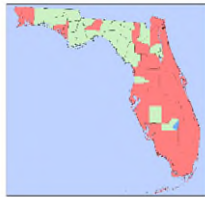
3170 **New Guinea Flatworms (*Platydemus manokwari*)**

3171 **SUMMARY:** The New Guinea flatworm (NGF; *Platydemus manokwari*)
 3172 belongs to the phylum Platyhelminthes, specifically to the subgroup of land
 3173 planarians (family Geoplanidae) (**Figure 7-61**). This species is a predator of snails,
 3174 slugs, insects, annelids, and other invertebrate prey, occasionally also being
 3175 scavengers. Its main prey consists of different species of snails, including tree snails.
 3176 The impact of this species on endemic tree snails in Pacific Islands is severe, making
 3177 this animal one of the 100 worst invasive species in the world (Global Invasive
 3178 Species Database 2023), and this impact is now negatively affecting the native tree
 3179 snail community in South Florida. Floridian native tree snail species such as *Liguus*
 3180 *fasciatus* and *Orthalicus floridensis* are readily consumed by this species. Its
 3181 presence in tropical hardwood hammocks in the Miami Rock Ridge in southeast
 3182 Florida is negatively affecting populations of these unique Floridian tree snails
 3183 (Lopez et al. 2025).



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

3184 **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.

3191 **Control Tools:** No control tools are currently approved for NGF. Testing of control measures are
 3192 necessary to mitigate their population growth and spread. Killing of the NGF by using hot water (43 to 50
 3193 degrees Celsius) could be used to treat potted plants that could carry this species.

3194 **Monitoring:** Monitoring is essential in understanding the population and seasonal dynamics of this
 3195 species. FWC (Florida Keys) and FDEP (Dagny Johnson and John Pennekamp state parks) monitor this
 3196 species with the use of ground boards. Also, Florida International University (FIU) researchers have found
 3197 this species follows annual seasonal cycles, being more common during the wet or rainy season and less
 3198 common during the dry season. Monitoring activities need to be implemented across Florida.

3199 **Interagency Coordination:** Results from research conducted by FIU have found that this flatworm
 3200 species has established populations in tropical hardwood hammocks in the Miami Rock Ridge area and is
 3201 causing ecological problems especially on native tree snail communities (Lopez et al. 2025).

3202 **Regulatory Tools:** Currently, there are no regulatory tools to control NGF. Regulations should be
 3203 applied to the plant trade, which could prove helpful to limit the spread of this species into new areas in
 3204 Florida.

3205 **Critical Needs:** This species needs further research in terms of its invasive biology and
 3206 experimentation for the ways by which populations of this species could be controlled. The impact of NGF
 3207 to native species of tree snails has been observed by FIU researchers (Lopez et al. 2025), prompting the
 3208 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

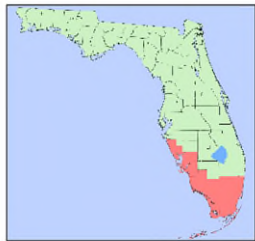
3209 **Black Spiny-tailed Iguana (*Ctenosaura similis*)**

3210 **SUMMARY:** The black spiny-tailed iguana (**Figure 7-62**) is native
 3211 Mexico and Central America and was first reported in Florida in 1979.
 3212 Black spiny-tailed iguana’s generalist diet includes vegetation as well as
 3213 variety of invertebrate and vertebrate species, including gopher tortoises
 3214 (Fitch and Hackforth-Jones 1983, Avery et al. 2009). Like the green
 3215 iguana, it has adapted to human-altered habitats throughout South Florida.
 3216 They are known to burrow into earthy and rocky banks, rock crevices, and
 3217 man-made structures, which raises concerns for impacts to SFWMD
 3218 infrastructure. The increasing spread of black spiny-tailed iguanas across
 3219 South Florida emphasizes the necessity to develop and implement
 3220 management strategies, potentially in tandem with green iguana
 3221 management.



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

3222 **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).

3230 **Control Tools:** There are currently no agency-sponsored, coordinated control
 3231 manual removal, firearms, and trapping. There are iguana control companies in operation who will also
 3232 remove black spiny-tailed iguanas.

3233 **Monitoring:** The UF EIRAMP program monitors black spiny-tailed iguanas throughout the Greater
 3234 Everglades. Most metropolitan monitoring is through reports from the public.

3235 **Interagency Coordination:** No significant interagency coordination presently aims to manage
 3236 this species.

3237 **Regulatory Tools:** There are currently no regulations that prohibit the importation or possession of this
 3238 species in Florida.

3239 **Critical Needs:** Research on the severity of economic and ecological impacts and development of
 3240 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

3241

EMERGING ISSUES

3242

3243 South Florida is particularly vulnerable to ongoing biological invasions due to its subtropical climate,
 3244 diverse ecosystems, extensive human activity, numerous international ports, and large population centers
 3245 (Searcy et al. 2023). The state hosts more non-native species than any other region in the continental United
 3246 States. Climate change—through rising temperatures and shifting precipitation patterns—is further
 3247 accelerating the spread of non-native species, complicating management efforts and underscoring the need
 3248 for a proactive, adaptive approach to invasive species control.

3249 This chapter has explored a range of invasive species issues, with a focus on the highest priority species
 3250 affecting South Florida’s native ecosystems. This section highlights several newly identified non-native
 3251 invasive species that may pose significant ecological risks. As with earlier parts of the chapter, this is not
 3252 an exhaustive review, but rather a snapshot of species that have recently drawn the attention of invasive
 3253 species researchers and natural resource managers. Rapid assessments and preliminary studies are currently
 3254 underway to evaluate their potential impacts and to determine possible control measures to slow
 3255 their spread.

3256 **Halophila Seagrass (*Halophila stipulacea*)**

3257 *Halophila* seagrass (*Halophila stipulacea*)
 3258 (Figure 7-63) is a fast-growing species of seagrass
 3259 native to the Red Sea region. This marine plant grows
 3260 in sublittoral sediments on sand, mud and coral rubble
 3261 (Winters et al. 2025). *H. stipulacea* is listed as an
 3262 invasive species in the Mediterranean Sea
 3263 (Bourdouresque and Verlaque 2002) and is also
 3264 included on a list of the 100 worst alien species in
 3265 Europe (EEA 2007). *H. stipulacea* is reported to grow
 3266 faster than native plants and dominate native sea grass
 3267 communities. This species is documented to have a
 3268 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)

3269 *H. stipulacea* was documented for the first time in
 3270 the continental United States in August 2024 at a
 3271 marina on Key Biscayne, Florida (Campbell et al.
 3272 2025). Subsequent surveys have confirmed that *H.*
 3273 *stipulacea* had already spread beyond the marina into
 3274 adjacent waters. The seagrass was assessed by UF IFAS using the Predictive Tool and found *H. stipulacea*
 3275 to have a high invasion risk in Florida’s marine waters (UF IFAS 2025). Researchers suspect that its
 3276 introduction to Florida occurred via recreational boats traveling from the Caribbean, where the species is
 3277 already established (Ruiz Ballantine 2004). The ecological implications of this invasion are concerning, as
 3278 *H. stipulacea* has been documented to be more aggressive in Caribbean waters compared to invasions in
 3279 the Mediterranean Sea (Winters et al. 2023). For example, the extirpation of congener *H. decipiens* from the
 3280 island of Dominica has been documented, where invasive *H. stipulacea* now occurs in habitats where
 3281 *H. decipiens* previously existed (Steiner and Willette 2015). FWC has distributed an invasive plant advisory
 3282 for *H. stipulacea* urging the public and partner agencies to report sightings in support of ongoing monitoring
 3283 efforts. Individuals are advised not to remove the plant as disturbance can cause the plant to fragment and
 3284 spread via currents.

3285

3286 **Vacuolar Myelinopathy**

3287 Vacuolar myelinopathy (VM) is a fatal neurodegenerative disease marked by extensive vacuolization—
3288 formation of fluid-filled spaces—in the white matter of the brain. First identified in 1994 in bald eagles in
3289 the southeastern United States (Thomas et al. 1998), VM has since been documented across a growing
3290 number of sites in the region. Although initially observed in avian species such as waterfowl and raptors
3291 (Haram et al. 2020), the disease has also been found to affect a broader range of wildlife, including
3292 amphibians, reptiles, and fish. Both field observations and laboratory experiments have demonstrated that
3293 VM can move through the food web, transferring from herbivorous species to their predators (Dodd et al.
3294 2016, Breinlinger et al. 2021).

3295 The causative agent of VM is aetokthonotoxin, a potent neurotoxin produced by the cyanobacterium
3296 *Aetokthonos hydrillicola* (Breinlinger et al. 2021). This cyanobacterium grows epiphytically—on the
3297 surface—of submerged aquatic vegetation, most notably the invasive plant *Hydrilla verticillata* (Wilde et
3298 al. 2014). Although *A. hydrillicola* was first discovered on hydrilla, it has also been found growing on other
3299 aquatic plant species. The geographic origin of *A. hydrillicola* remains unknown, and it is still unclear
3300 whether the organism is native to North America or introduced.

3301 In aquatic systems, *H. verticillata* forms dense mats that serve as an ideal substrate for the proliferation
3302 of *A. hydrillicola*. Studies conducted across the southeastern United States have shown that 45% of
3303 surveyed watersheds with hydrilla were colonized by *A. hydrillicola* (Breinlinger et al. 2021). Notably,
3304 wildlife deaths from VM have only been reported in reservoirs where both hydrilla and *A. hydrillicola* are
3305 present in high densities, suggesting a strong correlation between colonization and disease outbreaks.

3306 The link between plant and pathogen is made more complex by environmental chemistry. *H. verticillata*
3307 provides an optimal substrate for *A. hydrillicola* (Wilde et al. 2014), which has been shown to
3308 hyperaccumulate bromide from its surroundings—a key precursor in the biosynthesis of aetokthonotoxin.
3309 Laboratory studies confirm that exposure to potassium bromide significantly increases toxin production by
3310 *A. hydrillicola*, indicating that environmental conditions can directly influence the virulence of this
3311 disease pathway.

3312 The ecological relationship between *H. verticillata*, *A. hydrillicola*, and the toxin aetokthonotoxin
3313 represents a unique and concerning example of how an invasive plant can facilitate a cascading disease
3314 outbreak across trophic levels in aquatic and avian wildlife. Of particular concern for the Everglades
3315 ecosystem is the detection of aetokthonotoxin in five of ten Burmese python tail tissue samples (Susan
3316 Wilde, University of Georgia, unpublished data). This raises the risk of toxin transfer through the food web
3317 and has led to speculation that the neurological disease affecting Florida panthers (*Puma concolor coryi*)
3318 and bobcats (*Lynx rufus*) may be linked to aetokthonotoxin. This hypothesis is based on the presence of the
3319 toxin in affected animals and the similarity in clinical signs to those observed in other wildlife known to
3320 have been exposed to aetokthonotoxin (Susan Wilde and Tobias Elliott Haymes, University of Georgia,
3321 personal communication, unpublished data).

3322 Further research is needed to confirm this connection and determine whether aetokthonotoxin is
3323 contributing to mortality in panthers and bobcats. To date, this plant-cyanobacterium interaction has only
3324 been documented in artificial reservoirs and eutrophic lakes in the southeastern United States, including
3325 confirmed detections in the Kissimmee River Watershed (e.g., Lake Tohopekaliga).

3326 **Toungeworms**

3327 *Raillietiella orientalis* is a species of an invasive pulmonary pentastomid parasite, commonly referred
3328 to as toungeworms, with an indirect lifestyle that includes snakes as its definitive host and invertebrates,
3329 anurans, lizards, and likely small mammals, as intermediate hosts. This pentastome is native to Southeast
3330 Asia where it infects a diversity of native snakes including Burmese pythons. Introduction of this species

3331 was likely due to human mediated dispersal pathways including the exotic pet trade of Burmese pythons
3332 (Miller et al. 2018).

3333 *Raillietiella orientalis* has been documented in over half of the counties in Florida since its initial
3334 discovery in South Florida by Miller et al. (2018). Many species of native snakes exhibit high parasite
3335 prevalence and intensity, which has facilitated the spread of *R. orientalis* beyond the known range of
3336 Burmese pythons (Miller et al. 2020). Unlike the often inconsequential impacts to snakes infected by *R.*
3337 *orientalis* within the parasite's native range, when a parasite such as *R. orientalis* is introduced to hosts that
3338 do not share a coevolutionary history with the parasite, such as our native snakes in Florida, the impacts of
3339 infection may be more severe. *R. orientalis* often achieves high prevalence and intensity, and larger size, in
3340 Florida's native snakes compared to pythons (Miller et al. 2020). More research is needed to understand
3341 the implications of infection to native snake populations as well as physiological impacts to hosts and this
3342 is currently underway by UF, USGS, and USDA as well as other researchers. Anecdotal evidence
3343 suggesting *R. orientalis* may result in host mortality is concerning and stresses the need for robust
3344 examination of the impacts of this pentastome. Evidence from research suggests *R. orientalis* can infect a
3345 diversity of native snake species in Florida and North America and that this parasite may continue to expand
3346 and invade a broad geographic range and infect additional snake species (Miller et al. 2020). Endangered
3347 native snake species such as the eastern indigo snake (*Drymarchon couperi*) could be impacted from this
3348 nonnative parasite as *R. orientalis* infection may be associated with an incidence of mortality observed for
3349 a captive individual of this species (Bogan et al. 2022) and wild populations of indigo snakes have been
3350 documented to be infected by the pentastome (Miller et al. 2018). In addition to the threat of *R. orientalis*
3351 to Florida's native snakes, *R. orientalis* has also been documented to infect Argentine black and white tegus
3352 and tokay geckos (Goetz et al. 2021, Fieldsend et al. 2021) in Florida. The extent to which invasive lizards,
3353 and other nonnative taxa, may be aiding transmission of *R. orientalis* is unknown and warrants further
3354 investigation.

3355 The introduction, establishment, and spread of a nonnative pentastome attributed to an invasive species
3356 highlights additional unintended and indirect consequences of invasive species on the landscape, the far-
3357 reaching impacts to native fauna beyond the range of the invader, and the importance of proactive
3358 prevention of invasive species introductions.

3359 ***Vallisneria* × *pseudorosulata***

3360 An important component of aquatic ecosystems
3361 eelgrass (*Vallisneria*) is often used in restoration of
3362 aquatic habitats in Florida and elsewhere due to its
3363 native status and desirable ecological benefits.
3364 Historically, all species of *Vallisneria* within the
3365 United States were classified as American eelgrass
3366 (*Vallisneria americana*). However, recent genetic
3367 studies have verified that there are two species of
3368 *Vallisneria* native to the eastern United States (*V.*
3369 *americana* and *V. neotropicalis*) (Martin and Mort
3370 2022). Additionally, nonnative *Vallisneria* species
3371 and hybrid cultivars are being identified in Florida
3372 that were widely used in restoration efforts because
3373 they were thought to be native to Florida. This
3374 cultivar, dubbed “Rock Star” is in fact a hybrid
3375 whose parental species are *V. spiralis* L. and *V. denseserrulata* Makino and is referred to as *Vallisneria* ×
3376 *pseudorosulata* (Figure 7-63) (Gebhart et al. 2024).



3377 **Figure 7-63.** *Vallisneria* × *pseudorosulata*
3378 growing in Florida waterway (photo by FWC).

3377 Identification of *Vallisneria* × *pseudorosulata* and *V. americana* in situ is challenging due to limited
3378 diagnostic characteristics between the two but the collections of samples that have been genetically

3379 analyzed have confirmed that the nonnative hybrid *Vallisneria x pseudorosulata* is outcompeting native
3380 *V. americana*, becoming established as the dominant species in water bodies and is aggressively spreading
3381 and displaying the ability to disperse over long ranges (Gebhart et al. 2024). Management of nonnative
3382 *Vallisneria* species with herbicide is an option for aquatic habitat managers but research is limited into the
3383 ability to selectively control nonnative species of *Vallisneria* without adversely impacting native species,
3384 an issue that is compounded by their frequent co-occurrence in water bodies in Florida (Beets et al. 2024).

3385 State agencies are working with partners and researchers to try to determine how widely spread
3386 nonnative *Vallisneria* populations are within the state and elsewhere as well as how these species respond
3387 to management activities and how they interact with other *Vallisneria* species through competitive ability.
3388 Managers and researchers are also interested in how the nonnative species of *Vallisneria* interacts with
3389 aquatic flora and fauna and how they may alter ecosystems or impact recreational opportunities
3390 for stakeholders.

3391 **FUTURE NEEDS IN MANAGEMENT AND CONTROL**

3392 The elements of a comprehensive management program for some invasive plant species—legislation,
3393 coordination, planning, research, education, training, and funding—have been in place in Florida for many
3394 years. Most plants identified in this chapter as priority species are being managed on public lands by local,
3395 state, or federal agencies. This is not true for many invasive animal species, though significant strides have
3396 been made in this area in recent years. The threat of invasive animals has become an important ecological
3397 and restoration issue for many agencies in Florida. Meaningful legislation to significantly limit
3398 establishment of new nonnative species, continued funding for control programs, and coordination at all
3399 levels are needed for a comprehensive invasive animal management program for Florida. The Florida
3400 *Melaleuca Management Plan* (Laroche 1999), *Invasive Exotic Species Strategic Action Framework*
3401 (SFERTF 2020), and the *Florida Python Control Plan* (FWC et al. 2021) are all excellent examples of the
3402 coordination required to effectively address invasive species in the restoration footprint. The number of
3403 invasive species is overwhelming, and agencies charged with managing natural systems have a
3404 responsibility to understand the distribution and impacts of these species and either initiate management
3405 operations or accept their occurrence and consequences in natural areas.

3406 Given the documented impacts of invasive organisms in South Florida, scientists are obliged to factor
3407 these species and their impacts into restoration planning and models. Continued research is needed to
3408 understand the distribution, biology, and impacts of these invasive organisms. Controlling and managing
3409 invasive organisms in an all-taxa approach is a relatively new concept, even among ecologists, but it is
3410 emerging as an important field of science given global trade and insufficient regulatory controls. Organisms
3411 will continue arriving and establishing breeding populations in new environments, especially in
3412 South Florida.

3413 Regardless of taxa, the process of biological invasion—from introduction to establishment to ecosystem
3414 engineer—is complex, involves many environmental factors, and may take many decades to complete.
3415 Relatively few nonnative species become invasive in their new environments, but a very few species can
3416 wreak major economic and ecological havoc. Species that appear benign for many years or even decades
3417 may suddenly spread rapidly following floods, fires, droughts, hurricanes, long-term commercial
3418 availability, or other factors. Resource managers must recognize these species during the early, incipient
3419 phase to maximize the potential for containing or eradicating them. As part of this effort, an applied
3420 monitoring program and a tracking system for nonnative plant and animal species are needed before their
3421 introduction. Advanced prioritization and predictive screening tools would be a boon for managers, aiding
3422 in the identification of potential detrimental threats so resources could be allocated to maintain them at the
3423 bottom of the invasion curve (**Figure 7-25**) prior to unanticipated rapid spread and infestation.

3424 Species like the sacred ibis in the Everglades and Gambian pouched rat in the Florida Keys illustrate
3425 the need for agencies to act quickly to contain and attempt to eradicate animals that have the potential to
3426 become widespread and difficult to control. While definitive research is lacking to support the immediate
3427 management of many species, it is widely accepted in the invasive species literature that catching a species
3428 in its incipient phase is advantageous, even where research may be inadequate or lacking. This is one of the
3429 most important reasons to develop a biological risk assessment “toolbox” for nonnative species to help
3430 discern which species are most likely to become invasive both prior to introduction and during the earliest
3431 phases of their establishment when eradication is most feasible (Springborn et al. 2011).

3432 The use of an EDRR program increases the likelihood invasions will be controlled while the species is
3433 still localized and population levels are so low eradication is possible (National Invasive Species Council
3434 2003). Once populations of an invasive species are widely established, eradication becomes virtually
3435 impossible and perpetual control is the only option. Implementing an EDRR program is typically much less
3436 expensive than a long-term management program. Given the risks associated with waiting for research and
3437 long-term monitoring to catch up, some agencies have opted to initiate control programs concurrently with
3438 biological or ecological research programs. Prompt cooperative action has been successful to eliminate or
3439 locally contain emerging populations of sacred ibis and the invasive mangrove species *Lumnitzera*
3440 *racemosa*. These EDRR efforts may have prevented widespread ecological harm by these new invaders and
3441 saved significant public resources required to manage more widespread invasions. Biological risk
3442 assessments are being developed to enable agencies to determine which species are most likely to become
3443 problems (Gordon et al. 2006, Simons and De Poorter 2009, Springborn et al. 2011). Many states struggle
3444 with how to implement an EDRR approach because awareness and funding often lag, preventing a real
3445 rapid response. For South Florida, groups such as the CISMAs and the SFERTF are attempting to initiate
3446 additional EDRR efforts.

3447 An overarching theme in this chapter is describing the alarming extent and impacts of some invasive
3448 species and stating the need for increased coordination and control. While these observations are valid,
3449 control efforts against certain invasive species have proven successful and demonstrate effective
3450 management is possible with effective interagency support and adequate funding. For instance, melaleuca
3451 once was thought to be unmanageable in the state because it was so widespread and difficult to control. The
3452 SFWMD-led melaleuca management program has been implemented for over 30 years, and the plant is
3453 now under maintenance control on Lake Okeechobee and in most of the Greater Everglades. The success
3454 of this program is largely attributed to integrated management approaches, sustained funding, and close
3455 interagency coordination, all of which foster information and technology transfer, regional strategic
3456 planning, increased financial efficiency, and improved public awareness.

3457 For the invasive species already widely established, long-term commitments to integrated control
3458 programs are the only feasible means of containing and reversing impacts. Effective management of other
3459 entrenched and difficult-to-control species, such as Old World climbing fern and the Burmese python, will
3460 require sustained resource allocation for development and implementation of control programs, like that
3461 used for the management of melaleuca, if Everglades restoration is to be successful. Further, many
3462 biological invasions are likely to be permanent and may easily reestablish dominance if maintenance and
3463 control management is not sustained. For this reason, policymakers, regulators, scientists, and land
3464 managers should focus on preventing importation of potentially invasive species through improved
3465 regulatory programs and regional monitoring programs.

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