# ANNEX G

# INVASIVE AND NUISANCE SPECIES MANAGEMENT PLAN

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## G.0 INVASIVE AND NUISANCE SPECIES MANAGEMENT PLAN

In accordance with the Comprehensive Everglades Restoration Plan (CERP) Guidance Memorandum 062.00 (CGM62), Invasive Species, the CEPP will incorporate invasive and nuisance species assessments and management of those species into pertinent planning documents and phases of the project. The Invasive and Nuisance Species Management Plan (INSMP) is a living document and will be updated throughout the Design, Construction and Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) phases.

The Project Partnership Agreement (PPA) and the Construction Phasing, Transfer, and Warranty (CPTW) Plan are developed and agreed to prior to construction. The documents outline the responsibilities of the federal and non-federal sponsor during the construction phase, the operational testing and monitoring period, and the OMRR&R phase, and will include the cost estimates associated with this INSMP. This INSMP must be included with the CPTW Plan.

This plan was developed with the input and guidance of multiple agencies and subject matter experts. The following provided text, technical guidance, and cost estimates.

- South Florida Water Management District – David Black, LeRoy Rodgers
- U.S. Army Corps of Engineers – Jeremy Crossland, Angie Huebner, Jon Morton, Jessica Spencer, Sue Wilcox
- U.S. Fish and Wildlife Service – John Galvez, Art Roybal
- Everglades National Park – Jeff Kline, Jonathan Taylor
- Florida Fish and Wildlife Conservation Commission – Jenny Ketterlin Eckles, Kelly Gestring
- University of Florida – Frank Mazzotti

## G.1 INTRODUCTION

The Central Everglades Planning Project (CEPP) encompasses the Everglades Agricultural Area Storage Reservoir, Decompartmentalizaton of Water Conservation Area (WCA) 3, Everglades National Park (ENP) Seepage Management, and Everglades rain driven operations. The components of this plan are highly interdependent features that will be implemented in a comprehensive and integrated manner and are the main portion of CERP.

Nationally, more than 50,000 species of introduced plants, animals, and microbes cause more than $120 billion in economic damages and control costs each year (Pimentel et al., 2005). Not all introduced species become invasive species. According to the Office of Technology Assessment, Harmful Non-indigenous Species in the United States report, approximately 10 to 15% of introduced species will become established and 10% of the established species may become invasive.

Executive Order (E.O.) 13112, entitled *Invasive Species*, signed 03 February 1999, states an "invasive species means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health." Alien species means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores or other biological material capable of propagating that species, that is not native to that ecosystem. Invasive species are broadly defined and can be a plant, animal, fungus, plant disease, livestock disease or other organism. The terms 'alien' and exotic also refer to non-native species. A native species is defined as a species that historically occurred or currently occurs in a particular ecosystem and is not the result of an introduction.

Invasive non-native species decrease biodiversity, displace native plant and animal communities, reduce wildlife habitat and forage opportunities, alter the rates of soil erosion and accretion, alter fire regimes, upset predator/prey relationships, alter hydrology, degrade environmental quality and spread diseases to native plants, animals and other organisms. Furthermore, invasive species are the second largest threat to biodiversity following only habitat destruction (Wilcove et al., 1998); invasive species are second in destructive nature only to human development. In the United States, invasive species directly contributed to the decline of 49% of the T&E species (Wilcove et al., 1998). In addition to environmental impacts, invasive species impact human health, reduce agricultural production and property values, degrade aesthetic quality, decrease recreational opportunities and threaten the integrity of human infrastructure such as waterways/navigation channels, locks, levees, dams and water control structures.

Florida is particularly vulnerable to the introduction, invasion and naturalization of non-native species. This is due to several factors including a subtropical climate, dense human population centers, major ports of entry and the pet, aquarium and ornamental plant industries. Major disturbance to the landscape has also increased Florida's vulnerability to invasive species. Alteration of the landscape for urban development, flood control and agricultural uses has exacerbated non-native plant and animal invasions. Florida is listed as one of the states with the largest number of invasive species. This list also includes Hawaii, California, and Louisiana. On average, 10 new organisms per year are introduced into Florida that are capable of establishing and becoming invasive and causing environmental harm. Approximately 90% of the plants and animals that enter the continental United States enter through the port of Miami (JP Cuda, 2009a). Stein, Kutner & Adams (2000) estimated that over 32,000 exotic species (25,000 plants and 7,000 animals) have been introduced into Florida. There are approximately 4,000-5,000 native species of plants and animals in Florida. The number of non-native species that have been introduced is eight times the total number of native species in the entire state.

The Atlas of Florida Vascular Plants (Wunderlin and Hansen, 2008) documented 4,289 plant species in Florida. Of the 4,289 plant species, 1,419 were considered non-native and were naturalized (freely reproducing) populations. The Florida Exotic Pest Plant Council (FLEPPC) identifies 76 of the 1,419 species of non-native plants as Category I species in the 2011 Invasive Plant List. Searches through existing data and resources indicate 156 non-native plant species have been documented to occur within the project area (refer to Table G-3: Invasive Plant Species Documented in the Project Area). Other non-native species are probably present; however, documented citations could not be located. Of the 156 species of plants documented to occur within the project area, there are 76 FLEPPC Category I species, 38 FLEPPC Category II species and 28 Florida Noxious Weed species.

Significant scientific evidence and research document invasive non-native plants are degrading and damaging south Florida natural ecosystems (Doren and Ferriter, 2001). Many species are causing significant ecological impacts by crowding out and displacing native plants, altering soil types and soil/water chemistry, altering ecosystem functions such as carbon sequestration, nutrient cycling and fire regimes and reducing gene pools and genetic diversity. Non-native invasive animal distribution, extent and impacts are not well understood, however implications of invasive animals are apparent in south Florida. It has been documented there are 14 non-native species that are causing direct impacts to threatened and endangered species and rare habitats. It has also been documented that 19 species within Florida are among the world's worst weeds (Holm et al., 1977). It is estimated that federal, state and county agencies in Florida spend between $94 million and $127 million each year in an effort to manage invasive non-native plants (GAO, 2000).

Invasive species are a major threat to the success of CERP. "The intent of CERP is to restore, preserve and protect the south Florida ecosystem while providing for other water-related needs of the region. CERP focuses on hydrologic restoration to improve degraded natural habitat in the south Florida ecosystem. Hydrologic restoration alone cannot ensure habitat restoration (USACE and SFWMD, 2010)." In order to restore the Everglades and ensure south Florida's natural ecosystems are preserved and remain intact, invasive species must be comprehensively addressed (Doren and Ferriter, 2001). The lack of management will allow invasive non-native species to flourish and to continue to out-compete native species.

## G.2 STATUS OF PRIORITY SPECIES AND THEIR IMPACTS

### G.2.1 Plants

Table G-3 (Invasive Plant Species Documented in the Project Area) provides the list of non-native plant species that have been documented to occur within the project area. Searches through existing data and resources indicate 156 non-native plant species have been documented; other non-native species are probably present however documented citations could not be located. Of the 156 species of plants documented to occur within the project area, there are 76 FLEPPC Category I species, 38 FLEPPC Category II species, and 28 Florida Noxious Weed species.

There are four non-native invasive plant species and one native nuisance plant that infest large portions of the project area. These plant species are currently a concern and have the potential to impact project benefits. In addition there are four species of non-native invasive plants that have the potential to be spread by new project features and changes in operational procedures. These plant species are described below.

#### G.2.1.1 Widely Established Species

According to the 2013 South Florida Environmental Report, there are four species of non-native invasive plants infesting more than 144,770 acres within the Everglades Protection Area. These species include Australian pine (*Casuarina equisetifolia*), Old World climbing fern (*Lygodium microphyllum)*, melaleuca (*Melaleuca quinquenervia)* and Brazilian pepper (*Schinus terebinthifolius)*. The acreage of these plants was estimated by the SFWMD and the National Park Service (NPS) through regional invasive plant surveys utilizing digital aerial sketch mapping (DASM). The inventory was completed within the Everglades Protection Area, which is approximately 2.8 million acres in size, between March 2010 and February 2012. Wildlife management areas surveyed included Holeyland, Rotenberger, and Southern Glades. Other areas surveyed included the Seminole Tribe of Florida's Big Cypress Reservation, Loxahatchee National Wildlife Refuge (LNWR), Everglades Wildlife Management Area (WCAs 2 and 3), the Miccosukee Tribe of Indians of Florida's Reservations, Big Cypress National Preserve, ENP, East Coast Buffer Lands, South Dade Wetlands, and several other areas (SFER, 2013). Summaries on the distribution and impacts of these widely established species are included below. Other non-native plant species with limited or localized distributions or which have a high potential to spread into the project area are also discussed. These include torpedograss (*Panicum repens*), tropical American water grass (*Luziola subintegra*), rotala (*Rotala rotundifolia*), and cogongrass (*Imperata cylindrica*).

#### G.2.1.2 Australian pine

Australian pine is an evergreen tree that can grow to 150 feet tall. It has inconspicuous flowers and produces tiny fruit, a 1-seeded winged nutlet that is formed in a woody cone-like cluster. Australian pine is

a prolific seed producer and seeds are dispersed by birds, wind and water flow. It is native to Australia, the south Pacific Islands and southeast Asia. Australian pine was introduced in the late 1800's and was planted extensively in south Florida as windbreaks and shade trees. It inhabits sandy shores and pinelands and is salt tolerant. It also invades disturbed sites such as filled wetlands, roadsides, cleared undeveloped land, canal banks and levees. Australian pine grows rapidly shading out native species, produces dense litter accumulation, causes beach erosion and produces an allelopathic agent that inhibits growth of other species. In addition it interferes with nesting of sea turtles and the American crocodile (Langeland and Burks, 1998). According to the survey, approximately 6,986 acres of Australian pine are present within the survey area and it is the least abundant of the surveyed species. According to the SFER 2013 report, Australian pine is now at a maintenance control level in many areas within the Everglades. Maintenance control, as defined by the Florida Fish and Wildlife Conservation Commission (FWC), "is the coordinated and consistent management of invasive plants in order to maintain the plant population at low levels." The major infestations, approximately 87%, of Australian pine were present on SFWMD and Miami-Dade County lands in the South Dade Wetlands and Model Lands Basin. In these areas, Australian pine is present in remote mangrove swamps and sawgrass marshes where populations vary from dense stands to widely scattered patches. In ENP, this species is present in the northeastern sawgrass marshes in widely scattered patches (SFER, 2013).

#### G.2.1.3 Brazilian pepper

Brazilian pepper is an evergreen shrub or tree that can grow up to 40 feet tall. It forms dense thickets and is a prolific seed producer. It produces a small bright red fruit in the form of a spherical drupe. Brazilian pepper is native to Brazil, Argentina and Paraguay and was imported in the 1840's as an ornamental plant (Langeland and Burks, 1998) Brazilian pepper inhabits natural areas such as pinelands, hardwood hammocks and mangrove forests. It is an aggressive pioneer species that quickly colonizes and thrives in disturbed areas (Francis, n.d.) such as fallow farmland, fence lines, right-of-ways, roadsides, canal banks and levees. Seeds are spread primarily by birds and mammals through consumption and deposition of the fruit. Seeds are also spread by flowing water (Langeland and Burks, 1998). Brazilian pepper seedlings will not tolerate inundation and are quickly killed; however large plants can withstand 6 months of flooding (Francis, n.d.) with several feet of inundation. Brazilian pepper forms dense monocultures and completely shades out, crowds and displaces native vegetation. It also produces allelopathic agents that possibly suppress the growth of other plants. Brazilian pepper is a member of the family Anacardiaceae which includes plants such as poison ivy, poison oak and poison sumac. The leaves, flowers and fruits of Brazilian pepper produce a chemical that can irritate and form a rash on human skin and cause respiratory problems (Langland and Burks, 1998). Approximately 75,310 acres of Brazilian pepper are widely distributed throughout the survey area. It is the most abundant of the species surveyed. In ENP, Brazilian pepper is dominant in certain buttonwood swamps and grass marshes along the inner edge of the southwestern mangrove swamps. Nearly 60% of the Brazilian pepper infestation within the survey area is present from the Ten Thousand Islands area to Cape Sable. This was the most severe infestation that was surveyed. Within the Seminole Tribe of Florida's Big Cypress Reservation, dense infestations of Brazilian pepper are present primarily on improved pastures and along the outer edge of cypress swamps. Throughout the central Everglades region, Brazilian pepper was present on small tree islands and in many cases dominant in the canopy. Observations of the tree islands from the ground indicated relatively no understory of native vegetation was present beneath the Brazilian pepper canopy. In Big Cypress National Preserve, Brazilian pepper is widely scattered, but it is present in dense infestations in the western Everglades hardwood hammocks. Little to no Brazilian pepper is present on the tree islands of the LNWR.

Physical control, sometimes referred to as cultural control, is the physical manipulation of an invasive species or their habitat. A number of techniques are used for physical control. These include manual removal, installing barriers and environmental alterations such as water level manipulation, prescribed fire and light attenuation.

Mechanical control refers to the use of machinery designed to cut, shear, shred, uproot, grind, transport and remove invasive species. Equipment used to complete mechanical control may include but is not limited to heavy equipment such as an excavator or front-end loader (with a root rake, grinding heads or other attachments), cutter boats, dredges and mechanical harvesters (Haller, 2009).

Chemical control is the use of a specially formulated pesticide to control an invasive species. The United States Environmental Protection Agency defines a pesticide as "a substance or mixture of substances intended for the prevention, destruction, repulsion, or mitigation of any pest". The term pesticide encompasses a broad range of substances including herbicides, insecticides, fungicides etc. Pesticides are applied through ground and aerial applications.

Biological control, also known as bio-control, is the planned use of one organism to suppress the growth of another. Biological control is primarily the search for and purposeful introduction of species-specific organisms that selectively attack a single target species. Organisms such as insects, animals or pathogens that cause plant diseases are used as biological controls (Cuda, 2009).

Objectives of management can include complete eradication within a given area, population suppression, limiting spread and reducing effects of invasive species. Once an invasive species becomes widely established complete eradication is usually not feasible. The most effective action for managing widely spread invasive species is often preventing the spread and reducing the impacts by implementing control measures. This concept is known as maintenance control. Maintenance control is defined as controlling an invasive species in order to maintain the population at the lowest feasible level.

### G.3.5 Risk and Uncertainties Related to Invasive Species

As with most land management activities, there are a number of risks and uncertainties associated with invasive species management. The use of an adaptive management approach will help develop and prioritize invasive species control strategies. As restoration proceeds, invasive species may establish and/or spread as a direct result or independently of restoration activities. In the context of CEPP and the long-term management of the natural resources within the study area, risks include but are not limited to:

- Introduction of new invasive species which are difficult or impossible to control.
- Restoration activities which unintentionally facilitate the spread of invasive species via contaminated earth moving equipment.
- Undetected spread of invasive species into new areas, making containment of populations more costly and less likely to succeed.
- Uncontrolled invasive species which create disturbances or alter ecosystems such that desired restoration outcomes are not achieved.
- Failure to secure necessary funding to control invasive species.
- Undesirable impacts on non-target species and ecosystem functions resulting from invasive species control efforts.
- Not taking action to manage a species due to inaccurate assessments of the species impact on restoration activities.

The major uncertainty is that in most cases we do not have necessary information for detailed, specific pre-project evaluations of the need for management activities to control invasive species. With the exception of a few well-established and well-studied species (e.g., melaleuca), there is an information deficit on the status, potential impact, and effective control techniques for priority species. This is particularly true for non-indigenous animals. Current knowledge on invasion mechanisms suggests that some restoration activities may facilitate the spread of certain priority species in the Everglades. For example, partial removal of canals and levees could encourage spread of or provide sites for colonization by numerous invasive species, including Brazilian pepper, Old World climbing fern, tegus, Nile monitors, pythons, and Cuban treefrogs. However, there remains considerable uncertainty regarding the degree to which different species will respond, if at all, to restoration activities and how these responses will impact achievement of restoration goals.

Given the high degree of uncertainty, the most effective and lowest cost management option is early detection and rapid removal of invasive species during and post project. Central to this strategy is the implementation of a rigorous monitoring program (discussed below).

Several specific uncertainties have been identified in the initial analysis of the selected plan. They are listed here to provide a starting point for developing monitoring, control and BMP strategies for the construction and operations phases of the restoration.

- Will Rotala and other aquatic weeds expand into ENP with expanded conveyance capacity and flow distribution?
- Will increased flow result in increased nutrient loading thereby increasing spread of invasive and/or nuisance plants (e.g., torpedograss, cattail)?
- Will constructed tree islands associated with Miami Canal backfill create desirable habitat for certain invasive plants and animals?
- Will changes in hydrology in WCA 3B promote expansion of Old World climbing fern in tree islands?
- Will non-indigenous fish species spread into new areas as a result of decompartmentalization activities?
- Will there be secured and available funding for management and control of invasive species? Will other priorities outcompete for funds?
- How will the introduction of new invasive species affect ecosystem restoration efforts?
- How will the lack of biological information for new introduced species affect invasive species management?

## G.4 EXISTING MANAGEMENT PROGRAMS

### G.4.1 South Florida Water Management District

The SFWMD manages invasive exotic aquatic and terrestrial plants in canals and on levees of the C&SF Project, WCAs 2 and 3, stormwater treatment areas (STAs), and interim project lands and on public conservation lands. Most of the vegetation management is outsourced through the Vegetation Management Division and includes herbicide application contractors, mechanical removal contractors, and use of biological controls such as plant specific insects and herbivorous fish. The Melaleuca Control Program is a major focus for the SFWMD, but other priority plant species are controlled within the CEPP study area as funding resources allow.

### G.4.2 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) manages floating vegetation on Lake Okeechobee, the Okeechobee Waterway and associated tributaries. The USACE also conducts treatments of priority species on the Herbert Hoover Dike. In addition to the operations and maintenance program on Lake Okeechobee, the USACE conducts treatments of vegetation during the construction phase of CERP and Modified Water Deliveries to ENP projects in south Florida. Vegetation treated includes FLEPPC Category I and II species, as well as native nuisance species.

### G.4.3 Everglades National Park

The ENP Exotic Plant Management Team is actively engaged in treatment of numerous priority invasive plant species, primarily melaleuca, Old World climbing fern, and Australian pine. In recent years, ENP has focused invasive plant control efforts in the northeastern sections of the park and in the extreme southwestern sections where Old World climbing fern aggressively invades marsh communities. Brazilian pepper is also managed as part of the Hole-in-the-Donut restoration program.

### G.4.4 U.S. Fish and Wildlife Service

Invasive plant management in the LNWR is carried out by the U.S. Fish and Wildlife Service (USFWS) under a 50-year license agreement with SFWMD. The USFWS invasive plant management strategy addresses control of all invasive, non-indigenous species but the primary focus is on melaleuca, Brazilian pepper, Australian pine, and Old World climbing fern. Brazilian pepper and Australian pine are currently managed at low levels (maintenance control) and melaleuca is nearing low levels in most sections of the refuge. Old World climbing fern remains a significant management challenge given its aggressive invasion in tree islands and limited control options.

### G.4.5 U.S. Department of Agriculture / University of Florida

The SFWMD, USACE, NPS, USFWS, FWC, and other agencies provide financial support to the U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) and the University of Florida (UF) for the development of invasive plant biological controls. Efforts to identify safe and effective biological controls have led to important advancements in the integrative management of several invaders, including melaleuca, Old World climbing fern, water hyacinth, and alligator weed. The *CERP Melaleuca Eradication and Other Exotic Plants – Implement Biological Controls Project* is dedicated to the implementation of biological control agents once overseas surveys and quarantine testing has developed agents deemed safe for release in Florida. The project included the construction of a mass rearing annex to the existing USDA-ARS biological control facility in Davie, Florida, in support of implementing the mass rearing, field release, establishment, and field monitoring of approved biological control agents for melaleuca and other invasive nonindigenous species. The construction of the mass rearing facility is and therefore mass rearing and release operations are scheduled to commence.

### G.4.6 Florida Fish and Wildlife Conservation Commission

The FWC's Invasive Plant Management Section is the designated lead entity in Florida responsible for coordinating and funding the statewide control of invasive aquatic and upland plants in public waterways and on public conservation land. In addition to funding the SFWMD melaleuca control program, FWC annually awards funding for individual invasive plant management projects in the Everglades region.

Allocation of control funding is determined by an interagency regional working group. FWC land managers also implement control programs for other invasive plant species in wildlife management areas (WMA) within the CEPP footprint, including Holeyland, Rotenberger, Everglades, and Southern Glades WMAs.

### G.4.7 Invasive Animals

Efforts to develop control tools and management strategies for several priority species are underway for a few priority animal species. These include the Burmese python and other giant constrictors, the Nile monitor, and the Argentine black and white tegu. Control tools are very limited for free-ranging reptiles, and the application of developed methods is often impracticable in sensitive environments where impacts to non-target species are unacceptable. Available tools for removing large constrictor snakes and lizards currently include trapping, detection dogs, and visual searching. Potential tools include the use of toxicants, introduced predators, and pheromone attractants, but these have not been fully explored to date.

Regional invasive biologists have developed a conceptual response framework for established priority invasive animals in south Florida. Objectives within this framework are classified into three main categories—containment (slow the spread), eradicating incipient populations (remove outliers), and suppression (reduce impact in established areas). The resources to implement this strategic framework remain insufficient, but close collaboration between agencies has allowed for some coordinated efforts. Currently, FWC, NPS, UF, and SFWMD are conducting trapping and visual searching for Burmese pythons, northern African pythons, Argentine black and white tegus, spectacled caimans, and Nile monitors.

## G.5 EXISTING MONOTORING PROGRAMS

Since 2008, the SFWMD and USNPS, along with other partner agencies, have utilized digital aerial sketch mapping (DASM) for a region-wide mapping program over 728,000 ha in the Everglades. DASM is a method for mapping plant infestations “on-the-fly” using GPS-linked computers and trained biologists. Visual surveys allow an observer to learn to recognize targeted species, sometimes at low densities, under a range of environmental and phenological conditions. Visual aerial surveys also may provide data more rapidly than other methods, which is important when rapid responses to newly established threats are expected. The primary objective of the DASM inventory program is to determine the distributions of four priority invasive plant species on managed conservation lands in the region. These are Australian pine, Brazilian pepper, melaleuca, and Old World climbing fern. A secondary objective of the program is to detect new plant species invasions in remote areas to facilitate rapid response efforts. This data is currently collected on a two year cycle.

There are no system-wide ground based monitoring programs for invasive plants in the Everglades region. Individual agencies may collect spatial information on infestations, but these efforts are not part of a formalized, systematic monitoring network. Interagency working groups (e.g., Everglades Cooperative Invasive Species Management Area (ECISMA)) regularly meet to exchange information on new or potential invasive plants. As these species are detected, ad hoc efforts to conduct rapid assessment (monitoring and risk assessment) and containment are pursued. However, a lack of dedicated funding for rapid response limits the effectiveness of these initiatives.

In 2010, the UF, FWC, and SFWMD began collaboration on the Everglades Invasive Reptile, Amphibian, and Mammal Monitoring Program (EIRAMMP). The purpose of the project is to develop a monitoring program for priority invasive reptiles and amphibians and their impacts to south Florida. Specifically, the program seeks to (1) determine the status and spread of existing populations and the occurrence of new populations

of invasive reptiles and amphibians, (2) provide additional EDRR capability for removal of invasive reptiles and amphibians, and (3) evaluate the status and trends of populations in native reptiles, amphibians, and mammals. The monitoring program involves visual searches for targeted invasive species on fixed routes along levees and roads within Arthur R. Marshall LNWR, WCA's-2&3, Big Cypress National Preserve, and ENP. Visual searches and call surveys, in addition to trapping, are conducted to monitor invasive reptile and amphibian species. Thirteen routes have been established.

## G.6 MANAGEMENT STRATEGY AND PLAN

Many of the new features of the water management system, as well as construction and operations and maintenance activities, have the potential to spread and promote establishment of non-native invasive and native nuisance species. Proposed restoration activities may affect ecosystem drivers that directly or indirectly influence the invasiveness of non-native species. These factors may affect invasive species positively or negatively, depending on the unique characteristics of individual species and the environmental conditions for a given biological invasion (Doren et al., 2009). Many of the areas where features are proposed are currently inhabited by non-native invasive and native nuisance species. Construction of the proposed features has the potential to spread the existing non-native invasive and native nuisance species on site as well as introduce new invasive species via contaminated equipment. Disturbed areas resulting from construction are likely to become established with non-native invasive and native nuisance species. New flows created by operations of the proposed features may serve as vectors to spread invasive and native nuisance species into new areas. Monitoring is a critical component of the management strategy. Information on distribution and restoration responses of invasive species should be used to inform decisions on control strategies Invasive species surveillance, monitoring, and control should be carried out within the construction footprints, as well as impacted areas. Species of non-native vegetation to be treated include, but are not limited to, species listed in the current version of the FLEPPC invasive plant lists and the Florida Department of Environmental Protection prohibited plant list. The priorities for managing vegetation include FLEPPC category I and II species, new invasive plant introductions, native nuisance species and plants that impact project operations. Management of animal species will include surveillance, control, and monitoring.

The strategy for managing invasive species will be to utilize an IPM approach. Objectives of management will include complete eradication, population suppression, limiting spread and reducing effects of invasive species. Eradication will be the objective for new established species that are localized. The objective for wide spread invasive species will be to implement control measures to suppress and prevent the spread of identified priority invasive species.

### G.6.1 Surveillance – Early Detection and Rapid Response

EDRR should be implemented during every phase, for the life of a project. EDRR is an effective management measure to controlling and containing invasive species that were not previously within the project area. EDRR minimizes the negative impacts the invasive species has on the ecosystem and economy, and reduces future treatment and management costs. It is very difficult to predict when and where an invasive species may appear. As such, estimating a needed budget is near impossible. However, to assist managers, a priority list of species to immediately respond to under EDRR management strategy has been developed (refer to Table G-2: Priority Species / Areas for Early Detection and Rapid Response).

A framework for establishing an EDRR program in the Everglades was recently drafted by an interagency team of invasive species experts and land managers (see ECISMA EDRR Plan at

http://www.evergladescisma.org/ECISMA_EDRRPlan_2009-2011.pdf). As discussed above (Section G.3.3 Early Detection and Rapid Response), EDRR includes three strategy elements: 1) early detection, 2) rapid assessment, and 3) rapid response.

*1.) Early Detection*: This plan proposes implementation of routine surveillance in the project area in order to minimize the time between initial introduction and detection of a new species. Strategic surveillance by trained biologists in proximity to the CEPP project elements should greatly increase the probability of detection of new species. In many cases, existing programs could be expanded to include focused monitoring in the CEPP footprint. For example, the EIRAMMP is well suited for enhanced surveillance for numerous invasive animal species (see Section G.4 EXISTING MANAGEMENT PROGRAMS).

*2.) Rapid Assessment*: Following the detection of new invasions (or expansion of formerly contained invasions), it is important to gather and process available information to determine the potential risk and control options in the face of high uncertainty. Critical questions must be answered in a relatively short period of time. Example questions include:

- What is the spatial extent and abundance of the non-indigenous species?
- What is the likelihood that the species will impact native species, ecosystem function, operations infrastructure, or human health?
- What are the management options for containment or eradication?

Numerous tools are available to assist natural resource managers with the assessment phase of EDRR, though none of them is likely to be 100% accurate in assessing the risk of a species. This plan proposes utilization of the IFAS Assessment of Non-native plants in Florida's Natural Areas, the Florida Exotic Pest Plant Council's Invasive Species List, the FWC Non-native Animal Bioprofile protocol, and the ECISMA Rapid Response Plan for assessing the risks of non-indigenous species in the CEPP footprint. These assessments should be conducted with CEPP biologists, subject matter experts, and stakeholders.

*3.) Rapid Response:* This is the "risk management" component of EDRR. Once a species is determined to have a high probability of ecological impact and control options are available, rapid response strategies aimed at containment, and ultimately eradication, can be formulated and implemented. To be effective, rapid response programs must have built in procedural, financial and logistical capacity to respond quickly to newly established threats. Since it is not possible to accurately predict the number and severity of new invasions during the project, this plan proposes contingency funding for rapid response activities in the event new, high-priority species establish in the project area. During the pre-construction phase, protocols for implementing rapid response should be developed.

### G.6.2 Control

A combination of biological, physical, mechanical, and chemical control methods will be utilized to manage invasive species.

Biological control agents will be used to decrease the targeted invasive species competitive advantages over native species and to weaken the invading population by increasing leaf mortality, decreasing plant size, reducing flower and seed production, and/or limiting population expansion. Biological control agents will be acquired through the Melaleuca Eradication and Other Exotic Plants – Implement Biological Controls project which is a component of CERP. One element of this CERP component includes the implementation of biological control agents which involves mass rearing, field release, establishment and monitoring of approved biological controls in south Florida and the Everglades. The four main invasive plant species

targeted for control through this component include melaleuca, Australian pine, Brazilian pepper and Old World climbing fern.

It is anticipated that physical control methods will be limited. Prescribed burns will be conducted in order to promote native plant growth and should be planned, if possible, to target invasive species when they are most susceptible to fire. Hand pulling of melaleuca and other non-native plant species will occur when it is feasible. Weed/debris barriers will be placed at water control structures when it is required to minimize dispersal of floating vegetation. Physical control measures will be utilized for invasive animal control. Examples of these measures include trapping of feral hogs, controlled harvest/overfishing (nets, fishing tournaments specific to invasive fish species) and compliance with FWC Fishing Regulation release/movement of fish (no return to water/used as bait).

Mechanical control will be implemented to remove non-native plant species when the construction of project features requires such removal. Heavy equipment such as bulldozers, front-end loaders and trackhoes (with or without grinding heads) will be utilized to uproot, grind and/or clear and grub. It is expected this type of control method will be utilized during levee degrades, canal backfilling and during construction of new project features such as water control structures.

Chemical control will be utilized to treat aquatic and terrestrial invasive plants. Methods for treatment will include hack-n-squirt, basal bark, cut-stump, foliar and aerial application. EPA approved herbicides will be utilized to control invasive plants. Chemical control will be utilized to treat invasive plants in canals, along levees, in wetland/natural areas as well as WCA's, FEB's, etc.

### G.6.3 Monitoring

Monitoring of invasive species populations will be conducted through DASM, Unmanned Aircraft System (UAS) surveys, electrofishing and EIRAMMP. Invasive species will also be identified through monitoring for the Adaptive Management Plan. This information will be provided to invasive species managers to ensure appropriate management measures are implemented.

### G.6.4 Pre-construction Phase

Baseline conditions need to be established prior to the construction phase. Existing monitoring programs should be used as much as possible to establish baseline conditions prior to construction activities beginning. Although there are no system-wide monitoring programs for invasive species in the Everglades region, several individual agencies collect data. Data mining will be the primary resource to obtain baseline data, via collaboration with the individual agencies and the ECISMA. In areas with data gaps, surveys will need to be accomplished by the most cost-effective method (e.g. ground survey, Unmanned Aircraft Systems survey, DASM).

Existing monitoring and management programs should continue to be implemented. The existing programs help maintain invasive and nuisance species at a controlled level.

A significant length of time lapses from the time a project is planned to when it receives congressional authorization and appropriations, and ultimately goes to construction. As property (lands and structures) sit with no activity, vegetation and wildlife changes can occur. Unmanaged areas become inhabited by many species of flora and fauna, native and non-native. Older growth vegetation is more difficult and more costly to treat / remove versus lands that are managed along the way. As these lands become established with

invasive species, there is an increased risk of spreading the invasive species to neighboring lands. Therefore, it is beneficial, ecologically and economically, to manage the lands early on. Managing invasive vegetation throughout the interim phase reduces construction costs since mowing is much less costly than clearing/grubbing and treating, and rapid response of new infestations helps reduce spread into environmentally sensitive areas. Site 1 Impoundment is an excellent example. $2.9M is estimated to manage invasive species during construction and until turnover to the local sponsor. The property's prior use included plant nurseries and pasture. Once project lands were acquired by the sponsor, the land sat unused until the Site 1 project was ready to begin construction. By this time, the project lands became highly vegetated, primarily by invasive species. It would have been significantly less expensive to have maintained the lands until the time of construction versus waiting until construction started.

### G.6.5 Design and Construction Phases

The best method of controlling invasive and nuisance species is to prevent non-native species from being introduced and established to begin with. Incorporation of invasive species prevention and control into project designs, alternatives analysis, and operational plans has the potential to save significant resources during the long-term. The plans and specifications phase should simply design "with the end in mind." When the end goal is ecosystem restoration, the designers should periodically obtain input from invasive species experts to identify design features and operation strategies that could potentially favor the establishment and spread of invasive species. An example of design influences on invasive species is levee removal without backfill of canals. Without canal backfilling, deep water refuges for non-native fishes and invertebrates (from both seasonal cold temperatures and seasonal drying) are maintained, and barriers to dispersal from canal waters to marsh habitats are removed. Design alternatives should be explored that would allow seasonal cooling of water in the canals. Cooler water temperatures will reduce the refuge capacity for cold temperature sensitive non-native fishes. In some cases, such as the coastal canals, aquatic barrier technologies could be used to mitigate the spread of non-indigenous aquatic species.

Below are examples of cost-saving measures to consider during design and construction.

- Include invasive species management staff from the Corps, SFWMD, and other partner agencies throughout the design and construction phases.
- Work with subject matter experts to identify design features that may create habitat or entry points for invaders. Evaluate design alternatives to mitigate potential design vulnerabilities.
- Design to promote the establishment of native species.
- Use construction methods that minimize ground disturbance whenever possible.
- Contain mobilized nutrients resulting from soil disturbances.
- Require all construction contractors to follow vehicle and equipment decontamination protocols prior to deployment. Coordinate with invasive species specialists for decontamination protocol specifications.
- Evaluate cost/benefit ratios for treating invasive/nuisance species prior to construction activities. In some cases, pre-construction removal of a species may significantly reduce its spread.
- Implement a monitoring and rapid response protocol aimed at detecting and controlling new invasions early.
- Manage and control invasive/nuisance species during the entire construction phase.
- When native planting is specified in the plans, use plant material from regional sources that are weed and pathogen free.

Construction will be the responsibility of either the Corps or the SFWMD. This will be determined at a future time. Regardless of which agency will be responsible, both agencies commit to requiring the construction contractor to implement preventive measures and best management practices that will minimize the potential introduction and spread of invasive and nuisance species due to construction equipment (including personal protective equipment) and activities. This commitment is also included in the Project Implementation Report/Environmental Impact Assessment (Section 5.2.5 Environmental Commitments).

The Corps currently includes the following language in all of their specifications (Specification # 01 57 20 Environmental Protection, "Prevention of Invasive and Nuisance Species Transfer"):

> *The Contractor shall thoroughly clean equipment prior to and following work on the project site to ensure that items/materials including, but not limited to, soil, vegetative debris, eggs, mollusk larvae, seeds, and vegetative propagules are not transported from a previous work location to this project site, nor transported from this project site to another location. Prevention protocols require cleaning all equipment surfaces, including but not limited to, undercarriages, tires, and sheet metal. All equipment, including but not limited to, heavy equipment, vehicles, trailers, ATV's, and chippers must be cleaned. Smaller equipment, including, but not limited to, chainsaws, loppers, shovels, and backpack sprayers, must be cleaned and inspected to ensure they are free of eggs, vegetative debris, vegetative propagules, etc. The Contractor may utilize any method accepted by the Government; common accepted methods include pressure washing and steam cleaning/washing equipment. Prevention protocols should also address clothing and personal protective equipment.*
>
> *Prior to the commencement of work, the Contractor shall complete and provide an invasive and nuisance species transfer prevention plan to the Corps for approval. This plan shall be part of the Environmental Protection Plan as defined in subparagraph "Environmental Protection Plan" of paragraph SUBMITTALS (Part 1.5) above. The invasive and nuisance species transfer prevention plan shall identify specific transfer prevention procedures and designated cleaning sites/locations. Prevention protocols may vary depending upon the nature of the project site. It will be the responsibility of the Contractor to ensure all equipment coming onto and leaving the project site is inspected and not harboring materials that would spread, or potentially spread, invasive and nuisance species onto or off the project site. The Contractor shall provide a report verifying equipment brought on site was cleaned and shall provide a report verifying equipment was cleaned prior to removal from the project site.*

### G.6.6 Operational Testing and Monitoring Period

The operational testing and monitoring period is the timeframe from the end of construction until the project is transferred and accepted by the local sponsor. EDRR is very critical and the most cost-effective management measure during this period. Disturbed areas, such as areas impacted from construction activities, are prone to the establishment of invasive and nuisance species. Early detection of invasive and nuisance species and immediate treatment/control measures prevent these species from establishing and becoming long-term problems, ecologically and economically.

### G.6.7 OMRR&R Phase

"Prevention of Invasive and Nuisance Species Transfer" language applies not only to the construction phase, but also to the OMRR&R phase. The preventive measure applies to contractors and government employees. Maintenance equipment and rental equipment are often used at multiple locations. As equipment is moved

from one location to another, this potential spread vector can easily be reduced / prevented simply by ensuring the equipment is clean prior to arrival on site and prior to leaving the site.

In addition, numerous operational aspects of the restoration can influence mechanisms of invasion. For example, many non-indigenous species become more invasive in environments with elevated nutrient availability. With large pulses of only slightly elevated phosphorus levels, some invasive plant species could establish and spread.

### G.6.8 Specific Control by Project Feature – Construction Phase

#### G.6.8.1 Lake Okeechobee and the Northern Estuaries

Several agencies manage vegetation on Lake Okeechobee and associated water bodies. It is recommended the agencies continue to aggressively treat priority species to achieve maintenance control in order to minimize spread of those species to other areas.

#### G.6.8.2 A-2 Flow Equalization Basin

During the construction phase, thorough surveys should be conducted to identify and treat high priority species, which could proliferate after construction phase and impact FEB operations. Depending on design of the FEB, it may or may not be necessary to treat Brazilian pepper or other priority species along the agricultural ditches. If the ditches are filled with existing spoil then Brazilian pepper and other species would be removed by the scraping of material to fill the ditches. If the spoil is not used to fill the ditches then treatment or removal of Brazilian pepper other species should be completed. Management options include aerial herbicide application and mechanical removal via heavy equipment. The levee should be maintained throughout the construction phase to prevent invasion of plant species such as cogongrass. The spreader canal may require maintenance of emergent or other species during the construction phase.

#### G.6.8.3 Diversion of L-6 Flows and L-5 Improvements

Surveys of the L-5 canal should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. New growth of priority plant species on spoil areas should be treated throughout the construction phase. Woody vegetation should not be piled/disposed of on spoil areas because it could create habitat for certain invasive animal species such as the Burmese python. Electrofishing should be conducted prior to construction to determine the baseline of non-native fish species. Periodic electrofishing should be conducted throughout the construction phase to identify high priority non-native invasive fish species. Coordination with other agencies should be conducted to determine the appropriate measures to be implemented to address the high priority non-native invasive fish species.

#### G.6.8.4 L-4 / L-5 – Spreader Canal and Levee Degradation

Baseline levels of plants should be established prior to construction in L-4 and L-5. Surveys of the L-5 canal and levee should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Periodic surveys of the spreader canal, the marsh immediately downstream of the spreader canal, degraded areas and remnant levee portions should be conducted throughout the construction phase to identify growth of priority species. Priority plant species in these areas should be treated.

### G.6.8.5 Miami Canal Backfill – S-8 to I-75

Baseline levels of plants in the Miami Canal should be established prior to construction. Surveys of Miami Canal and the levee should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Periodic surveys of the backfill/degraded areas, remnant levee portions, and constructed tree islands should be conducted throughout the construction phase to identify growth of priority species. Priority plant species in these areas should be treated. It is recommended the adjacent areas within 0.5 mile of the canal and levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper. Diligent monitoring and prompt control of invasive species on constructed tree islands should be a priority during the construction phase as these disturbed soils are very likely to be colonized by invasive plant and animal species.

### G.6.8.6 L-28 Levee Degradation / Backfill

Baseline levels of plants in L-28 should be established prior to construction. Surveys of the L-28 levee should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Periodic surveys of the backfill/degraded areas and remnant levee portions should be conducted throughout the construction phase to identify growth of priority species. Priority plant species in these areas should be treated. It is recommended the adjacent areas within 0.5 mile of the levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper.

### G.6.8.7 Increase Capacity of S-333

Monitoring during de-watering operations or other construction activities should occur in order to identify and potentially remove priority fish and other non-native animal species. Priority species present near the water control structure that could be spread by construction equipment and associated construction activities should be treated or removed.

### G.6.8.8 L-67A Gated Structures / Spoil Removal

Surveys of the L-67A levee and canal should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Periodic surveys of the degraded areas, the remnant levee portions, spoil islands and the areas adjacent to the structures should be conducted throughout the construction phase to identify growth of priority species. Priority plant species in these areas should be treated. It is recommended the adjacent areas within 0.5 mile of the levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper.

### G.6.8.9 L-67C Levee Degradation

Baseline levels of plants in L-67C should be established prior to construction. Surveys of the L-67C levee should be completed prior to construction to identify priority species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Periodic surveys of the degraded areas, remnant levee portions, spoil islands, the spreader canal and the area adjacent to the

spreader canal should be conducted throughout the construction phase to identify growth of priority species. Priority plant species in these areas should be treated. It is recommended the adjacent areas within 0.5 mile of the levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper. Monitoring throughout the construction phase adjacent to the spreader canal and north and south of the new structures should be conducted in order to identify and treat cattail expansion or other priority species.

#### G.6.8.10 Build North-South Levee in WCA 3B

During the construction phase, the area impacted by construction should be monitored to identify priority species. In addition, as portions of the levee are completed periodic surveys should be conducted to identify priority species. Such species should be treated throughout the construction phase.

#### G.6.8.11 L-67 Extension – Levee Degradation / Backfill

Enhance existing monitoring and removal efforts (EIRAMMP) targeting non-native invasive animals such as the Burmese python prior to beginning levee degradation and canal backfill construction activities. Multiple monitoring and removal efforts should be conducted in order to minimize dispersal of non-native animals due to construction. Surveys of the L-67 Extension levee and canal should be completed prior to construction to identify priority plant species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Remaining spoil, levee remnants, degraded and backfill areas should be surveyed during construction and priority species should be treated and/or removed.

#### G.6.8.12 L-29 Levee Degradation

Surveys of the L-29 levee and canal should be completed prior to construction to identify priority plant species that may be spread (e.g. rotala) by construction activities. Such species should be treated prior to the beginning of construction. Remaining levee remnants, degraded areas and the canal should be surveyed during construction and priority species should be treated and/or removed. Periodic electrofishing should be conducted throughout the construction phase to identify and remove high priority non-native invasive fish species. The area adjacent to the L-29 canal should be monitored for encroachment of cattail and other non-native obligate wetland species. Priority species should be treated. Monitoring for invasive species of apple snail should be conducted and control measures should be implemented if effective control measures are identified.

#### G.6.8.13 Divide Structure on L-29

A survey of the installation area should be completed prior to construction to identify priority plant species that may be spread (e.g. rotala) by construction activities. These species should be treated prior to beginning construction activities. Monitoring and treatment of submersed and floating plant species that could impact construction should occur throughout the construction phase.

#### G.6.8.14 Increase S-356 Capacity to 1,000 cfs

A survey of the area surrounding S-356 should be completed prior to construction to identify priority plant species that may be spread (e.g. rotala) by construction activities. These species should be treated prior to

beginning construction activities. Monitoring and treatment of submersed and floating plant species that could impact construction should occur throughout the construction phase.

#### G.6.8.15 Remove ~6 Miles of Old Tamiami Trail Roadway from L-67 Extension to Tram Road

Enhance existing monitoring and removal efforts (EIRAMMP) targeting non-native invasive animals such as the Burmese python prior to beginning roadway degradation construction activities. Multiple monitoring and removal efforts should be completed in order to minimize dispersal of non-native animals due to construction. Surveys of the Old Tamiami Trail should be conducted prior to construction to identify priority plant species that may be spread by construction activities. Such species should be treated prior to the beginning of construction. Remaining spoil, roadway remnants and degraded areas should be surveyed during construction and priority species should be treated and/or removed. Monitoring for invasive species of apple snail should be conducted and control measures should be implemented if effective control measures are identified.

#### G.6.8.16 G-211 Operational Modifications / Coastal Canals Conveyance

Monitor and treat submersed and floating plant species that could impact the structure throughout the construction phase.

#### G.6.8.17 Seepage Barrier

A survey of the installation area should be completed prior to construction to identify priority plant species that may be spread by construction activities. These species should be treated prior to beginning construction activities. Monitoring and treatment of priority plant species within the construction footprint should be conducted throughout the construction phase.

### G.6.9 Specific Control by Project Feature – OMRR&R Phase

#### G.6.9.1 A-2 Flow Equalization Basin

Vegetation within the FEB will be difficult to manage due to high nutrient loading from surface water inflows. Similar conditions are experienced in the storm water treatment areas (STA), and maintenance control of many invasive plant species have proven difficult and not cost-effective. In addition, most of these species have not spread downstream of the STAs into the WCA. Vegetation management within the FEB should focus on maintaining FEB functionality. Vegetation should be controlled to ensure adequate surface water conveyance and minimal impact to infrastructure (e.g., levee instability, floating tussocks). However, any invasive species capable of establishing in the FEB and spreading to natural areas should be a priority for control. Chemical treatments of floating and submersed vegetation should be performed upstream and downstream of water control structures. Occasional mechanical removal of tussocks or uprooted submersed species may be required in order to maintain operations and the function of the FEB. It is recommended to utilize best management practices such as strategic management of vegetation in strips immediately in front of water control structures to prevent floating vegetation and mats from blocking the structures. This has been demonstrated to be an effective management practice in STA's and reduces the cost of operations and maintenance. Levee vegetation should be maintained throughout the OMRR&R phase, with an emphasis on minimizing the spread of invasive plants capable of spreading to natural areas (e.g., cogongrass). The spreader canal will require maintenance of floating, emergent and submersed plant species in order to maintain the function of the canal.

#### G.6.9.2 Diversion of L-6 Flows and L-5 Improvements

Monitoring of the L-5 canal should be conducted on a regular basis to identify invasions of priority species. Such species should be treated based on their priority level (i.e. maintenance control or EDRR). Priority species of vegetation on spoil areas should be treated throughout the construction phase. Periodic electrofishing should be conducted to identify high priority non-native invasive fish species. Coordination with other agencies should be conducted to determine the appropriate measures to be implemented to address the high priority non-native invasive fish species.

#### G.6.9.3 L-4 / L-5 – Spreader Canal and Levee Degradation

This feature will require periodic surveys of the spreader canal, the marsh immediately downstream of the spreader canal, degraded areas and remnant levee portions throughout the OMRR&R phase. The detection of priority invasive plant animal species should trigger prompt control efforts. Regular mowing of any "dead end" levees is recommended to limit the establishment of invasive plant and animal species on the artificially high ground.

#### G.6.9.4 Miami Canal Backfill – S-8 to I-75

Periodic surveys of the backfill/degraded areas, remnant levee portions and tree islands should be conducted throughout the OMRR&R phase to identify growth of priority species. Priority plant species in these areas should be treated. It is recommended the adjacent areas within 0.5 mile of the canal and levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper.

#### G.6.9.5 L-28 Levee Degradation / Backfill

Periodic surveys of the backfill/degraded areas and remnant levee portions should be conducted during the OMRR&R phase to identify growth of priority species. Such species should be treated. It is recommended the adjacent areas within 0.5 mile of the levee be systematically surveyed and treated to eliminate close proximity seed sources. This would assist in preventing spread of priority species such as Brazilian pepper.

#### G.6.9.6 Increase Capacity of S-333

Monitoring during de-watering operations or other maintenance activities should occur in order to identify and potentially remove priority fish and other non-native animal species. Priority species present near the water control structure that could be spread by construction equipment and associated activities should be treated or removed.

#### G.6.9.7 L-67A Gated Structures / Spoil Removal

Periodic surveys of the degraded areas, the remnant levee portions, spoil islands and the areas adjacent to the structures should be conducted throughout the OMRR&R phase to identify growth of priority species. Priority plant species in these areas should be treated. The remnant levee portions and spoil islands should be monitored for new colonization of invasive animal species; priority species should be removed.

#### G.6.9.8 Build North-South Levee in WCA 3B

The area impacted by construction and the levee should be monitored throughout the OMRR&R phase to identify growth of priority species. Priority species should be treated or removed. Cattail growth and expansion is expected along the toe of the levee and should be target for control.

#### G.6.9.9 L-67 Extension – Levee Degradation / Backfill

Conduct periodic monitoring and removal efforts (EIRAMMP) targeting non-native invasive animals such as the Burmese python on remnant levee portions during the OMRR&R phase. Monitor remaining spoil, levee remnants, degraded and backfill areas for priority species. Priority species should be treated and/or removed.

#### G.6.9.10 L-29 Levee Degradation

Remaining levee remnants, degraded areas and the canal should be surveyed during the OMRR&R phase and priority species should be treated and/or removed. Periodic electrofishing should be conducted to identify high priority non-native invasive fish species. Coordination with other agencies should be conducted to determine the appropriate measures to be implemented to address the high priority non-native invasive fish species. The area adjacent to the L-29 canal should be monitored for encroachment of cattail and other non-native obligate wetland species. Priority species should be treated. Monitoring for invasive species of apple snail should be conducted and control measures should be implemented if effective control measures are identified.

#### G.6.9.11 Divide Structure on L-29

Monitoring and treatment of submersed and floating plant species that could impact the structure should occur throughout the OMRR&R phase.

#### G.6.9.12 Increase S-356 Capacity to 1,000 cfs

Monitoring and treatment of submersed and floating plant species that could impact the structure should occur throughout the OMRR&R phase.

#### G.6.9.13 Remove ~6 Miles of Old Tamiami Trail Roadway from L-67 Extension to Tram Road

Perform monitoring and removal efforts (EIRAMMP) targeting non-native invasive animals such as the Burmese python throughout the OMRR&R phase. Remaining spoil, roadway remnants and degraded areas should be monitored during the OMRR&R phase and priority species should be treated and/or removed. Monitoring for invasive species of apple snail should be conducted and control measures should be implemented if effective control measures are identified.

#### G.6.9.14 G-211 Operational Modifications / Coastal Canals Conveyance

Monitor and treat submersed and floating plant species that could impact the structure throughout the OMRR&R phase.

#### G.6.9.15 Seepage Barrier

Monitoring and treatment of priority plant species within the project footprint should be conducted throughout the OMRR&R phase in order to maintain the integrity of the seepage barrier.

## G.7 EDUCATION / OUTREACH

### G.7.1 Education / Outreach Opportunities at Recreational Areas

Recreational opportunities will be created by the Central Everglades Planning Project. Recreation areas such as boat ramps, hiking trails, and hunting areas can serve as vectors and pathways for aquatic and terrestrial invasive species. For example, invasive species can be transferred from one area to another by hikers and by boats/trailers. Many recreational users are unaware of their role in the spread of unwanted species. Hence, educating the public on preventing the spread of invasive species can be a cost effective component of the overall management strategy. The recreation access points can be used to display educational information on invasive species identification, prevention/control measures, and awareness of the invasive species programs in the area, and how individuals can contribute to invasive species prevention. Educational kiosks are recommended and should include information on:

- Specific priority invasive species in the area
- Impacts and costs of invasive species on conservation, human health, and recreation
- Preventative measures, such as removing vegetation from boats/trailers before leaving the boat ramp or removing vegetation from shoes and clothing before leaving the area.
- Ways to report invasive species observations
- Programs that citizens can get involved with and learn more about invasive species
- Laws against the release of non-native wildlife

## G.8 COSTS

A summary of costs are below in Table G-1: Invasive and Nuisance Species Management Costs. Detailed costs can be found in Tables G-5 and G-6 (Table G-5: Invasive and Nuisance Species Management Costs – Construction Phase and Table G-6: Invasive and Nuisance Species Management Costs – OMRR&R Phase). It was assumed that in the field baselines and potential invasive species treatments and management would need to occur starting about 2 years prior to the actual construction start date. Costs were estimated for the life of the project, assuming a 50-year life. However, due to size, the OMRR&R table only shows years 1 through 3.

**TABLE G-1: INVASIVE AND NUISANCE SPECIES MANAGEMENT COSTS**

| **Invasive and Nuisance Species Management** | |
|---|---|
| 2 Years Pre-Construction | $4,946 |
| 1 Year Pre-Construction | $719,216 |
| Construction Phase | $4,012,555 |
| Operational Testing & Monitoring Phase | $3,104,255 |
| 1 Year OMRR&R Phase | $3,053,740 |
| 50-Year OMRR&R Phase (Includes Year 1) | $190,695,832 |
| **Total Management Cost** | **$198,536,804** |
| **Invasive and Nuisance Species Management Monitoring** | |
| 2 Years Pre-Construction | $124,800 |
| 1 Year Pre-Construction | $0 |
| Construction Phase | $0 |
| Operational Testing & Monitoring Phase | $356,626 |
| 1 Year OMRR&R Phase | $356,626 |
| 10-Year OMRR&R Phase (Includes Year 1) | $3,731,096 |
| **Total Monitoring Cost** | **$4,212,522** |

**TABLE G-2: PRIORITY SPECIES / AREAS FOR EARLY DETECTION AND RAPID RESPONSE**

| Species | Natural Area Threat | Structural / Operational Threat |
|---|---|---|
| ***Plants*** | | |
| Australian pine (*Casuarina spp*.) | X | X |
| bishopwood (*Bischofia javanica*) | X | |
| Brazilian pepper (*Schinus terebinthifolius*) | X | X |
| Burma reed (*Neyraudia reynaudiana*) | X | |
| climbing cassia (*Senna pendula*) | X | X |
| cogongrass (*Imperata cylindrica*) | X (uplands only) | X |
| floating heart (*Nymphoides cristata*) | X | X |
| melaleuca (*Melaleuca quinquenervia*) | X | |
| napier grass (*Pennisetum purpureum*) | X (disturbed soils) | X |
| Old Word climbing fern (*Lygodium microphyllum*) | X | |
| para grass (*Urochloa mutica*) | X | X |
| roundleaf toothcup (*Rotala rotundifolia*) | X | X |
| schefflera (*Schefflera actinophylla*) | X | |
| shoebutton Ardisia (*Ardisia elliptica*) | X | |
| torpedograss (*Panicum repens*) | X | X |
| tropical American watergrass (*Luziola subintegra*) | X | X |
| West Indian marsh grass (*Hymenachne amplexicaulis*) | X | |
| wetland nightshade (*Solanum tampicense*) | X | |
| Wright's nut-rush (*Scleria lacustris*) | X | |
| ***Invertebrates*** | | |
| ambrosia beetle (*Xyleborus glabratus*) | X | |
| island apple snail (*Pomacea insularum*) | X | |
| ***Amphibians*** | | |
| Cuban treefrog (*Osteopilus septentrionalis*) | X | |
| ***Reptiles*** | | |
| Argentine black and white tegu (*Tupinambis merianae*) | X | |
| Burmese python (*Python molurus bivittatus*) | X | |
| green iguana (*Iguana iguana*) | | X |
| Nile monitor (*Varanus niloticus*) | X | |
| ***Fish*** | | |
| asian swamp eel (*Monopterus albus*) | X | |
| brown hoplo (*Hoplosternum littorale*) | X | |
| bullseye snakehead (*Channa marulius*) | X | |
| sailfin catfish (*Pterygoplichthys disjunctivus*) | X | X |
| ***Mammals*** | | |
| feral hog (*Sus scrofa*) | X | X |
| Gambian pouched rat (*Cricetomys gambianus*) | X | |

**TABLE G-3: INVASIVE PLANT SPECIES DOCUMENTED IN THE PROJECT AREA**

| Invasive Plant Species | | Region Documented In | | | | FLEPPC Category | Florida Noxious Weed List |
|---|---|---|---|---|---|---|---|
| **Common Name** | ***Scientific Name*** | **LO** | **NE** | **EAA** | **GE** | | |
| rosarypea | *Abrus precatorius* | x | x | x | x | I | |
| Florida Keys Indian mallow | *Abutilon hirtum* | | | | x | | |
| velvetleaf | *Abutilon theophrasti* | | x | x | x | | |
| earleaf acacia | *Acacia auriculiformis* | x | x | x | x | I | |
| bee wattle | *Acacia sphaerocephala* | | | | x | | |
| foxtail copperleaf | *Acalypha alopecuroidea* | | | | x | | |
| sisal | *Agave sisalana* | x | x | x | x | II | |
| mimosa | *Albizia julibrissin* | x | x | x | x | I | |
| woman's tongue tree | *Albizia lebbeck* | x | x | x | x | I | |
| golden trumpet | *Allamanda cathartica* | x | x | x | x | | |
| alligatorweed | *Alternanthera philoxeroides* | x | x | x | x | II | |
| sessile joyweed | *Alternanthera sessilis* | x | x | | x | | x |
| common ragweed | *Ambrosia artemisiifolia* | x | x | x | x | | |
| coral vine | *Antigonon leptopus* | x | x | x | x | II | |
| coral ardisia | *Ardisia crenata* | x | x | x | x | I | |
| shoebutton ardisia | *Ardisia elliptica* | x | x | x | x | I | x |
| Sprenger's asparagus fern | *Asparagus aethiopicus* | x | x | x | x | I | |
| Chinese violet, ganges primrose | *Asystasia gangetica* | x | x | x | x | II | |
| mountain ebony | *Bauhinia variegata* | x | x | x | x | I | |
| hairy beggarticks | *Bidens pilosa* | x | x | x | x | | |
| Javanese bishopwood | *Bischofia javanica* | x | x | x | x | I | |
| Browne's blechum, green shrimp plant | *Blechum pyramidatum* | x | x | x | x | II | |
| bottlebrush | *Callistemon viminalis* | x | x | x | x | II | |
| Alexandrian laurel | *Calophyllum inophyllum* | | | | x | I | |
| Brazilian jackbean | *Canavalia brasiliensis* | | | | x | | |
| river sheoak | *Casuarina cunninghamiana* | x | x | x | x | II | |
| Australian-pine | *Casuarina equisetifolia* | x | x | x | x | I | |
| gray sheoak | *Casuarina glauca* | x | x | x | x | I | x |
| Madagascar periwinkle | *Catharanthus roseus* | x | x | x | x | | |
| day jessamine | *Cestrum diurnum* | x | x | x | x | II | |
| camphortree | *Cinnamomum camphora* | x | x | x | x | I | |
| turk's turbin | *Clerodendrum indicum* | x | x | x | x | | |

| Invasive Plant Species | | Region Documented In | | | | FLEPPC Category | Florida Noxious Weed List |
|---|---|---|---|---|---|---|---|
| **Common Name** | ***Scientific Name*** | **LO** | **NE** | **EAA** | **GE** | | |
| coco yam, wild taro | *Colocasia esculenta* | x | x | x | x | I | |
| Asian nakedwood | *Colubrina asiatica* | x | x | x | x | I | x |
| Benghal dayflower | *Commelina benghalensis* | | x | | | | x |
| smooth crotalaria | *Crotalaria pallida* | x | x | x | x | | |
| showy rattlebox | *Crotalaria spectabilis* | x | x | x | x | | |
| carrotwood | *Cupaniopsis anacardioides* | x | x | x | x | I | x |
| tarweed cuphea | *Cuphea carthagenensis* | x | x | x | x | | |
| umbrella plant | *Cyperus involucratus* | x | x | x | x | II | |
| miniature flatsedge, dwarf papyrus | *Cyperus prolifer* | x | x | x | x | II | |
| crowfootgrass | *Dactyloctenium aegyptium* | x | x | x | x | II | |
| Indian rosewood | *Dalbergia sissoo* | x | x | x | x | II | |
| pangolagrass | *Digitaria eriantha* | x | x | x | x | | |
| violet crabgrass | *Digitaria violascens* | x | x | x | x | | |
| winged yam | *Dioscorea alata* | x | x | x | x | I | |
| air-potato | *Dioscorea bulbifera* | x | x | x | x | I | x |
| waterhyacinth | *Eichhornia crassipes* | x | x | x | x | I | |
| goosegrass | *Eleusine indica* | x | x | x | x | | |
| Cupid's-shaving-brush | *Emilia fosbergii* | x | x | x | x | | |
| centipede tongavine | *Epipremnum pinnatum* | x | x | x | x | II | |
| Surinam cherry | *Eugenia uniflora* | x | x | x | x | I | |
| Chinese banyan | *Ficus microcarpa* | x | x | x | x | I | |
| limpograss | *Hemarthria altissima* | x | x | x | x | II | |
| hydrilla | *Hydrilla verticillata* | x | x | x | x | I | |
| miramar weed, green hygro, Indian swampweed | *Hygrophila polysperma* | x | x | | x | I | |
| West Indian marsh grass | *Hymenachne amplexicaulis* | x | x | x | x | I | |
| jaraguagrass | *Hyparrhenia rufa* | x | x | | x | II | |
| Brazilian satintail | *Imperata brasiliensis* | x | x | x | x | | |
| cogongrass | *Imperata cylindrica* | x | x | x | x | I | x |
| hairy indigo | *Indigofera hirsuta* | x | x | x | x | | |
| swamp morning glory | *Ipomoea aquatica* | x | x | x | x | I | |
| ivyleaf morning glory | *Ipomoea hederacea* | | x | | x | | |
| threelobe morning glory | *Ipomoea triloba* | x | x | x | x | | x |
| Gold Coast jasmine | *Jasminum dichotomum* | x | x | x | x | I | |
| jazmin de trapo | *Jasminum fluminense* | x | x | x | x | I | |

| Invasive and Nuisance Species Management - Construction Phase | | | | | |
|---|---|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Pre-Construction 2 Years** | **Pre-Construction 1 Year** | **Construction** | **Operational Testing & Monitoring Phase** |
| *Construction Period -3 years* | Plants | | | | |
| | Plant Control/Treatment | | $5,336 | $23,920 | $47,840 |
| | EDRR Surveillance and Removal Animals | $1,200 | $1,200 | $1,800 | $2,400 |
| | Coordination/Inspection /Contract Implementation | $300 | $2,794 | $13,390 | $17,200 |
| | | | | | |
| **G-211 Modifications** *Construction Period -1 year* | EDRR Surveillance - Plants | | $928 | $1,856 | $3,712 |
| | Plant Control/Treatment | | $575 | $1,150 | $2,300 |
| | Coordination/Inspection /Contract Implementation | | $376 | $752 | $1,503 |
| | | | | | |
| **Seepage Barrier** *Construction Period -1 year* | EDRR Surveillance - Plants | | $928 | $1,856 | $3,712 |
| | Plant Control/Treatment | | $575 | $1,150 | $2,300 |
| | Coordination/Inspection /Contract Implementation | | $376 | $752 | $1,503 |
| | | | | | |
| **Everglades National Park** | EDRR Surveillance - Plants | | $4,640 | $55,680 | $18,560 |
| | Plant Control/Treatment | | | $30,139 | $24,111 |
| | Coordination/Inspection /Contract Implementation | | $1,160 | $21,455 | $10,668 |
| | | **$4,122** | **$599,346** | **$3,343,796** | **$2,586,880** |
| **Other Cost** | | $824 | $119,869 | $668,759 | $517,375 |
| | Management Activities Oversight<br>Revise/Update INSMP<br>Development of EDRR Framework<br>Budget, Contract, Administrative Support<br>Assessment of Species | | | | |
| | **Total** | **$4,946** | **$719,216** | **$4,012,555** | **$3,104,255** |

| Invasive and Nuisance Species Management - Construction Phase | | | | | |
|---|---|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Pre-Construction 2 Years** | **Pre-Construction 1 Year** | **Construction** | **Operational Testing & Monitoring Phase** |
| | **Total Cost Estimate** | **$7,840,973** | | | |

**TABLE G-6: INVASIVE AND NUISANCE SPECIES MANAGEMENT COSTS – OMRR&R PHASE**

| Invasive and Nuisance Species Management - OMRR&R Phase | | | |
|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Year 1 OMRR&R** | **50-Year OMRR&R** |
| **A-2 FEB** | EDRR Surveillance - Plants | $18,560 | $1,196,437 |
| | Plant Control/Treatment - Floating/Emergent | $125,580 | $8,095,286 |
| | Plant Control/Treatment - Submersed | $14,375 | $926,658 |
| | EDRR Surveillance/Removal Animals | $58,325 | $3,759,815 |
| | Coordination/Inspections/Contract Implementation | $43,368 | $2,795,639 |
| | | | |
| **L-5** | EDRR Surveillance - Plants | $7,424 | $478,575 |
| | Plant Control/Treatment (14a) | $8,372 | $539,686 |
| | EDRR Surveillance/Removal Animals | $1,200 | $77,356 |
| | Electrofishing | $24,000 | $1,547,116 |
| | Coordination/Inspections/Contract Implementation | $8,199 | $528,547 |
| | | | |
| **L-6** | EDRR Surveillance - Plants | $7,424 | $478,575 |
| | Plant Control/Treatment | $9,568 | $616,784 |
| | Coordination/Inspections/Contract Implementation | $3,398 | $219,072 |
| | | | |
| **L-4 Levee Degrade** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment (28a) | $9,660 | $622,714 |
| | EDRR Surveillance/Removal Animals | $290 | $18,694 |
| | Electrofishing | $9,600 | $618,847 |
| | Coordination/Inspections/Contract Implementation | $4,652 | $299,909 |
| | | | |
| **Divide Structure on L-4** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $575 | $37,066 |
| | Coordination/Inspections/Contract Implementation | $857 | $55,271 |
| | | | |
| **WCA-3A** | EDRR Surveillance - Plants | $55,680 | $3,589,310 |
| | Plant Control/Treatment | $179,400 | $11,564,695 |
| | Electrofishing | $32,000 | $2,062,822 |
| | Coordination/Inspections/Contract Implementation | $53,416 | $3,443,365 |
| | | | |
| **Miami Canal Backfill** | EDRR Surveillance - Plants | $11,136 | $717,862 |
| | Plant Control/Treatment (165a) | $28,463 | $1,834,783 |

| Invasive and Nuisance Species Management - OMRR&R Phase | | | |
|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Year 1 OMRR&R** | **50-Year OMRR&R** |
| | EDRR Surveillance/Removal Animals | $14,000 | $902,485 |
| | EDRR Surveillance/Removal Animals | $1,350 | $87,025 |
| | Electrofishing | $21,600 | $1,392,405 |
| | Coordination/Inspections/Contract Implementation | $15,310 | $986,912 |
| | | | |
| **Increase S-333 Capacity** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $2,300 | $148,265 |
| | Coordination/Inspections/Contract Implementation | $1,202 | $77,511 |
| | | | |
| **L-67A 2 gated structures** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $2,300 | $148,265 |
| | Coordination/Inspections/Contract Implementation | $1,202 | $77,511 |
| | | | |
| **L-67A - Spoil Removal** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $12,512 | $806,563 |
| | Coordination/Inspections/Contract Implementation | $3,245 | $209,170 |
| | | | |
| **L-67C Levee Degrade** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $10,157 | $654,740 |
| | Coordination/Inspections/Contract Implementation | $2,774 | $178,805 |
| | | | |
| **Gated Structure N/Blue Shanty Levee** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $2,300 | $148,265 |
| | Coordination/Inspections/Contract Implementation | $1,202 | $77,511 |
| | | | |
| **L-67C Levee Degrade** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment (97a) | $2,677 | $172,581 |
| | Coordination/Inspections/Contract Implementation | $1,278 | $82,374 |
| | | | |
| **N/S Levee** WCA-3B | EDRR Surveillance - Plants | $27,840 | $1,794,655 |
| | Plant Control/Treatment | $862,077 | $55,572,214 |
| | Coordination/Inspections/Contract Implementation | $177,983 | $11,473,374 |

| Invasive and Nuisance Species Management - OMRR&R Phase | | | |
|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Year 1 OMRR&R** | **50-Year OMRR&R** |
| | | | |
| **L-67 Extension Levee Degrade / Backfill** | EDRR Surveillance - Plants | $7,424 | $478,575 |
| | Plant Control/Treatment | $31,050 | $2,001,582 |
| | EDRR Surveillance/Removal Animals | $550 | $35,455 |
| | Coordination/Inspections/Contract Implementation | $7,805 | $503,122 |
| | | | |
| **L-29 Levee** | EDRR Surveillance - Plants | $7,424 | $478,575 |
| | Plant Control/Treatment | $19,320 | $1,245,429 |
| | Plant Control/Treatment - Submersed | $8,625 | $555,995 |
| | EDRR Surveillance/Removal Animals | $430 | $27,719 |
| | Electrofishing | $32,000 | $2,062,822 |
| | Coordination/Inspections/Contract Implementation | $13,560 | $874,108 |
| | | | |
| **L-29 Divide Structure** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $1,150 | $74,133 |
| | Coordination/Inspections/Contract implementation | $972 | $62,684 |
| | | | |
| **Increase Capacity S-356** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $1,150 | $74,133 |
| | Coordination/Inspections/Contract Implementation | $972 | $62,684 |
| | | | |
| **Old Tamiami Trail** | EDRR Surveillance - Plants | $9,280 | $598,218 |
| | Plant Control/Treatment | $47,840 | $3,083,919 |
| | EDRR Surveillance/Removal Animals | $1,200 | $77,356 |
| | Coordination/Inspections/Contract Implementation | $11,664 | $751,899 |
| | | | |
| **G-211 Modifications** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $1,150 | $74,133 |
| | Coordination/Inspections/Contract Implementation | $972 | $62,684 |
| | | | |
| **Seepage Barrier** | EDRR Surveillance - Plants | $3,712 | $239,287 |
| | Plant Control/Treatment | $1,150 | $74,133 |
| | Coordination/Inspections/Contract Implementation | $972 | $62,684 |
| | | | |

| Invasive and Nuisance Species Management - OMRR&R Phase | | | |
|---|---|---|---|
| **Feature / Area** | **Management Activity** | **Year 1 OMRR&R** | **50-Year OMRR&R** |
| **Everglades National Park** | EDRR Surveillance - Plants | $18,560 | $1,196,436 |
| | Plant Control/Treatment | $24,111 | $1,554,295 |
| | Coordination/Inspections/Contract Implementation | $8,534 | $550,146 |
| | | $2,181,243 | $140,609,877 |
| **Other Costs** | | | |
| | Oversight of Management Activities<br>Revise/Update INSMP<br>Budget, Contract, Administrative support<br>Assessment of Species<br>Coordination with other agencies/EDRR response | | |
| | Total Other Cost | $872,497 | $49,213,457 |
| | **Total Cost Estimate** | **$3,053,740** | **$190,695,832** |

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