**Executive Summary**

The South Florida Ecosystem Restoration Task Force, along with members of the Everglades Cooperative Invasive Species Management Area (ECISMA) and other partners, has developed this Framework in order to enhance our collective ability to combat invasive exotic species. Florida is second only to Hawaii in the severity of the threat posed by invasive exotic species and is particularly vulnerable to the introduction, invasion, and establishment of non-native species because of its subtropical climate, major ports of entry, and pet, aquarium, and ornamental plant industries. Invasive exotic plants and animals, including marine and freshwater fish species, are causing rapidly increasing environmental and economic problems in south Florida.

**Why a Framework?**

**The stakes are high.** The South Florida Ecosystem, ecologically unique and imperiled by numerous threats, is the subject of the largest ecosystem scale restoration program in the world. The South Florida Ecosystem is also home to:

- a culturally diverse population of almost 8 million residents, including two Indian tribes,
- world renowned recreational opportunities, and
- strong agricultural and tourism-based economic engines.

Invasive exotic species threaten our environment, economy, culture, and human health. Combating invasive exotic species is integral to successful ecosystem restoration and the sustainability of south Florida.

**There is a need to better coordinate and communicate our collective efforts on invasive exotic species.** There is a large body of work already complete on invasive exotic species and their impacts on the South Florida Ecosystem. Many plans have been written to address specific species and areas of concern. This document is intended to strategically combine these efforts into a single framework that can be utilized by decision-makers, managers, and practitioners to enhance our collective ability to combat invasive exotic species. The intent is to create an overarching framework, and not another individual plan.

This framework aims to:

- Help decision-makers understand the connections between goals, strategies, and tactics;
- Maximize the extent to which the current capacity for partnership is leveraged to meet common goals;
- Help decision-makers make wise and timely investment decisions in the battle against invasive exotics; and
- Define success and provide for accountability.

**How will we get there?**

**The Invasion Curve serves as the organizing principle for the Framework.** Its four phases mirror our goals of prevention, early detection and rapid response, containment, and resource protection and long-term management. Use of the Invasion Curve is consistent with other national, state, local, and tribal strategies that deal with invasive exotic species. The Invasion Curve graphically depicts the four major categories of management actions that may be taken to combat invasive exotic species as the invasion progresses from initial establishment to widespread dominance on the landscape.
Prevention and eradication through early detection and rapid response (EDRR) give the best return on investment in the war on invasive exotic species (Goals 1 and 2). Preventing introductions of new invasive exotic species is the most cost-effective strategy and can yield benefits if invested in upfront and if current barriers are addressed. Successful early detection and rapid response (EDRR) of newly established invaders requires formal collaboration and dedicated staff and funding.

Over time, the costs and areas infested increase, resulting in containment efforts or development of long-term management programs to best protect the environment and economy (Goals 3 and 4). Consistent resources to address containment, resource protection, and long-term management are needed.

The four goals are supported by strategies, actions, and case studies, and are based on the following **key principles:**

- Science should form the foundation for our strategies within every phase of the invasion curve.
- Invasive exotic species issues are inherently multi-disciplinary.
- Success will require interagency cooperation, innovative partnerships, and an informed, involved public.
- A successful invasive exotic species program requires long-term commitment of resources.

![The Invasion Curve and Related Goals](image)

**Figure 1:** The Invasion Curve and Goals. Adapted from Invasive Plants and Animals Policy Framework, 2010, Department of Environment and Primary Industries, Victoria Australia.
Introduction

How Invasive Exotic Species Affect the Unique South Florida Ecosystem

The South Florida Ecosystem includes America’s Everglades and a diverse array of habitats and landscapes. Encompassing the boundary of the South Florida Water Management District, plus the adjacent marine systems, the South Florida Ecosystem covers over 18,000 square miles. This geographical region includes all or part of sixteen counties and contains a population of almost eight million residents. It is also home to more than 70 threatened and endangered species, three national parks, a national preserve, 19 national wildlife refuges, and extensive conservation lands managed by state, county, and local governments. The region also includes sovereign and perpetual lease tribal lands, one of the most important agricultural industries in the country, and supports a world renowned tourism and recreational industry.

The South Florida Ecosystem, ecologically unique and imperiled by numerous threats, is the subject of the largest ecosystem scale restoration program in the world. With its mild climate, diverse environments, and dense human population centers, South Florida is particularly vulnerable to naturalization by non-native species. A small number of these non-native species eventually become aggressive invasive species and spread into natural areas. Once established, the most aggressive invasive species in south Florida have displaced native species, altered ecosystem structure and food web dynamics, degraded critical wildlife habitat, introduced diseases to native species, and exerted additional pressures on threatened and endangered species. These invasive exotic species diminish the return on ecosystem restoration investment and threaten ecosystem functions and services, cultural values, recreational opportunities, and economic interests vital to the health of the entire state of Florida.
**Background**

**What are Invasive Exotic Species and How do They Get Here?**

An Executive Order (EO 13112) was signed in 1999 in order to "prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause." Consistent with EO 13112, invasive exotic species are defined within this document as a non-native species (including its seeds, eggs, spores, or other propagules) whose introduction to the South Florida Ecosystem does or is likely to cause economic, environmental, or cultural harm or harm to human health.

Pathways are the means by which species are transported from one location to another. These include natural pathways, such as wind and currents, and man-made pathways, such as deliberate and unintentional importation of plants and animals through international commerce. Globalization of trade and advances in transportation technology have dramatically increased the movement of live organisms across oceans, continental divides, and other natural emigration barriers. Some of these species are well-adapted to their introduced environment and, in the absence of co-evolved predators and pathogens, are able to proliferate and cause significant changes to their new environment.

![Diagram of South Florida Ecosystem with Pathways](image-url)

*Figure 2: Invasive Exotic Species' Pathways. Adapted from the National Invasive Species Council and Aquatic Nuisance Species Task Force Pathways Ranking Guide (2005).*
Specific Concerns for the South Florida Ecosystem and America’s Everglades

Environment

The South Florida Ecosystem and America’s Everglades are prime habitat for invasive exotic species, proving to be hospitable to many plant and animal species that are native to similar climates throughout the world. Central and South American as well as African and Asian species have found a new home in the humid subtropical climate South Florida offers. The abundant water and food and warm temperature provide perfect conditions for invasive species, giving them a foothold in Florida and the United States. Some introduced species are not encumbered by the natural control mechanisms, such as predators and diseases, that exist in their native range. Without any natural mechanisms to keep these introduced populations in check, some exotic plant and animal populations can establish and expand into new areas.

Invasive exotic species are detrimental to the South Florida ecosystem causing: 1) direct biological harm to native species through predation; 2) indirect harm by disruption of the food web and competition for resources; 3) the harm and irreparable loss of threatened and endangered species and 4) physical changes to habitats and ecological processes.

Figure 3: After an American crocodile, a federally threatened species, is captured laying eggs by a wildlife camera, an Argentine black and white Tegu is caught by the same camera feeding on the eggs. Photo:

Figure 5: Burmese pythons are feeding generalists, capable of eating most appropriately sized terrestrial vertebrate species, with larger snakes eating larger prey. Documented prey items include over 40 species of mammals and birds, as well as American alligators. Some of these prey items, for example the wood stork and the Key Largo wood rat, are at risk of extinction because of their already low population sizes or limited geographic distribution, and it is unclear how their populations will respond to increased predation pressure. Evidence suggests that many prey populations (e.g., raccoons, opossums) have declined dramatically since the python’s introduction. Photo: Roy Wood.

Figure 4: An Everglades marsh overtaken by melaleuca. Photo:
Economy

Invasive exotic species can have both a direct and indirect impact on the south Florida economy. Examples of direct costs are: 1) prevention efforts including inspection/interdiction at points of entry (airports, seaports, and mail); 2) monitoring, rapid response, containment, and long-term management efforts; and 3) reduction in crop yields, injury to livestock, and reduction in tourism and recreation. Indirect costs are associated with the loss of ecosystem services, including habitat destruction and the displacement or loss of native species. These indirect costs are much more difficult to enumerate and value.

**Inspection/Interdiction:** The interdiction of species is partly under the jurisdiction of the U.S. Customs and Border Protection (CBP) and the U.S. Department of Agriculture (USDA). The CBP and USDA are responsible for protecting our agricultural and economic interests from harmful pests and disease import and have teams that actively inspect cargo at the ports of entry in Florida. The U.S. Fish & Wildlife Service Office of Law Enforcement and the Florida Fish and Wildlife Conservation Commission have staff that work to prevent the of import or export of endangered species. These agencies coordinate when interdiction falls in another agency's jurisdiction.

The scale of the job these agencies face is staggering. Over 6 million tons of perishable cargo enter Florida each year. Over 85% of the plants imported to the U.S. go through Miami [Dixon 2008]. And agricultural trade and pest interceptions at Florida's ports of entry have been doubling every 5-6 years [UF/IFAS].

**Agriculture:** Invasive exotic species can negatively impact commercial nurseries and agricultural crops. One example is the successful but ongoing battle being waged against the fruit fly. The permanent establishment of these pests in the United States could cause significant economic losses as a result of the destruction and spoilage of a number of commodities, the costs associated with implementing control measures, and loss of market share due to restrictions on domestic and export shipment of affected commodities. In addition, the establishment of exotic fruit flies in Florida could indirectly impact natural systems as a result of an increased need for treatments to control established infestations in agricultural and/or urban areas near wild lands, and/or tribal lands.

USDA's Animal and Plant Health Inspection Service (APHIS) employs a number of regulatory and non-regulatory actions to prevent the entry of fruit fly species and to address outbreaks when outbreaks occur. In fiscal year 2013, the cost to operate the Fruit Fly Exclusion and Detection program and the Sterile Insect Technique Preventative Release Program was $9.5 million nationally. From an internal APHIS report, each dollar APHIS invested in these programs yielded approximately $120 in cost benefits to the U.S. citrus industry alone. This cost benefit ratio increases significantly when you consider the fact that fruit flies affect a wide variety of fruits and vegetables. Benefits of an aggressive and proactive fruit fly exclusion and eradication program include sustainable crop yields, continued access to domestic and foreign markets, and lower production costs for producers who don't have to implement additional pest management measures. On a larger scale, society benefits from the abundant availability of a wide array of fruits and vegetables at a reasonable cost.
Recreation/Tourism: Wildlife-based recreational activities that collectively provide over $8 billion in economic activity in Florida are threatened by invasive exotic species that can significantly diminish these opportunities that are enjoyed by the public (see table below). The impacts of invasive exotic species range from disruption of active recreational activities to diminished availability of passive recreational opportunities such as bird watching. Venomous lionfish invasions may make certain areas unsafe for divers, impacting tour providers. The prevalence of pythons in the news media has made some members of the public wary of even visiting the Everglades. A more calculable direct impact involves water hyacinth, a non-native floating aquatic plant that can form impenetrable barriers that obstruct water flow and navigation and impact fishing and water sports. Florida spends approximately $3 million per year just for the management of this individual species.

<table>
<thead>
<tr>
<th>Total EXPENDITURES of US Citizens in 2011 in Florida on wildlife-economic activity, in order of magnitude</th>
<th>PARTICIPANTS in Wildlife-Related Recreation in Florida in 2011 (U.S. residents 16 years old and older)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fishing $4.6 billion</td>
<td>1. Wildlife Watching 4.3 million</td>
</tr>
<tr>
<td>2. Wildlife Watching $3 billion</td>
<td>2. Anglers 3.1 million</td>
</tr>
<tr>
<td>3. Hunting $716 million</td>
<td>3. Hunters 242 thousand</td>
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Impacts from invasive species are not limited to natural areas, flood control, and agricultural interests in south Florida. While difficult to quantify, the cultural impacts of some biological invasions can be significant. Tribal lands within south Florida are not immune to invasion of exotic vegetation. Exotic vegetation disrupts and alters native habitats utilized by the tribes for cultural and medicinal practices by displacing native species of vegetation. Exotics vegetation consists of, but is not limited to melaleuca (*Melaleuca quinquenervia*), Old-World climbing fern (*Lygodium microphyllum*), Brazilian pepper (*Schinus terebinthifolia*), and Arrowhead vine (*Syngonium podophyllum*). Significant tribal resources are expended on an annual basis to treat heavily infested areas and manage levels of exotic vegetation within community and native areas. Pastures and agricultural practices on tribal lands are also greatly impacted by exotic species of vegetation such as Cogon grass, Tropical Soda Apple, and Brazilian pepper infestations. These exotic species can significantly reduce the grazing capacities of pastures.

Another example is the loss of plants used in traditional Native American life and cultural practices from Laurel Wilt disease. Spread by the recent introduction of the exotic redbay ambrosia beetle (*Xyleborus glabratus* Eichhoff), laurel wilt now threatens to substantially reduce native swamp bays in the Everglades. The bay tree is one of the most important cultural resources to the Miccosukee and Seminole Indian tribes, who use the plant for ritual practices. The loss of bay trees could also lead to long-term changes to Everglades tree islands—another important cultural resource for the tribes and other south Floridians. As large numbers of swamp bays succumb to the exotic disease, scientists are concerned that the disturbance will allow aggressive invasive plants, such as Brazilian pepper and Old World climbing fern, to overtake the tree islands and alter their physical structure and native species diversity. This disease also has direct economic impacts due to its effect on the avocado industry. According to the 2010 report *Potential Economic Impact of Laurel Wilt Disease on the Florida Avocado Industry* published in *HortTechnology*, direct losses (including lost sales, property damage, and increased management costs) from the invasion could range from $183 million to a remarkable high of $356 million. Laurel wilt disease poses one of the greatest risks to the combined socio-economic values of south Florida today.
The Invasion Curve

The Invasion Curve has been selected as the organizing principle for the Framework. It depicts, at a glance, the ability to combat invasive exotic species in terms of time, resources, and likelihood of eradication or containment. The left-hand side of the Invasion Curve represents the best chance for long-term success. Since eradication of widely established invasive species is rarely achieved, a long-term commitment to controlling established species is required to protect the natural resource. Long-term suppression of these established species is a challenge and is costly. Thus, early detection and control of new invasive species results in lower overall environmental impact and economic cost along with a higher likelihood for eradication. Variations of the Invasion Curve have also been used to portray actions to be taken against a specific invasive species.

Four major categories of management actions may be taken to combat invasive exotic species depending on the status of the species in its invasion process: Prevention, Eradication, Containment, and Resource Protection & Long-term Management. Preventing new introductions through effective regulation and public education is the best and only mechanism available prior to the introduction of an invasive exotic species. Once a species is introduced, eradication can be attempted. This requires that the species be detected early in the invasion process and that sufficient tools and resources are available to respond rapidly to the invasion. Early detection and rapid response (EDRR) is the second most cost-effective way to address invasive species, though there are few formal EDRR programs in south Florida. Once the populations increase and become distributed over a greater area, eradication is far less likely. At this point, natural resource managers generally shift their management strategy to containment efforts, with the purpose of preventing the spread to new areas. Finally, once invasive exotic species are widespread and abundant, efforts shift to population suppression to lowest feasible level in order to mitigate the impacts of the invader on natural resources, economic interests, and human health.

Each portion of the Invasion Curve is linked to a specific strategic goal in the Framework. Prevention and eradication through early detection and rapid response give the best return on investment in the war on invasive exotic species (Goals 1 and 2). Over time, the costs and areas infested increase, resulting in containment efforts or development of long-term management programs to best protect the environment and economy (Goals 3 and 4). The four goals are supported by objectives, strategic actions, and case studies, including implementation tools such as research, outreach/education, and coordination.

Figure 8: The Invasion Curve. Adapted from Invasive Plants and Animals Policy Framework, 2010, Department of Environment and Primary Industries, Victoria Australia.
Vision and Strategic Goals

The Framework is guided by a vision statement that succinctly describes what success looks like in the battle on invasive exotic species:

*The South Florida Ecosystem, including America’s Everglades,*
*its environmental, economic, and cultural values and human health,*
*is protected from the harmful effects of invasive exotic species.*

From this vision statement, the four goals were developed based on the phases of the Invasion Curve. These goals are presented in detail in the following section.

Underlying the vision and goals are four key principles:

- Science should form the foundation for our strategies within every phase of the invasion curve.
- Invasive exotic species issues are inherently multi-disciplinary.
- Success will require interagency cooperation, innovative partnerships, and an informed, involved public.
- A successful invasive exotic species program requires long-term commitment of resources.
Goal 1: Prevent the introduction of invasive exotic species.

Preventing introductions of new invasive exotic species is the most cost effective strategy and can yield benefits if invested in upfront and if current barriers are addressed.

Preventing the introduction of invasive exotic species into the South Florida Ecosystem protects both the environment and the economy from the negative ecological impacts of those species and the high costs associated with long-term control efforts. Prevention requires both the ability to identify risks and the ability to implement tools that will stop the identified species from entering our region. Prevention is often seen as only a high-level regulatory tool. However, many other tools, including best management practices and public education, are also available.

The ability to prioritize prevention efforts will rely on technical expertise and tool development, including ecological risk assessments. Current and future efforts will build on existing resources developed by partners working on invasive exotic species.

Preventing the introduction of high priority invasive exotic species will rely upon a cooperative and cohesive multi-jurisdictional approach that aims to fortify the ecosystem from invasion. Better understanding the risks from pathways can help develop robust and more effective biosecurity measures that prevent invasions before they produce significant economic and ecological damages, while simultaneously protecting safe commerce. Securing current and potential pathways will require enhanced import/export screening, full utilization of existing regulatory tools, and development of new regulatory tools.
Goal 1: Prevent the introduction of invasive exotic species.

**PRIORITIZE**

**Objective 1A: Prioritize prevention efforts.**

- Assemble technical work groups.
- Develop tools to identify invasive exotic species that pose the highest ecological, cultural, and/or health risks or are most likely to become established and thrive when introduced to the ecosystem.
- Utilize ecological risk assessments.
- Educate and create public acceptance of risk assessment process.

**PREVENT**

**Objective 1B: Prevent high priority invasive exotic species from entering.**

- Enhance import/export screening.
- Maximize use of existing regulatory tools.
  - Manage pathways of introductions of invasive exotic species using both regulatory and voluntary approaches.
- Seek new regulatory tools.
- Improve understanding of threats to domestic bio-security via intrastate and interstate pathways.
- Utilize best management practices (BMPs).
  - Activities that have the potential to introduce or disseminate invasive species on public lands should include an analysis to determine the potential for the introduction or movement of invasive species.
  - Develop a prevention plan (e.g. Hazard Analysis and Critical Control Point (HACCP) plan) or appropriate set of prevention and containment practices that will be implemented to mitigate or reduce the potential for invasive species movement onto and off of public lands and privately-owned/publicly managed lands.
- Engage the public and broaden the partnership actively working to prevent the introduction of invasive exotic species.
- Encourage the use of prevention practices in partner agency contracts and by entities working on or on the behalf of all partner agencies.
A Deadly Hitchhiker

Heartwater is an often fatal tick-borne disease historically endemic to sub-Saharan Africa, Madagascar, and more recently several islands in the Caribbean. The potential for Heartwater gaining a foothold in South Florida is increased due to the favorable climate for the ticks and the large volume of African reptiles that are imported into Miami International Airport.

Don’t Pack a Pest

Yellow Anaconda

TO BE UPDATED.
Goal 2: Eradicate Invasive Exotic Species by Implementing Early Detection and Rapid Response (EDRR).

Successful early detection and rapid response (EDRR) of newly established invaders requires formal collaboration and dedicated staff and funding.

It is imperative to be able to respond quickly and deal with emerging threats while they remain localized. EDRR is the second most cost-effective method to deal with invasive exotics, after prevention.

Preparation of EDRR efforts should begin before species are identified in the wild. According to ECISMA’s EDRR Plan, “in order to respond rapidly and effectively to an invasion, actions should be anticipated and consensus reached on as many response details as possible prior to discovery of an unwanted introduction. Then, when a response is needed, it will be rapid, streamlined, and more effective.” Preparation and monitoring, to identify invasions as early as possible, provide the foundation for the next steps in EDRR.

Early detection requires effective communication between experts, responders, and the public and should seamlessly connect to rapid response and eradication efforts. Once a new invader is detected, rapid assessment should occur so that the response priority can be determined. All of the prior steps should enable a rapid response to identified threats. Eradication depends upon dedicated funding and an effective logistical framework in order to be able to quickly respond to threats. Barriers, such as permitting issues for responders, must be identified and solutions found to ensure rapid response and increase our ability to eradicate the species.
<table>
<thead>
<tr>
<th>Goal 2: Eradicate Invasive Exotic Species by Implementing Early Detection and Rapid Response (EDRR).</th>
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<tbody>
<tr>
<td><strong>PREPARE &amp; MONITOR</strong></td>
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<tr>
<td><strong>Objective 2A:</strong> Prepare and monitor to enhance early detection.</td>
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</table>
| 1. Establish a regional monitoring/reporting network to increase likelihood of detection.  
2. Expand and implement a systematic, prioritized, all-taxa monitoring and inventory plan.  
4. Develop an outreach and communication strategy coordinated among all managing agencies.  
5. Compile on-call expert and responder lists.  
6. Assemble technical expert work groups for specific species of concern. |
| **ASSESS** |
| **Objective 2B:** Ensure rapid assessment of newly detected species. |
| 1. Establish protocols for rapid assessment of newly detected species so that response priority can be determined.  
2. Provide the resources (funding and staff) to maintain a team with the full-time responsibility of assessing the status and risks of newly detected incipient invasive species populations.  
3. Utilize ecological risk assessments. |
| **RESPOND** |
| **Objective 2C:** Rapidly respond to identified threats. |
| 1. Establish rapid response programs/ cooperatives that allow for nimble attempts at eradication.  
2. Update and implement the ECISMA response protocol.  
3. Establish a rapid response fund in addition to consistent, dedicated resources for early detection.  
4. Update and provide access to EDRR guidelines, model response plans, and other resources.  
5. Expand and enhance training programs for rapid responders.  
6. Establish strike teams.  
7. Reduce barriers to interagency EDRR efforts such as permitting issues for responders.  
8. Prevent spread of incipient populations with limited distribution. |
An EDRR Success Story

Sacred ibis are wading birds indigenous to African wetlands that would directly compete with native wading birds if they became established in South Florida. Zoo Miami and the USDA Wildlife Services led a successful interagency EDRR program to eradicate 75 sacred ibis from Miami-Dade and Palm Beach counties. (Photo: Zoo Miami)

Gambian Pouched Rats

Gambian Pouched rats are large rodents native to Africa that are a vector for serious diseases, including monkey pox. Efforts to eradicate this species from the Florida Keys are being led by the Florida Fish and Wildlife Conservation Commission. (Photo: FWC)

A Threat to Agriculture

Tephritid fruit flies are considered the most destructive pest of fruits and vegetables, attacking more than 400 different plants, and are the focus of USDA APHIS' cooperative EDRR program that includes efforts offshore, at the border, and within the United States.
Goal 3: Contain the spread of invasive exotic species.

Consistent resources to address containment, resource protection, and long-term management are needed.

Once it is determined that eradication of an invasive exotic species is not possible, we enter the third phase of the Invasion Curve. Control and containment efforts focus on preventing the spread of an invasive exotic species to new areas in order to minimize the damage to the ecosystem and reduce long-term control costs. Elements of the containment phase include further refinement of control tools, improving coordination, and investing in monitoring.

Efforts to improve coordination at all levels should be enhanced and strengthened to enable better coordinated on-the-ground management activities directed at species, pathways, and high-value assets. There is a need to identify technical, enforcement, or financial assistance for activities needed to eliminate or reduce the environmental, public health, and safety risks associated with invasive exotic species. General containment plans by major taxa should be put in place a priori. These plans should focus on identification of feasible, cost-effective management practices, and measures for the cooperating entities to prevent and control invasive exotic infestations. Providing greater support will yield significant leveraging of resources on the ground and actions across-the-board for a variety of invasive exotic species.

Science must remain the foundation of our efforts to address invasive species. Most of our public natural resource management agencies are committed to science-based decision-making, and this should include invasive species. Investment in and consistent application of science during risk assessment, methods development, control implementation, species monitoring, and assessment of control efforts will provide the justification and support needed for success.

Goal 3: Case Study

**Tegus**

The Argentine black and white tegu is a large, invasive lizard native to South America that has become established in southern Miami-Dade County. The goal is to protect sensitive habitats, including nearby national parks and crocodile nesting areas, by containing them to their current range. (Photo: Dustin Smith)
### Goal 3: Contain the Spread of Invasive Exotic Species.

#### COORDINATE

**Objective 3A: Standardize containment efforts through enhanced coordination.**

- Describe invasive exotic species (flora and fauna) impacting South Florida Ecosystem restoration.
- Develop a shared plan for creating an emergency response fund to help support and increase the capacity of interagency and inter-jurisdictional teams to tackle emerging invasive species issues.
- Ensure that partnership policies, mechanisms, and implementation tools help support and encourage cooperative efforts across agencies, landscapes, and jurisdictions.
- Ensure vertical coordination amongst agencies on the ground combating invasive exotic species.

#### CONTAIN

**Objective 3B: Utilize existing control tools to contain invasive exotic species.**

- Develop and promote decontamination protocols (best management practices to prevent the inadvertent spread of invasive exotic species).
  - Require that all activities that have the potential to introduce or disseminate invasive species on public lands include an analysis to determine the potential for the introduction or movement of invasive species.
  - Develop a prevention plan (e.g., Hazard Analysis and Critical Control Point (HACCP) plan) or appropriate set of prevention and containment practices that will be implemented to mitigate or reduce the potential for invasive species movement onto and off of public lands and privately-owned/publicly managed lands.
  - Encourage the use of containment practices in contracts and by entities working on or on the behalf of all partner agencies.
- Retreat or reassess areas to ensure containment of invasive exotic plants and animals.
- Prevent new incipient populations with limited distribution.
- Enforce existing laws regarding transplanting species.

#### INVEST

**Objective 3C: Invest in monitoring, research, science, and tool development.**

- Develop tools to assist in the containment and control of invasive exotic species.
- Conduct inventory and monitoring to improve understanding of population dynamics.

#### ASSESS & ADAPT

**Objective 3D: Determine effectiveness of containment efforts on invasive exotic species’ populations.**

- Report successes/failures and lessons learned for each species and/or geographic region.
- Incorporate lessons learned into ongoing and future containment efforts.
- Augment public dissemination of control efforts to bolster support, understanding and cooperation.
- Conduct low level impact analyses.
- Conduct economic impact analyses.
Goal 4: Reduce the populations of widely established invasive exotic species and maintain at lowest feasible levels.

Consistent resources to address containment, resource protection, and long-term management are needed.

The final stage of the Invasion Curve is resource protection and long-term management. This phase endeavors to reduce the population and impact of an invasive exotic species so it is no longer plays a dominant role in the ecosystem. This can be accomplished by using control tools to reduce the population densities of a species within a specific area and by strengthening the resilience of natural areas through restoration efforts.

The underlying concept of this goal is to continue to combat invasive exotic species in order to move efforts left along the Invasion Curve. Investment in science and research may yield future tools that could dramatically reduce the population and extent of invasive exotic species that are well established today. Continual assessment and adaptation based on lessons learned may also have a great impact on the extent and population of a currently established species.
Goal 4: Case Studies

**Lionfish**
Lionfish (*Pterois volitans* and *P. miles*) are the only reproducing examples of 32 ornamental marine fish observed on Florida reefs since the 1980’s. Within 40 years, these two lionfish species populated the Caribbean, Gulf of Mexico, the Southeastern US coastline, and the Bermuda coastline. There are no suitable traps ready for deployment, nor any other cost effective collection strategy for control.


**Burmese Python**
Burmese pythons are giant constricting snakes which have an established invasive population in southern Florida. The pythons are large predators with little risk of predation themselves, and have the potential to negatively impact a multitude of native species. Management of the invasive python population has proven very difficult, and the population continues to grow despite an increasingly coordinated effort of several governmental and academic agencies. (Photo: ENP)

**Melaleuca**
Melaleuca is a fast-growing evergreen tree native to eastern Australia. The plant is a prolific seed producer, is fire-adapted, and is able to thrive in both flooded and well drained soils. First introduced to Florida in the early 1900’s as an ornamental tree and soil stabilizer, melaleuca quickly spread. Large sections of the Greater Everglades have reached or are nearing maintenance-control levels where melaleuca once dominated. However, some portions of the South Florida Ecosystem still contain sizable melaleuca infestations. (Photo: Vic Ramey, UF/IFAS)

**Shoebutton Ardisia**
An evergreen shrub/small tree that is native to Asia has invaded short hydroperiod wetlands, hammocks, and tree islands in south Florida. It impacts both the community structure and ecological function of native habitats. Miami-Dade County’s Environmentally Endangered Lands (EEL) Program is working to identify cost-effective controls to manage this invasive species. (Photo: Miami-Dade County EEL Program)

**Ambrosia Beetle**
Laurel wilt disease threatens to cause the extinction of native redbay trees, swamp bays in the Everglades, and seriously impact commercial avocado (*Persea americana*) groves in South Florida. This has implications for the structural integrity of tree islands in the Everglades and bay trees are one of the most important cultural resources to the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida. (Photo: Courtesy of Sun Sentinel.)
Goal 4: Reduce the populations of widely established invasive exotic species and maintain at lowest feasible levels.

COMBAT

Objective 4A: Reduce population of established invasive exotic species through new controls or increased utilization of existing control tools.

- Eliminate, to the extent possible, invasive exotic plants and animals from natural areas by reducing invasive exotic species densities, reducing reproductive capacities of invasive exotic species, and employing a variety of control measures.
- Ensure that control measures are not deleterious to native species.
- Continue to review and update invasive species management techniques.
- Conduct routine surveys to detect new infestations and new species.
- Evaluate effectiveness of different treatment techniques and treatment intervals on invasive plants.
- To the extent practical, integrate federal, state, and local agency invasive exotic plant and animal control programs.

RESTORE

Objective 4B: Reduce impacts of invasive exotic species through restoration of native habitats and species.

- Support efforts to increase the total spatial extent of natural areas and restore natural hydrology.
- Coordinate invasive species management activities with monitoring of existing rare plant and animal species and to minimize unintended impacts to rare species.
- Coordinate invasive species management with restoration activities to prevent degradation of habitat.
- Reintroduce populations of extirpated and rare species, and augment existing populations where appropriate to improve native plant and animal species abundance and diversity.
- For listed species, use USFWS Recovery Plans as guides.

INVEST

Objective 4C: Invest in monitoring, research, science, and tool development.

- Develop tools to assist in the long-term management of invasive exotic species.
- Prevent new incipient populations with limited distribution.
- Conduct inventory and monitoring to improve understanding of population dynamics.

ASSESS & ADAPT

Objective 4D: Determine effectiveness of long-term management efforts on invasive exotic species’ populations.

- Report successes/failsures and lessons learned for each species and/or geographic region.
- Incorporate lessons learned into ongoing and future management efforts.
- Conduct low level impact analyses.
- Conduct economic impact analyses.
- Apply lessons learned into management actions (adaptive management).