National Park Service | U.S. Department of the Interior
South Florida Natural Resources Center

Everglades National Park

2024 STATE OF CONSERVATION

Report to the World Heritage Committee

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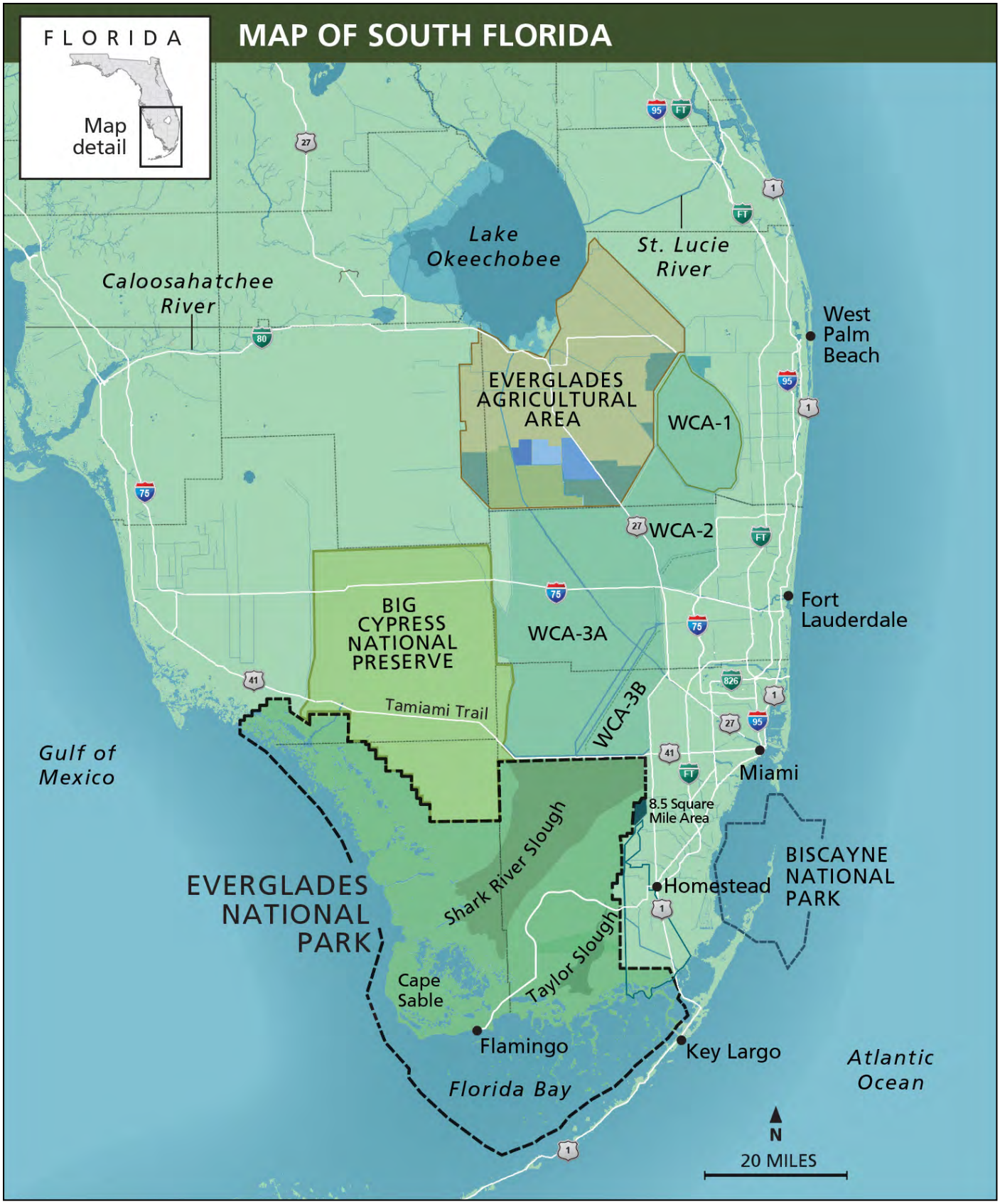
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20 MILES

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Sunset over mangrove islands | *NPS Photo by D. Blankenship*

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Looking down the beach at Cape Sable | *NPS Photo by D. Diaz*

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QUESTIONS AND ANSWERS

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Graphic design provided by RED, Inc.

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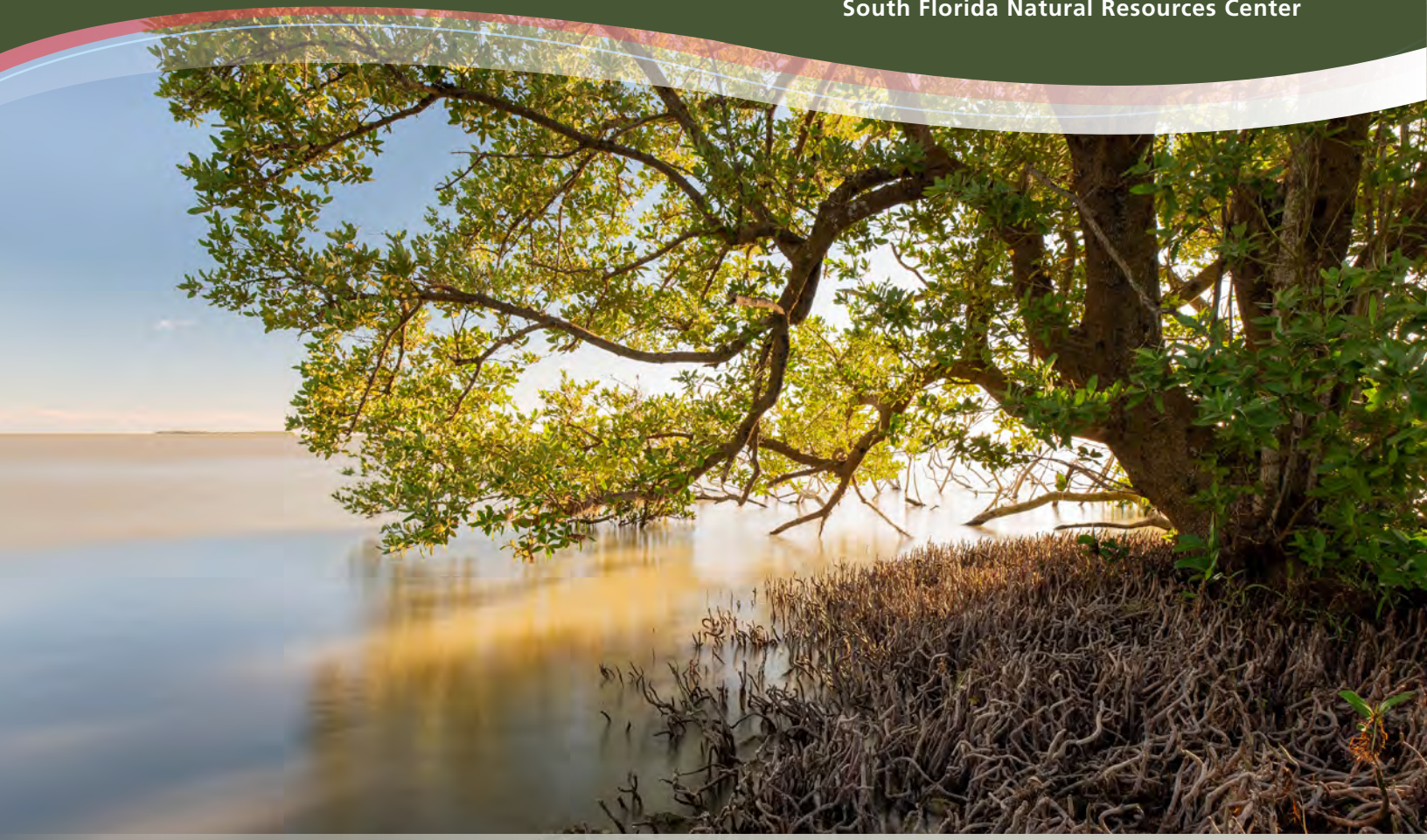
Cover photos:

Front: **Flamingos** | *NPS Photo by P. Zarba*

Back: **Pine rocklands sunset** | *NPS Photo by F. Acevedo*

List of Abbreviations

8.5 SMA	8.5 Square Mile Area
BBSEER	Biscayne Bay and Southeastern Everglades Restoration
BMP	Best Management Practice
C&SF Project	Central and Southern Florida Project
CDMP	Comprehensive Development Master Plan
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
CFB	Central Florida Bay
Chl-*a*	Chlorophyll-*a*
COP	Combined Operational Plan
CSOP	Combined Structural and Operational Plan
DSOCR	*D*esired *s*tate *o*f *c*onservation for the *r*emoval of the property from the List of World Heritage in Danger
EAA	Everglades Agricultural Area
EDRR	Early Detection and Rapid Response
FDOT	Florida Department of Transportation
FEB	Flow Equalization Basin
GMP	General Management Plan
IAS	Invasive Alien Species
IDS	Integrated Delivery Schedule
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LOSOM	Lake Okeechobee System Operating Manual
MeHg	Methylmercury
MWD	Modified Water Deliveries
NBR	Normalized Burn Ratio
NCFB	North Central Florida Bay
NDVI	Normalized Difference Vegetation Index
NEFB	Northeast Florida Bay
NESRS	Northeast Shark River Slough
NGVD 29	National Geodetic Vertical Datum of 1929
NPS	National Park Service
OUV	Outstanding Universal Value
PIR	Project Implementation Report
PSU	Practical Salinity Unit
RAD	Resist-Accept-Direct
SFB	South Florida Bay
SFWMD	South Florida Water Management District
SRS	Shark River Slough
STA	Stormwater Treatment Area
TP	Total Phosphorus
TS	Taylor Slough
TTFF	Tamiami Trail Flow Formula
TTNS	Tamiami Trail Next Steps
TTNS2	Tamiami Trail Next Steps, Phase 2
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WCA	Water Conservation Area
WERP	Western Everglades Restoration Plan
WFB	West Florida Bay
WQBEL	Water Quality-Based Effluent Limit
WRDA	Water Resources Development Act
WY	Water Year



A tree extends over the water | *NPS Photo by A. Forjan*

Executive Summary

Everglades National Park is located at the southernmost end of the highly modified Everglades wetland ecosystem, an approximately 18,000 square-mile (47,000 km^2) area extending from the Chain of Lakes near Orlando down to Florida Bay, Biscayne Bay, and the Florida Keys. Before human intervention, freshwater flowed south from Lake Okeechobee to Florida Bay in a broad, slow-moving sheet. The quantity and timing of the water flow depended on rainfall patterns and on slow releases of water stored naturally in the ecosystem. Before it was altered by development, the natural water flow patterns provided abundant habitat and prey for many species of wading birds such as roseate spoonbills and other wildlife such as manatees, American crocodiles, and American alligators. In 1948, Congress authorized the U.S. Army Corps of Engineers (USACE) to build the Central and Southern Florida (C&SF) Project—a system of more than 1,700 miles (2,700 km) of canals and levees and 16 major pump stations—to prevent flooding of urban and agricultural developments and intrusion of saltwater into fresh water aquifers on the Atlantic coast. The C&SF Project reduced the natural north-south flow of water in the ecosystem and created an east-west flow to support agricultural and urban development. The engineering changes that resulted from the C&SF Project caused detrimental effects to wildlife habitats and water quality in the remainder of the Everglades.

In 1993, Everglades National Park (referred to here as "the park") was placed on the List of World Heritage Sites in Danger, based on four key threats to its Outstanding Universal Value (OUV):

1. Alterations of the hydrologic regime have resulted in changes in the volume, distribution, and timing of water flows to the park.

2. Adjacent urban and agricultural growth have resulted in the introduction of invasive species and the need for flood protection actions.

3. Increased nutrient pollution has impacted surface water quality, altered species composition and distribution, and impacted food webs in the park.

4. Reduction of freshwater flows to Florida Bay have resulted in higher salinity levels and increased nutrient loadings leading to major seagrass die-off events.

In response, a series of corrective measures were developed in 2006 to assess progress toward restoration of the site's OUV. In 2012, a suite of hydrologic and ecological indicators of integrity were added. The focus of these site-specific corrective measures is the provision of clean water to the freshwater marshes and to Florida Bay. The corrective measures will achieve this by re-establishing flows into the Northeast Shark River Slough (NESRS) basin of Everglades National Park, reducing groundwater seepage losses into the adjacent eastern developed areas, and redirecting these flows through the NESRS and Taylor Slough (TS) marshes to the coastal estuaries.

To date, considerable progress has been made toward achieving the corrective measures, and several of the ecological indicators of integrity are improving or are already within their Desired State of Conservation. However, not all integrity indicators are within their desired state, and a small number are even showing signs of deterioration. Along with continuing the progress made to restore the Everglades ecosystem, resource managers are also monitoring, mitigating, or managing the threats from invasive species, climate change, and mercury. While some of these emerging threats are outside of the park's ability to control, the park's work to improve the health of the ecosystem will increase its resilience and limit large-scale impacts.

This 2024 State of Conservation report generally covers the period from May 1, 2021–April 30, 2023, which coincides with the water years (WY) of 2022 and 2023 (WY22 and WY23). During the reporting period, water flows from the upstream Water Conservation Areas (WCA) into Shark River Slough (SRS) were over 1.1 million acre-feet in WY22 and peaked at over 1.3 million acre-feet in WY23. The increased water flows allowed for longer flooding

Sunset over the slough | *NPS Photo by R. Krayer*

durations, which can often lead to the increase of freshwater fish and macroinvertebrate communities that fueled wading bird supercolony formation. In the 2018 and 2021 wading bird nesting seasons, water depth and prey conditions in the western marl prairies and coastal ecotone of Everglades National Park appeared optimal. In response, exceptionally large white ibis supercolonies returned to the park with nesting numbers and fledgling success that had not been observed in 70 years. During the 2022 and 2023 nesting seasons, ibis supercolonies did not form in South Florida, but the birds continue to nest in greater numbers than in the early 2000s. If optimal hydrologic conditions occur during future nesting seasons, ibis supercolonies are expected to form again.

The increase in water flow during WY22 and WY23 also shifted eastward, moving 68% of the total volume toward NESRS in WY22 and 57% in WY23. This was a desirable shift toward the historic eastern flow path. Total fish abundance has been increasing in SRS since the drying event that preceded WY21, and has continued to increase during this reporting period, but was still lower than expected levels at most sites. In previous years, lower abundance of native fish and macroinvertebrates was attributed to the presence of invasive predatory fish, but for this reporting period it is possible that the eastward water flow shift positively affected abundance of native taxa. Overall, invasive fish abundance at many sites in SRS remains above desired levels posing a potential threat to small fish and crayfish populations.

American crocodile | *NPS Photo by C. Dryer*

Invasive Brazilian peppertree | *NPS Photo*

Along with increased water inflows, the quality of water entering from the upstream Everglades has remained stable at some structures, while other inflow structures have exhibited increasing levels of total phosphorus (TP). There is an inverse relationship between water levels in the headwaters of structure S-333 and TP concentrations in water flowing into SRS. Hence, water delivered to Everglades National Park when water levels are low has higher TP concentrations. The highest TP concentrations in water delivered to the park were observed from April through mid-July 2023, consistent with relatively low water levels in the L-29 and L-67A canals. The extended duration of low water levels with relatively high TP concentrations (>10 micrograms per liter, $\mu g\ L^{-1}$) at inflow structures corresponded with a downstream exceedance of the TP limit for SRS in WY23. Phosphorus concentrations across all marsh stations in the water quality monitoring network in the park were below the established long-term target of 6 to 8 $\mu g\ L^{-1}$ during the reporting period, although some sampling locations had concerning trends that may require additional investigation. Periphyton indicators of marsh water quality did not meet desired targets at some locations in both SRS and TS and will require further monitoring. Addressing the causes and possible remedies for the elevated TP concentrations delivered to the park is presently underway by federal and state water quality and hydrology experts.

The marked increase in water flow and rainfall received by Everglades National Park in WY22

and WY23 was beneficial to Northeast Florida Bay (NEFB). This area experienced extended periods of mesohaline (5–18 Practical Salinity Unit, PSU) conditions throughout the wet season. This was possibly a sign of increased freshwater delivery from changes in operations and project features in the neighboring C-111 basin. Hypersalinity events (salinity levels greater than 40 PSU) in other areas of Florida Bay, while still common, were not as extreme as observed in WY15 and WY16. Moderate hypersalinity continues to persist in the Central Florida Bay (CFB) region and will continue unless increased freshwater flow can be provided. Ultimately, conditions were variable across the bay, but conformed to the historic spatial pattern of hypersalinity dominating the central and coastal basins late in the dry season, with more moderate conditions throughout the year and in the remaining basins of the bay.

The frequency and severity of algal blooms, which negatively affect marine habitats and wildlife, have lessened in Florida Bay since Hurricane Irma in 2017. Florida Bay chlorophyll-*a* (chl-*a*) concentrations declined from WY18 to WY22, potentially reflecting recovery from the excess nutrients added to the system following the large seagrass die-offs in 2015 and Hurricane Irma in 2017. Sport fish catch per unit effort (CPUE), an indirect measure of fish abundance, for two of the four species monitored (snook and red drum) are improving or stable, which implies sustainable catch rates. However, the two other monitored species, gray snapper and spotted seatrout, experienced a drop in CPUE over the past two years for unknown reasons. The American crocodile population in the Everglades appears to be increasing related to stable hatchling survival and increased nesting effort. Crocodile distribution also appears to be expanding within and beyond the park boundaries. Improving freshwater inflows to northern Florida Bay should continue to improve crocodile hatchling survival rates as well as the other coastal and estuarine indicators.

Despite the ongoing efforts to restore the Everglades ecosystem through various projects, the impacts of climate change and rising sea levels are becoming increasingly significant. Roseate spoonbills historically nested in Florida Bay but have been abandoning historic nesting sites in favor of nesting locations in the coastal Everglades and elsewhere. Sea level rise associated with climate change is implicated in this nesting location

Dwarf cypress trees | *NPS Photo by F. Acevedo*

shift. The result of these increasing climatic stressors is that the metrics used to track bay-wide nesting (to include overall nesting numbers, nesting effort, and juvenile survival within the historic nesting regions of the park) will not be comparable going forward. Thus, even though state- and region-wide conditions are benefitting the species overall, the birds are no longer nesting in Florida Bay in high enough numbers to use them as an indicator for this and future reports. Therefore, Everglades National Park is requesting that the World Heritage Committee consider removing this species from the list of ecological integrity indicators.

Increasing freshwater flow into the park through restoration will push back against the encroaching saltwater and will mitigate the effects of sea level rise on the park's freshwater habitats. One of the planned restoration projects is the Biscayne Bay and Southeastern Everglades Restoration (BBSEER) project, with an objective to improve the conditions of southeastern Everglades National Park. With climate change and sea level rise, mangrove wetlands within the park have already encroached into freshwater wetlands. The most significant change is in the southeastern area of the park, where both sea level rise and reductions in water deliveries have caused increased salinity levels in NEFB and an expansion of the white zone, a transition zone of low productivity with minimal vegetation caused by periodic saltwater inundation. The BBSEER is working to increase water deliveries which should slow the encroachment of the white zone, expand viable wildlife habitats to the east and northeast, and contribute to improved salinities in NEFB.

Tamiami Trail bridge construction | *NPS Photo*

Besides supporting Everglades restoration efforts, the park is also expanding its internal climate change expertise by creating a Resiliency and Sustainability Team that will focus on understanding the impacts of climate change on the Everglades ecosystem, as well as how Everglades restoration will mitigate those impacts. Moreover, and for the next three years, Everglades National Park will be hosting brainstorming workshops to develop a climate change roadmap for the park's short-term and long-term futures. These workshops will focus on setting targets and developing a strategy for mitigating climate change and sea level rise. The outcome will be an adaptation strategy for the park within the resist-accept-direct (RAD) framework. Topics will focus on freshwater delivery needs and land management strategies to maintain marl prairie and ridge and slough habitats, salinity levels in Florida Bay, and a healthy mangrove/marsh ecotone interface.

Additional conservation issues that may impact Everglades National Park include invasive species and mercury/methylmercury concentrations. The park is working to maintain and expand existing successful invasive species control and maintenance programs. However, the scale of the problem and limited resources have prevented establishment of control programs for invasive fish and some invasive wildlife species. The park is focused on tracking existing and new invasions, investing in research, applying early detection and rapid response (EDRR) which is one of the most cost-effective invasion control methods, and working with partners and the public on education, outreach, and controlling the introductions of invasive species. While the source of mercury and conditions that lead to the creation of methylmercury in the Everglades are outside of the park's control, it is possible that Everglades restoration could influence the amount or distribution of mercury and methylmercury over the landscape. The park will continue to conduct monitoring to assess the impacts of water management changes and restoration on mercury concentrations in fish.

Several corrective measures needed to address the four threats to the site's OUV are nearing completion. Even though three initial water management projects authorized in 1994—Modified Water Deliveries (MWD), C-111 South Dade, and Everglades Construction Project—are now operational and the Combined Operational Plan (COP) is in use, larger-scale water management projects are needed to achieve the Desired State of Conservation.These projects include the State of Florida's Restoration Strategies Plan to further improve water quality. Other projects include the Central Everglades Planning Project (CEPP), as well as the Everglades Agricultural Area (EAA) Reservoir project that will redirect Lake Okeechobee discharges southward, back into the Everglades. While both projects are progressing, their full benefits are not expected to be realized before approximately 2032.

The expeditious implementation of corrective actions is required to halt any further deterioration of the ecosystem. Completion of the CEPP along with the EAA Reservoir over the coming years is critical for restoring a more historic hydrologic regime to the Everglades ecosystem. As an example, the combination of the CEPP and the EAA Reservoir is expected to send an additional 370,000 acre-feet of clean water to the Everglades by 2032. These new water deliveries to Everglades National Park are expected to occur also in the dry season, when the freshwater wetlands and estuaries need it most. These proposed water flow and water quality improvements are expected to fully achieve the site's Desired State of Conservation.

This report, prepared in 2024 for examination by the World Heritage Committee at its 47th session, is the sixth biennial report to be submitted by the NPS that includes the agreed upon physical and ecological indicators of integrity. This report follows the recommended format of the World Heritage Committee and responds to the recent decision of the committee. It provides updated information on progress toward implementing the corrective measures and describes recently detected changes in the status of the indicators of integrity. The information presented is intended to assist in decision-making for the State of Conservation of this site, which is on the List of World Heritage Sites in Danger. The report will also gauge the overall response of the park's ecosystems to factors such as changes in water management, climate change, invasive species, and implementation of Everglades restoration projects.

During the reporting period, there are some notable outcomes confirming that Everglades restoration efforts are on track:

1. The magnitude and distribution of flows are increasing and shifting toward the historic eastward path resulting in deeper water levels in Northeast Shark River Slough.
2. Alligator nesting efforts continue to increase resulting in higher nest density and distribution throughout freshwater hydrologic basins of the park. The trend is showing more stability in nesting efforts during poor to moderate conditions and record numbers during favorable conditions.
3. Crocodile distribution has continued to expand within and beyond the boundary of Everglades National Park in recent years. Nesting effort in the park is also exhibiting an increasing trend.
4. The number of wading birds nesting in the park's coastal ecotone region is gradually increasing and continues to be higher than in the 1990s and 2000s.
5. There have been no large-scale, damaging fires in the park in over a decade.
6. Despite seagrass die-offs and hurricanes, Florida Bay continues to support healthy sport fish populations and a world-class recreational fishery.

World Heritage Committee Decision

45 COM 7A.17 Extended 45th session (Riyadh, 2023)

EVERGLADES NATIONAL PARK (UNITED STATES OF AMERICA) (N76) DECISION: 45 COM 7A.17

The World Heritage Committee,

1. Having examined Document WHC/23/45.COM/7A.Add,

2. Recalling Decision 44 COM 7A.54 adopted at its extended 44th session (Fuzhou/online, 2021),

3. Welcomes the progress achieved in implementing the corrective measures, and notes with satisfaction that the Modified Water Deliveries (MWD), 'Canal-111 South Dade' (C-111), Everglades Construction Project, and the Combined Operational Plan (COP) are operational;

4. Commends the State Party for continuing to implement restoration projects in order to achieve the Desired state of conservation for the removal of the property from the List of World Heritage in Danger (DSOCR), and also notes with satisfaction the additional funding commitments of almost USD 1.5 billion;

5. Also welcomes the positive trend for some of the DSOCR indicators, but notes with concern that almost two thirds of the sub-indicators still remain below the restoration targets needed to achieve the DSOCR, and therefore requests the State Party to continue to strengthen current restoration efforts, including the State of Florida's Restoration Strategies Project, and the Central Everglades Planning Project (CEPP) with the Everglades Agricultural Area (EAA) Reservoir project;

6. Appreciates the new legislation and additional resources for the management of invasive alien species (IAS), and reiterates its request to the State Party to ensure a continued, long-term allocation of resources to control IAS within the property, and for the management strategy to emphasize prevention and early detection combined with rapid response measures;

Florida panther | *NPS Photo by R. Cammauf*

7. Notes with concern the increasing impacts of climate change on the Outstanding Universal Value (OUV) of the property, including the climate change-induced shift of habitat of some species outside the property, and requests the State Party to strengthen current restoration efforts to increase the resilience of the property and to develop a climate change adaptation strategy for the property, building on adaptation and mitigation measures identified in the General Management Plan (GMP) and emerging climate change challenges including sea level rise;

8. Welcomes the purchase of approximately 8,000 ha of land and drilling rights in the Everglades Protection Area to permanently prevent oil, gas and mineral exploration and extraction in this area;

9. Expresses its utmost concern about the reported adverse impact of the planned extension of the SR 836 / Dolphin Expressway on the Greater Everglades wetland ecosystem and urges the

State Party to identify alternatives that do not negatively impact on the OUV of the property, and to assess potential impacts of any proposed development on the OUV in line with the Guidance and Toolkit for Impact Assessments in a World Heritage Context prior to making any decisions that would be difficult to reverse, and to submit the assessment to the World Heritage Centre for review by IUCN;

10. Requests the State Party to work with the World Heritage Centre and IUCN to update the corrective measures, including a timeline for their implementation, and that the DSOCR be reassessed to take into account recent progress and challenges and to consider potential impacts on the OUV due to climate change and invasive species, and recalls that any changes to the corrective measures and the DSOCR should be reviewed by the Advisory Bodies and proposed to the Committee for approval;

11. Further requests the State Party to submit to the World Heritage Centre, by 1 February 2024, an updated report on the SR 836/Dolphin Expressway, and by 1 December 2024, an updated report on the state of conservation of the property and the implementation of the above, for examination by the World Heritage Committee at its 47th session;

12. **Decides to retain Everglades National Park (United States of America) on the List of World Heritage in Danger.**

A manatee swims down a river | *NPS Photo*

Response to the 2023 Decision of the World Heritage Committee

PARAGRAPH 5

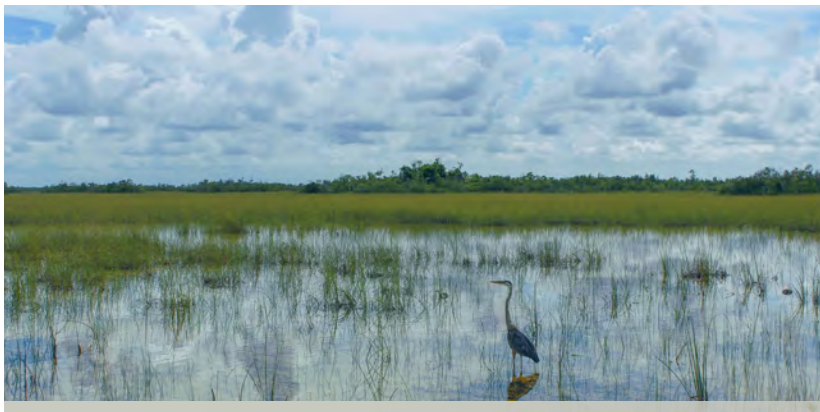
Also welcomes the positive trend for some of the DSOCR indicators, but notes with concern that almost two thirds of the sub-indicators still remain below the restoration targets needed to achieve the DSOCR, and therefore requests the State Party to continue to strengthen current restoration efforts, including the State of Florida's Restoration Strategies Project, and the Central Everglades Planning Project (CEPP) with the Everglades Agricultural Area (EAA) Reservoir project

Every year, state and federal sponsoring agencies, the U.S. Army Corps of Engineers (USACE) and South Florida Water Management District (SFWMD), update the Integrated Delivery Schedule (IDS) tracking the implementation of the Comprehensive Everglades Restoration Plan (CERP). The IDS is a guide for the planning, design, construction sequencing, timeline, and budgeting processes for the federally-funded and relevant state-funded South Florida ecosystem restoration projects. The IDS documents are updated annually and available at: https://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Integrated-Delivery-Schedule/.

As indicated in the IDS, CERP project components are gradually being planned, designed, and built to restore the quantity, quality, timing, and distribution of fresh water in the South Florida ecosystem. The ecological benefits from the Modified Water Deliveries (MWD), a foundation project to the CERP, are significant and accumulating since operational testing began in 2015. Increased flows to Northeast Shark River Slough (NESRS), longer hydroperiods, and shifts in vegetation communities are early signs indicating that increasing water deliveries at the right time and location to Everglades National Park will improve the ecological function of the ecosystem.

Several other major restoration projects are also critical to the overall success of moving Everglades National Park towards the Desired State of Conservation. The Central Everglades Planning Project (CEPP) is the single largest CERP component focusing on the central flow path of clean water to the park. One of the largest components of the CEPP is the EAA reservoir, a 240,000 acre-foot, 23-foot-deep reservoir that captures water during wet periods and releases water into the Everglades ecosystem during dry periods. The CEPP also increases southward water flows by about 40% by removing historic dams. The project is complex and expensive with major retrofits of water management works exceeding $4 billion. Continued focus on the implementation of CEPP features through 2033 is anticipated to benefit Everglades National Park marsh and coastal ecosystems. The CEPP will help restore some of the natural functions of the park that have been degraded by decades of ecologically damaging water diversion and management practices. The CEPP is expected to protect biodiversity by improving habitat quality for many species within the park.

The State of Florida's Restoration Strategies Plan is another important project expected to be fully constructed and operational by 2025. In 2012, the U.S. Environmental Protection Agency (USEPA) established a water quality—based effluent limit



A great blue heron stands in a slough | *NPS Photo by C. Rivas*

(WQBEL) for total phosphorus (TP) in stormwater treatment area (STA) discharge to not exceed 13 µg L^{-1} as an annual flow-weighted mean in more than three out of five water years on a rolling basis and 19 µg L^{-1} as an annual flow-weighted mean in any water year. This effluent limitation is intended to allow drainage to meet the 10 µg L^{-1} phosphorus criterion in the Everglades Protection Area. Under the Restoration Strategies Plan, the State of Florida is finishing the construction of additional STA expansion areas, flow equalization basins, and other planned improvements to meet the WQBEL.

Argentine black and white tegu | *NPS Photo by C. Spading*

PARAGRAPH 6

Appreciates the new legislation and additional resources for the management of invasive alien species (IAS), and reiterates its request to the State Party to ensure a continued, long-term allocation of resources to control IAS within the property, and for the management strategy to emphasize prevention and early detection combined with rapid response measures

Since the most recent update by the South Florida Ecosystem Restoration Task Force to their Invasive Exotic Species Action Framework (https://www.evergladesrestoration.gov/invasive-exotic-species-archive), interagency efforts to coordinate invasive species control have continued and strengthened. This framework is helping to align and prioritize the work of the various government entities (federal, state, and local) in the fight against invasive species in South Florida's ecosystems, including Everglades National Park.

In response to direction from the Water Resources Development Act (WRDA) 2020 to prioritize invasive species management (formerly referred to as the SLITHER Act: Suppressing Looming Invasive Threats Harming Everglades Restoration Act), the U.S. Department of Interior recently convened an interagency team of invasive species experts to develop a tool to prioritize potential new invasive species before they become established. The team also helps focus early detection and rapid response (EDRR) efforts if or when new species are detected in the wild. This effort is expected to be completed within the year.

Everglades National Park also engages in formal collaborations with federal, state, and local partners via participation in the Everglades Cooperative Invasive Species Management Area Steering Committee and the Florida Invasive Species Council. The result of these partnerships is regular coordination of management actions and research priorities for multiple taxa and a synergy of resources across agencies.

During the last two years, Everglades National Park worked to increase efforts managing invasive species in conjunction with state partners. This includes efforts to secure additional funding and resources in recognition of the fact that the invasive species threat continues to grow. In 2022 and 2023, the National Park Service (NPS) and its partners implemented invasive species management at levels similar to previous years, largely by focusing efforts on increasing efficiency and collaboration and prioritizing efforts. The park successfully continued aggressive treatments of priority invasive plants while also maintaining previously treated areas. Efforts continued to control Argentine black and white tegus and Burmese pythons and EDRR was implemented on several occasions.

The park continues to coordinate with agencies and academia to optimize trapping techniques for Argentine black and white tegus by experimenting with novel baits and attractants, as well as developing new methods to improve removal. From July 2022 through May 2024, a total of 53 tegus were captured in the park across all size classes confirming reproduction occurring within the park. During the same reporting period, 8,777 acres (3,552 ha) of invasive plants were treated. Treatment efforts focused on reducing melaleuca, Brazilian peppertree, shoebutton ardisia, and Australian pine infestations. Everglades National Park also achieved an important milestone in 2022 with the completion of the removal of invasive Brazilian pepper and shoebutton ardisia from the 6,300-acre (2,550 ha) Hole-in-the-Donut restoration project.

PARAGRAPH 7

Notes with concern the increasing impacts of climate change on the Outstanding Universal Value (OUV) of the property, including the climate change-induced shift of habitat of some species outside the property, and requests the State Party to strengthen current restoration efforts to increase the resilience of the property and to develop a climate change adaptation strategy for the property, building on adaptation and mitigation measures identified in the General Management Plan (GMP) and emerging climate change challenges including sea level rise

Climate change and sea level rise are causing some areas within Everglades National Park to experience marsh collapse, shifts in vegetation species, and saltwater intrusion. A clear indication of these changes is the inland progression of the "white zone," a transition zone of low productivity with minimal vegetation within the freshwater marsh caused by periodic saltwater inundation.

Projections indicate that South Florida will continue to face changes in surface, atmospheric, oceanic, and

Flooding near Flamingo after Hurricane Ian | *NPS Photo*

coastal water temperatures, altered rainfall patterns, increased evapotranspiration, and more intense tropical storms. Florida's sea level rise has outpaced national averages, with predictions ranging from 2.6 feet (80 cm) to 6.8 feet (207 cm) by 2100. Air temperatures are expected to continue rising throughout the 21st century, leading to increased evapotranspiration and reduced surface water availability, even if rainfall remains constant. Restoring the Everglades is a critical strategy to build a resilient ecosystem and mitigate the effects of climate change and sea level rise. Restoration of freshwater inflows will protect peat soil, keep saltwater out of freshwater ecosystems, and safeguard the aquifer supplying drinking water to South Florida's population.

The State of Florida and USACE have jointly accelerated the rate of project implementation for the CERP. One of these CERP projects is the Biscayne Bay and Southeastern Everglades Restoration (BBSEER) project, currently being planned, which will improve the conditions of southeastern Everglades National Park. With climate change and sea level rise, mangrove wetlands within the park have already encroached into freshwater wetlands. The most significant change is in the southeastern area of the park, where sea level rise and reductions in water deliveries have caused an expansion of the white zone and increased salinity levels in Northeast Florida Bay (NEFB). The BBSEER is working to increase water deliveries which should slow the encroachment of the white zone, expand

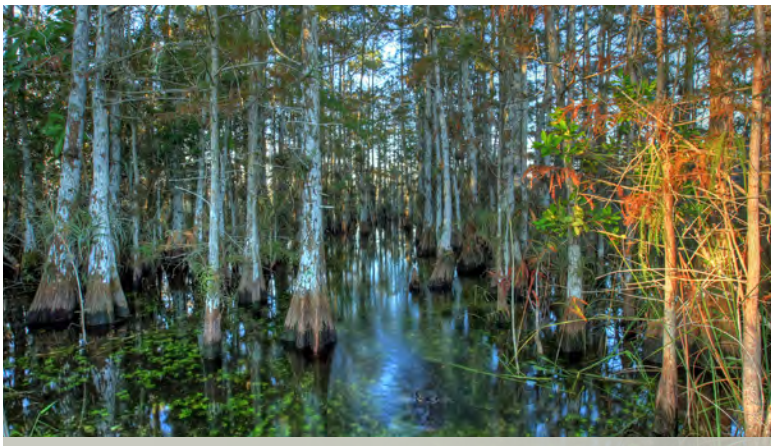
viable wildlife habitats to the east and northeast, and contribute to improved salinities in NEFB.

For the next three years, Everglades National Park will be hosting brainstorming workshops to develop a climate change roadmap for the park's short-term and long-term futures. These workshops will focus on setting targets and developing a strategy for mitigating climate change and sea level rise. The outcome will be an adaptation strategy for the park within the resist-accept-direct (RAD) framework. Topics presented will be placed in the context of restoration. They will include discussions around freshwater delivery needs and land management strategies that serve to maintain marl prairie and ridge and slough habitats, salinity levels in Florida Bay, and a healthy mangrove/marsh ecotone interface.

PARAGRAPH 9

Expresses its utmost concern about the reported adverse impact of the planned extension of the SR 836 / Dolphin Expressway on the Greater Everglades wetland ecosystem and urges the State Party to identify alternatives that do not negatively impact on the OUV of the property, and to assess potential impacts of any proposed development on the OUV in line with the Guidance and Toolkit for Impact Assessments in a World Heritage Context prior to making any decisions that would be difficult to reverse, and to submit the assessment to the World Heritage Centre for review by IUCN

In 2017, the Miami-Dade Expressway Authority proposed the extension of SR-836/Dolphin Expressway from its current terminus southward for 14 miles (23 km). The proposed extension is adjacent to the park and is planned by Miami-Dade County to go through, or have secondary impacts on, sensitive wetlands including the Bird Drive Basin and Pennsuco wetlands. These two parcels were set aside for the CERP and are currently within the



American alligator in a cypress dome | *NPS Photo by G. Gardner*

footprint of two CERP projects: the Biscayne Bay and Southern Everglades Restoration Project (BBSEER; planning in progress with a Tentatively Selected Plan to be identified late 2024) and the Southern Everglades Restoration Project (planning starting in 2025). Most of the proposed footprint is also outside of the approved urban development boundary specified by the Miami-Dade County Comprehensive Development Master Plan (CDMP) and approved by the State of Florida to delineate where dense urban development may be legally located.

This road extension project has been challenged by Tropical Audubon Society for the extension's inconsistency in planning with the CDMP. In 2020, a state administrative law judge sided with Tropical Audubon Society that the proposed highway extension was not allowed by the Miami-Dade County CDMP, and the project was temporarily halted. In June 2021, the State of Florida Administration Commission (Florida's Governor and Cabinet) voted to override the ruling which cleared the way for the county to move forward with the extension as proposed. This allowed the county to seek permits from state agencies to construct the extension. The Tropical Audubon Society appealed the Administration Commission findings. In July 2024, the court upheld the Administration Commission's ruling, which found that the CDMP amendment allowing for the highway extension was proper. As a response, the Tropical

Audubon Society filed a motion asking the court to clarify its ruling, rehear the matter, and certify the case for appeal to the Florida Supreme Court.

The NPS is involved in the planning process for the BBSEER project and is recommending that these sensitive wetlands remain in the project as study areas emphasizing their overall importance to restoration. Everglades National Park and the Department of Interior are closely following this matter and will work with authorities to avoid impacts to these sensitive wetlands.

PARAGRAPH 10

Requests the State Party to work with the World Heritage Centre and IUCN to update the corrective measures, including a timeline for their implementation, and that the DSOCR be reassessed to take into account recent progress and challenges and to consider potential impacts on the OUV due to climate change and invasive species, and recalls that any changes to the corrective measures and the DSOCR should be reviewed by the Advisory Bodies and proposed to the Committee for approval

The state and federal parties are implementing the CERP as the set of corrective actions with the IDS as the planning tool. The general framework of the CERP was signed into law in 2000 as a state/federal partnership plan to reverse much of the flow of water back to a historic north-south pattern. The CERP details 68 projects that would remove barriers to flow, store water to re-hydrate wetlands, provide for the water needs of agriculture and municipalities, and maintain flood control for developed areas. The main goal of CERP is to deliver the right amount of water, of the right quality, to the right places at the right times to restore, protect, and preserve the natural systems. The planning for each of these 68 projects is a lengthy interagency process with stakeholder involvement. During the planning process of each CERP component, options and alternatives are evaluated and optimized while assessing

Coastal mangrove forest | *NPS Photo by F. Acevedo*

the ecological benefits. Once a plan is finalized, it is delivered to the U.S. Congress for federal authorization and appropriations. The Desired State of Conservation represents the goals of restoration. Everglades National Park will soon be initiating a three-year planning process to develop a climate change roadmap for the park's short-term and long-term futures. The NPS will share the roadmap with the World Heritage Centre and IUCN for their review.

The park requests that the committee review and amend the DSOCR to remove roseate spoonbills as an integrity indicator. The roseate spoonbill (*Platalea ajaja*) was almost extirpated in Florida during the early decades of the 1900s. By 1935, the only known nesting colony in the state consisted of about 15 pairs of spoonbills in Florida Bay. Spoonbill abundance steadily increased from the time Everglades National Park was established in 1947 until the 1978–1979 nesting season, at which time 1,258 nests were observed in Florida Bay. However, the expansion of canal systems and changes in water management practices began to impact spoonbills nesting in Florida Bay by diminishing, redirecting, and disrupting the timing of freshwater inflows. This negatively affected prey availability in spoonbill foraging grounds. By 1984, there were less than half the number of nests as in 1979, and numbers steadily declined to a low of 87 nests during the 2010–2011 nesting season. The State of Florida reclassified

the status of the roseate spoonbill from a "species of special concern" to "threatened" because of the bird's small population and restricted range.

Numerous restoration projects and water management improvements have been implemented since the early 2000s which have increased freshwater flow from Water Conservation Area (WCA)-3 to NESRS. However, an increase in sea level rise has caused a sharp reduction in spoonbill aquatic prey concentration events. To forage efficiently during nesting season, spoonbills need foraging areas where water levels are approximately five inches (13 cm) or less, which concentrates prey. The result of these conflicting positive and negative influences in Florida Bay was a steady decline in nesting effort, but also a boost in reproductive output among the birds that did nest. A spoonbill tracking project investigating the mechanisms leading to the nesting effort decline in Florida Bay revealed a shift in the foraging location and nesting patterns.

The tracking study also showed that in the early 1990s, spoonbills primarily foraged in mangrove habitat in the estuarine areas just north of Florida Bay during peak nesting season. However, in the late 2000s spoonbill foraging was concentrated in the eastern coastal mangrove habitat. By 2020, higher water levels considerably reduced use of this eastern habitat. Instead, spoonbills foraged further west and further inland on the mainland, and within the interior ponds found on most of the islands in Florida Bay.

As nesting spoonbills have become difficult to locate in Florida Bay, tracking technology has been used to follow tagged adult birds to their nesting sites. Once new spoonbill nesting colony sites are located, remote cameras are placed and used to monitor nest outcomes and juvenile survival. This new method of monitoring nesting has found a change in adult foraging and nesting behavior—birds remaining in Florida Bay have abandoned their historic southern estuarine foraging areas in Everglades National Park. Instead, they are choosing to feed within the interior ponds of Florida Bay islands, where initial observations point to a marked increase in small prey fishes. Additionally, while nesting in Florida Bay has been steadily declining, new nesting islands and sites have been discovered in Florida Bay, which were previously unknown from bay-wide surveys. By using newer tracking and remote camera technology, nesting and foraging locations will continue to be documented within and north of Florida Bay.

The change in availability of foraging area and prey, likely driven by sea level rise, may be resulting in the change and decline in nesting effort in Florida Bay. These influences appear to be masking any positive impacts from restoration activities that may make Florida Bay more suitable for spoonbill nesting. However, it is important to note that, statewide, spoonbill numbers and nesting locations are on the rise, with statewide nests currently estimated to be about 1,250–1,500.

The result of these changes in spoonbill foraging and nesting within Florida Bay is that the metrics used to track bay-wide nesting, to include overall nesting numbers, nesting effort, and juvenile survival within the historic nesting regions of the park will not be comparable going forward. Thus, even though state- and region-wide conditions are benefitting the species overall, the birds are no longer nesting in Florida Bay in high enough numbers to use them as an indicator for this and future reports. Therefore, Everglades National Park is requesting the Committee to consider the removal of this species from the list of ecological integrity indicators.

Mangroves in Florida Bay | *NPS Photo*

Storm at sunset over the Everglades | *NPS Photo*

Background

Report Purpose

Everglades National Park was established in 1947 with a unique mission. In contrast to early National Park Service (NPS) sites in the western United States that feature majestic mountains and vast canyons, Everglades National Park was one of the first parks established to protect the abundant and diverse biological resources of a vast wetland ecosystem. Achieving this mission has proven challenging considering human modifications to the hydrologic regime and landscape in South Florida. Current restoration efforts serve to implement corrective measures that help the park achieve the Desired State of Conservation.

This report provides information on the status of site integrity indicators, the progress of Everglades restoration projects, and other corrective measures. The indicators herein provide quantitative and qualitative information to gauge the overall response of the park ecosystem to factors such as changes to water management, climate change, invasive species, and implementation of Everglades restoration projects. The synthesized information provides an assessment of the actions taken to move the park toward the Desired State of Conservation and to assist decision-makers in matters regarding the status of the park as a World Heritage Site in Danger.

Everglades National Park and its Conservation Designations

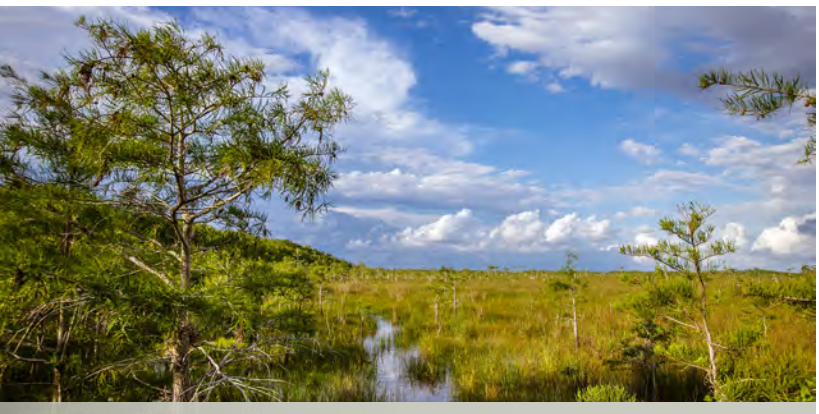
At 1.5 million acres (6,000 km^2), Everglades National Park is the largest subtropical wilderness reserve on the North American continent (*see map inside front*

GOALS OF EVERGLADES NATIONAL PARK REPORT TO THE WORLD HERITAGE COMMITTEE

- **Provide an update on the status and trends of important indicators of ecosystem integrity** that were agreed on as a Desired State of Conservation developed by the World Heritage Committee and the NPS.
- **Describe the progress of corrective measures** implemented to bring park habitats toward the Desired State of Conservation. Most of these corrective measures, especially those affecting the water management system, are under the direct control of the U.S. Army Corps of Engineers (USACE) and the State of Florida. The NPS reviews and recommends that these projects support the Desired State of Conservation.

cover). Located at the southern tip of the Florida peninsula, the park supports a high level of biological diversity. This is due to its location in a transition zone between temperate and tropical climates, as well as its high diversity of aquatic environments ranging from fresh to brackish to marine water.

Over the last 100 years, the areal extent of the historic Greater Everglades Ecosystem has been reduced by approximately 50% due to agricultural and urban development and related hydrologic changes. Everglades National Park protects vital remnants of pre-drainage Everglades habitats including forested uplands, freshwater wetlands, coastal wetlands, mangrove forests, and near-shore marine ecosystems. The uniqueness and value of this collection of habitats has brought about conservation designations at the state, federal, and international levels.



Cypress habitat | *NPS Photo by C. Dryer*

Conservation Designations of Everglades National Park

YEAR	DESIGNATOR (KEY)	DESIGNATION
1947	Federal	Everglades National Park
1976	International	International Biosphere Reserve
1978	Federal	Marjory Stoneman Douglas Wilderness
1978	State	Outstanding Florida Waters
1979	International	World Heritage Site
1987	International	Ramsar Wetland of International Importance
1989	State	Outstanding National Resource Waters
2012	International	Cartagena Convention Designation

Threats to Everglades National Park

Everglades National Park is located at the southernmost end of the highly modified Everglades wetland ecosystem. This makes the protection of its resources challenging. Historically, fresh water flowed through this approximately 18,000-square-mile (46,600 km^2) connected ecosystem in a broad, slow-moving sheet. The large water drainage basin that forms the Everglades historically began in Shingle Creek, near Orlando. From there, water flowed through the Kissimmee Chain of Lakes before reaching the Kissimmee River and filling Lake Okeechobee. The lake would eventually overflow its banks and provide seasonal pulses of water to the "River of Grass." The southwesterly flowing pulses of water from Lake Okeechobee rejuvenated the wetlands

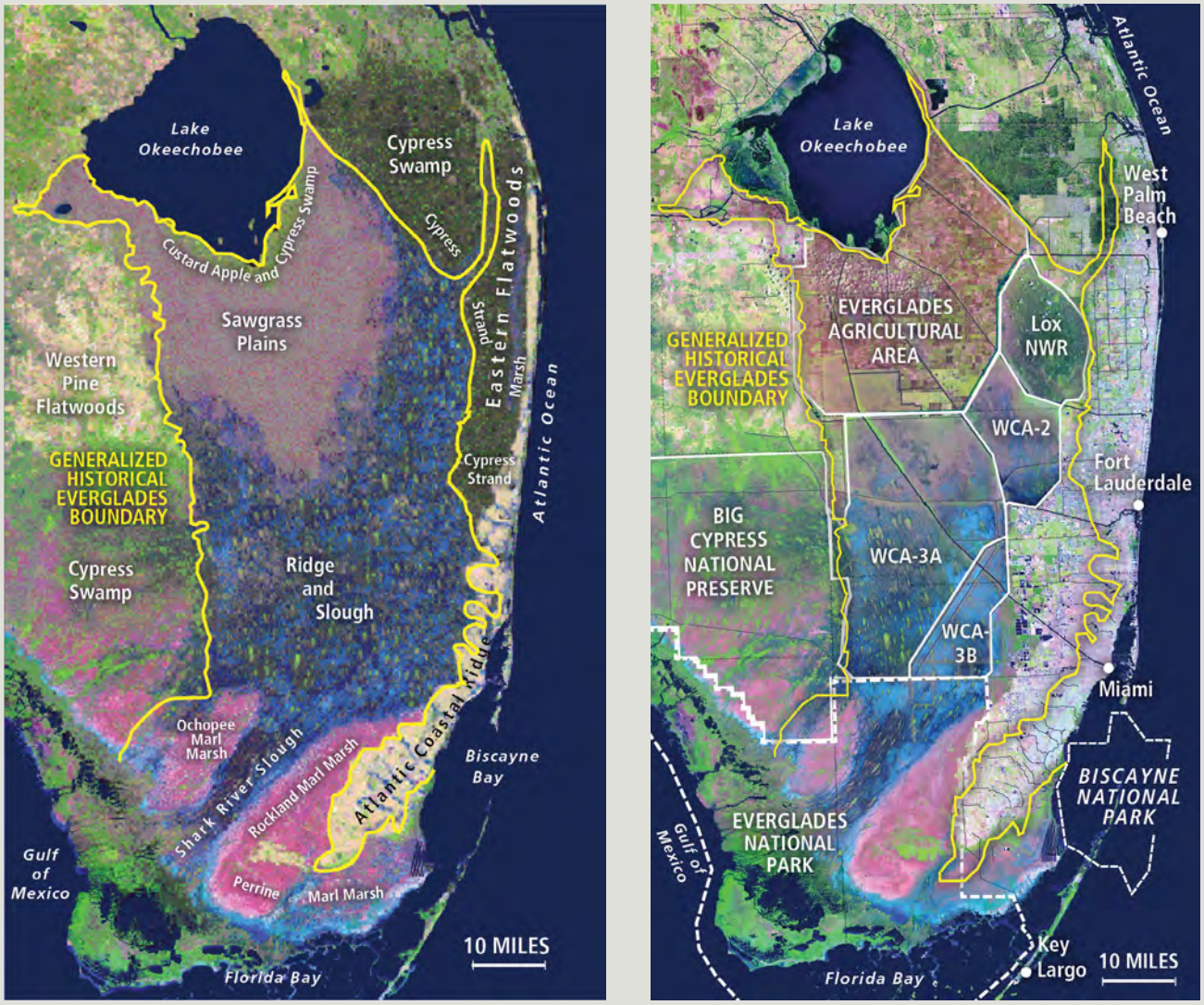


Figure 1. **Comparison of the historic South Florida landscape (left) with the highly compartmentalized landscape of today (right).** *The current landscape illustrates the extent to which characteristics of the historic landscape have been lost to agriculture and urban development. The barriers to sheetflow created by the construction of the levees and canals of the C&SF resulted in the loss of natural marsh connectivity. (Map adapted from McVoy et al. 2011.)*

of the Everglades. Once the water reached the coastline, it mixed with saltwater and fed the productive estuaries in Florida Bay, Biscayne Bay, and along the Gulf Coast. The influence of this fresh water extended as far as the marine environment of the Florida Keys. When, where, and how much water flowed through the ecosystem depended on natural rainfall patterns.

South Florida's wetlands were first modified for agriculture and urban development in the late 1800s. Hurricanes in the 1920s made it clear that more extensive drainage and flood protection were needed to protect new agricultural communities. In 1948, Congress authorized the USACE to build the Central and Southern Florida (C&SF) Project to provide flood control and water supply for municipal, industrial, and agricultural users. The C&SF Project accomplished these goals through a system of more than 1,700 miles (2,736 km) of canals and levees, 16 major pump stations, and five Water Conservation Areas (WCAs) upstream of Everglades National Park that act as shallow reservoirs to retain wet season rainfall and provide dry season

water deliveries. Presently, the flow of water in this once natural ecosystem is controlled and managed by people via the extensive network of canals, levees, WCAs, and pumps using water control plans. The alteration of flow resulting from the compartmentalization of the landscape reduced the Greater Everglades' natural north-south flow of water. Instead, it created an east-west flow to support and protect agricultural and urban development south of Lake Okeechobee (Fig. 1).

These upstream changes had tremendous impacts on the ecology of the ecosystem. The flow of water into the park's main water channel, Shark River Slough (SRS), was shifted. As a result, the normal salinity gradient of the estuaries of Florida Bay were altered from brackish to saline. The re-engineering of the Everglades' water flow and subsequent agricultural, industrial, and urban development reduced the Everglades ecosystem to about half its original size. This caused detrimental effects to wildlife habitats and water quality. The loss of habitat and ecosystem degradation placed many native plant and animal populations at risk. Alterations to the ecosystem have threatened iconic wildlife including Florida manatees, Florida panthers, American crocodiles, American alligators, and many species of wading birds such as wood storks and roseate spoonbills.

In recognition, and at the request of the U.S. government, Everglades National Park was inscribed on the list of World Heritage Sites in Danger in 1993. Four major threats, which had been repeatedly identified as sources of impacts to Everglades National Park since its inception, were highlighted at the time of the listing.

Foraging wading birds | *NPS Photo by L. Oberhofer*

PRIMARY THREATS TO EVERGLADES NATIONAL PARK

1. Alterations of the hydrologic regime have resulted in changes in the volume, distribution, and timing of water flows to the park.

This threat has had major impacts on the ecology of the park. The changes in water quantity, timing, and distribution have impacted the sheet flow characteristics of the Greater Everglades Ecosystem, the landscape pattern and heterogeneity, community dynamics, and impacts to soil accretion.

2. Adjacent urban and agricultural growth has resulted in flood protection actions (lowering of canal water levels along the eastern park boundary), which can drain the park's eastern wetlands. These developed areas are also locations where invasive nonnative species enter the park from man-made environments.

The porous nature of the limestone geology in South Florida and the proximity of urban and agricultural areas along the eastern boundary of the park have led to seepage problems draining the park wetlands. This is exacerbating Threat #1 as well as Threat #4 reducing water flows from reaching Florida Bay.

3. Increased nutrient pollution has resulted from the transport of agricultural and urban runoff into the park, causing alterations in native flora and fauna.

Inputs from urban and agricultural runoff caused accelerated loading of nutrients and other contaminants, resulting in altered surface water quality, altered species composition and distribution, and altered ecosystem function. The increase in phosphorus loadings to the park creates downstream spiral biogeochemical impacts.

4. Impacts to the protection and management of Florida Bay have resulted from reduced or re-directed freshwater flows, higher salinity levels and increased nutrient loadings.

Historically, freshwater from the Everglades would feed into Florida Bay, providing ideal conditions to a number of species. The lack of freshwater reaching Florida Bay has led to an increase in the frequency of salinity events in the Bay. A major seagrass die-off in North Central Florida Bay occurred in July 2015, affecting 40,000 acres (16,200 ha), and led to several years of recurring algae blooms that further impacted the bay and its fauna. A similar die-off in the mid-1980s took more than 20 years for seagrass to recover. Maintaining a healthy Florida Bay depends on our ability to implement Everglades Restoration and deliver fresh water through the Everglades to its southern end—Florida Bay.

Everglades National Park: A World Heritage Site in Danger

Except for a brief period in 2007–2010, Everglades National Park has been on the list of World Heritage Sites in Danger since 1993. At the time of the 2010 relisting, specific recommendations were made by the World Heritage Committee to enhance existing corrective measures. In 2012, for the purpose of securing the long-term restoration and preservation of the Everglades ecosystem, the park developed a narrative statement of the Desired State of Conservation and selected a suite of integrity indicators. Integrity indicators represent critical attributes of the ecosystem that are expected to benefit from the implementation of the corrective measures and allow measured progress toward the Desired State of Conservation. These integrity indicators, and their status, were presented in the 2012 State of Conservation Report to the World Heritage Committee.

In the 2013 State of Conservation Report, a "stoplight" evaluation system was developed to provide information on the status and trend of each indicator. The goal is that these can be used to evaluate progress toward the removal of Everglades National Park from the list of World Heritage Sites in Danger.

Sunrise over mangrove trees | *NPS Photo by P. Zarba*

Defining the Desired State of Conservation

The Desired State of Conservation represents the goal of restoration and preservation efforts. It is based on the characteristics of the physical factors, primary landscapes, and fish and wildlife in the Everglades ecosystem, as well as the Outstanding Universal Values (OUVs) that led to the inscription of Everglades National Park on the World Heritage list (Fig. 2). A detailed description of each important component was provided in the 2013 State of Conservation report. The summary statement of the Desired State of Conservation for each component is provided here.

The Physical Environment

Hydrology

The Desired State of Conservation for hydrology in Everglades National Park is broadly defined as a system where natural water depths, water distribution, and sheetflow patterns have been reestablished. Most of the water will flow through the historic path of Northeast Shark River Slough (NESRS) rather than through manmade canals to the east and west. The slough will have a long hydroperiod, drying out only infrequently. The operation of the water management system will allow for seasonal patterns of the rise and fall of water levels, in concert with rainfall.

A drying marsh | *NPS Photo*

Water Quality

Phosphorus is a limiting nutrient in the Everglades and freshwater marshes are historically adapted to extremely low phosphorus concentrations. The Desired State of Conservation is to have very low levels of phosphorus in the water entering the park (less than 10 micrograms per liter, μg L^{-1}) and to maintain levels in the interior marshes at the detection limit of 2 μg L^{-1}. Periphyton biomass, phosphorus content in periphyton, and composition will be restored to conditions that support stable aquatic communities.

The Freshwater Environment

Ridge, Slough, and Tree Island

The Desired State of Conservation for the ridge, slough, and tree islands landscape is broadly defined as a system that approaches the pre-drainage landscape patterns, vegetation, and fish and wildlife communities. A restored ridge and slough system will have re-established microtopography with tree islands serving as high points on the landscape. The Desired State of Conservation also requires water depths and multi-

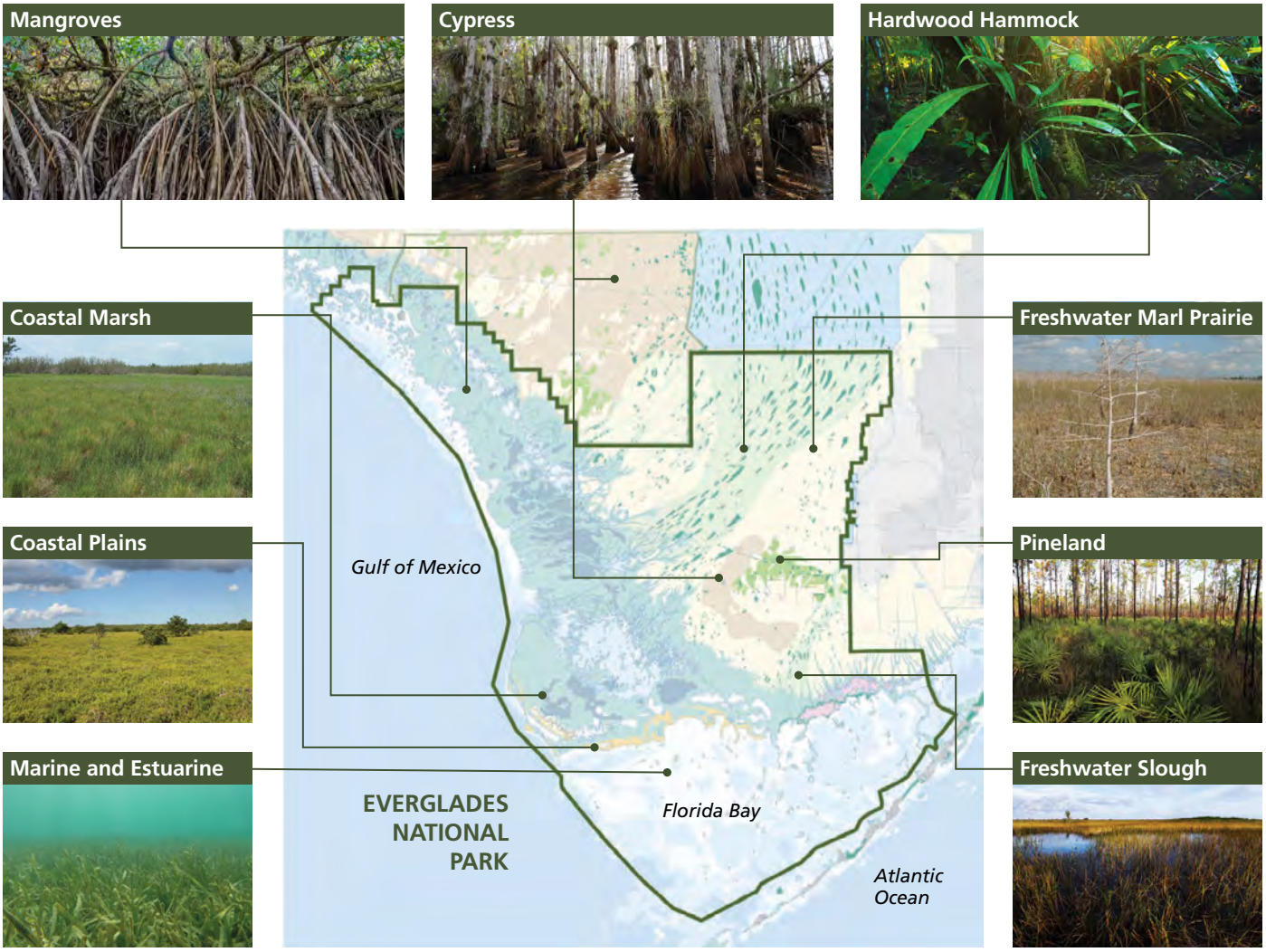


Figure 2. **Everglades National Park was declared a World Heritage Site in 1979 by the UNESCO World Heritage Committee.** The park was recognized as an area of Outstanding Universal Value due to the unique geological processes of the limestone substrate, the juxtaposition of temperate and tropical species and habitats, the complexity and integrity of biological processes, the large number of bird and reptile species, and the threatened and endangered species that reside within the ecosystem.

Tree islands in the Everglades | *NPS Photo*

year hydroperiods (stays wet for multiple years) that can support aquatic vegetation that grows in deeper water such as the American white waterlily (*Nymphaea ordorata*). Sloughs provide refuge for fish and aquatic macroinvertebrates during the dry season. Once the wet season returns, these animals spread out into surrounding wetlands. As the cycle repeats and water recedes gradually during the dry season, the fish and macroinvertebrate community becomes concentrated in shrinking pools of water. These concentrated communities serve as the prey base for American alligators (*Alligator mississippiensis*) and a diverse wading bird community.

Marl Prairie, Hardwood Hammock, and Pineland

The Desired State of Conservation requires longer hydroperiods, annual deposition of marl soil, and the re-establishment of a healthy mosaic of native, wet-prairie grass species interspersed with diverse hardwood hammocks. Severe and multi-year dry-down events will be less frequent than at present. Along the transition zone between the slough and marl prairies, more natural and seasonal fluctuations in water levels will promote an increase in alligator nesting frequency and create ideal foraging conditions for wading birds. The western marl prairies will be less flooded, and the population of Cape Sable seaside sparrows (*Ammodramus maritmus mirabilis*) will increase. The pinelands will retain their current diverse suite of rare and endemic plant species and will serve as habitat for wildlife such as the Florida panther (*Puma concolor coryi*), Florida wild turkey (*Meleagris gallopavo osceola*), and cavity-nesting birds.

The Coastal and Estuarine Environment

Coastal Marshes and Mangroves in Florida Bay

The Desired State of Conservation for the coastal wetlands and mangroves in Florida Bay is broadly defined as a system where more natural freshwater flows have been restored and the input of nutrients and contaminants has been reduced. In a restored system, algal blooms will occur less frequently than at present, and clear, clean water in the bay will support healthy seagrass beds, including an increased presence of widgeon grass (*Ruppia maritima*) and shoal grass (*Halodule wrightii*). Hardbottom communities such as sponges and corals will be restored. The Desired State of Conservation also requires that restored salinity gradients in the bay provide the conditions for a productive estuarine nursery that supports region-wide populations of pink shrimp (*Farfantepenaeus duorarum*) and sport fish, as well as improved conditions for the American crocodile (*Crocodylus acutus*). With more natural water recession rates during the dry season, salinity conditions in the mangrove transition zone will support wading bird nesting colonies in the area.

A pod of dolphins swimming over seagrass | *NPS Photo*

Burmese python in a tree | *NPS Photo by R. Cammauf*

Invasive Species in Everglades National Park

In the Desired State of Conservation, park habitats will reflect as much as possible the natural biological communities they represent, and the impact of invasive species will be nearly imperceptible. At present, the extent and number of invasive species established is high, and eliminating all invasive species from Everglades National Park is not expected to be possible. Instead, efforts focus on prevention, eradication, and control of the most problematic species. Currently, park efforts center on invasive plants, freshwater and marine fish, and herpetofauna (reptiles and amphibians). Advances toward the Desired State of Conservation are also dependent on the science to develop appropriate detection and control techniques, as well as on the resources available to successfully apply early detection, rapid response, and control methods. Education and outreach, as well as the examination of potential legislative and policy changes that reduce the risk of introduction of invasive species, are key to achieving the Desired State of Conservation.

Transition from coastal (foreground) to sawgrass (background) | *NPS Photo*

Roseate spoonbills forage with a wood stork | *NPS Photo by L. Oberhofer*

Integrity Indicators: 2024 Status

Everglades restoration is based on the premise that restoring more natural hydrologic conditions throughout the system will improve ecological conditions. This begins with primary productivity and moves up through the trophic system to plants, fish, wading birds, and crocodilians. The selected set of ecological indicators reflects that model and begins with an assessment of hydrologic and chemical parameters.

The 2024 integrity indicators that will improve with the implementation of corrective measures are listed in Table 1. The roseate spoonbill indicator added in 2015 has been removed in the current report because it no longer serves as a good ecological indicator (details provided in the "Response to the 2023 Decision of the World Heritage Committee" section). As in the previous report, a summary "stoplight" table is provided for each indicator. For each indicator criterion assessed, the Desired State of Conservation is stated in the first column, and the stoplight status is presented in the second column. A rationale for the status follows in the last column of the table. An explanation of the stoplight indicator colors and arrows is given in Table 2. This 2024 State of Conservation report generally covers the period from May 1, 2021–April 30, 2023, which coincides with water years 2022 and 2023 (WY22 and WY23).

TABLE 1. Integrity indicators for freshwater and estuarine ecosystems of Everglades National Park.

PHYSICAL INDICATORS	
Water volume and distribution	Water quality
Water pattern and water levels	

FRESHWATER RIDGE, SLOUGH, AND MARL PRAIRIE INDICATORS	
Freshwater fish and aquatic invertebrates	Everglades wading birds
American alligators	Fire regime

COASTAL AND ESTUARINE INDICATORS	
Salinity patterns	Estuarine fish
Algal blooms	American crocodiles
Seagrasses	

INVASIVE SPECIES INDICATORS	
Invasive plants	Invasive herpetofauna
Invasive freshwater fish	Invasive marine fish

TABLE 2. Stoplight indicator key.

STATUS	
Significant Concern	
Caution	
Good Condition	

TREND	
↑	Improving
↔	Unchanging
↓	Deteriorating

The Physical Environment

Hydrologic Indicators

Water flows into Shark River Slough (SRS) and Taylor Slough (TS) are a major driver of downstream marsh water levels and flooding durations. They also influence freshwater discharge and salinity in the Gulf Coast and Florida Bay estuaries. Therefore, water flow and marsh water level characteristics are key indicators of the ecosystem health of Everglades National Park and can closely track progress on the corrective measures needed to restore the Desired State of Conservation.

For the reporting period, water flows into SRS were over 1.1 million acre-feet in WY22 and peaked at over 1.3 million acre-feet in WY23, lower than the extreme high in WY21, but a significant increase over other recent years. This increase in flow also shifted eastward, moving 68% of the total volume toward Northeast Shark River Slough (NESRS) in WY22 and 57% in WY23, a desirable shift toward the historic eastern flow path. Water level

within NESRS is improving, with an annual average water level in WY22 of approximately 7.7 feet (2.3 m) National Geodetic Vertical Datum of 1929 (NGVD 29) and WY23 of approximately 7.8 feet (2.4 m) NGVD 29. The highest monthly water levels were between September and November 2023, when monthly averages remained over 8.2 feet (2.5 m) for 3 months.

Several significant restoration projects have been completed, or are currently underway, contributing to the measured progress towards the desired conditions. Since the previous reporting period, the construction of a 2.3-mile (3.7 km) sub-surface seepage barrier along the eastern boundary of Everglades National Park was completed, protecting properties in the neighboring 8.5 Square Mile Area (8.5 SMA), and allowing more water to remain in the park. Additionally, the Tamiami Trail Next Steps Phase 2 (TTNS2) project is progressing, with the goal of increasing the elevation and stability of Tamiami Trail roadway to allow for higher water levels in the L-29 canal on the northern boundary of the park and consequently increased flow through large culverts and bridges built into that roadway. The construction on this project began in April 2021, and upon completion of roadway improvements scheduled for early 2026, water levels in the L-29 canal should be able to be maintained up to 9.7 feet (approximately 2.9 m) NGVD 29, providing for additional flow into NESRS and greater sustained water levels in the marsh.

A hydrologic monitoring station in the marsh | *NPS Photo*

WATER VOLUME AND DISTRIBUTION

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Magnitude and direction of sheetflow – On an average annual basis, at least 55% of flows should come through NESRS and at most 45% through Northwest Shark River Slough (NWSRS).	**Caution Improving**	Improvements have been made to the distribution of flows between NWSRS and NESRS. Over the reporting period (WY22–WY23), more than 62% of the total SRS inflows were delivered into NESRS and 38% into NWSRS.
Average annual water volume into NESRS – On average, a total annual volume of water should be delivered to NESRS of 550 thousand acre-feet in years of average rainfall, 200 thousand acre-feet in years of below-average rainfall, and 900 thousand acre-feet in years of above-average rainfall, respectively.	**Caution Unchanging**	Over the period from 1980 to 2018 (38 years), the target was met only one time. During the current two-year reporting period, annual flows ranged between 751 and 769 thousand acre-feet. As WY22 and WY23 were years of below- and above-average rainfall respectively, the target was met in WY22 but not in WY23. However, in WY23 the flow volume did surpass the target for a year of average rainfall.

WATER PATTERN AND WATER LEVELS

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Timing and spatial distribution of water levels – The annual average water levels (stages) in NESRS should be 8.0 feet (2.4 m) NGVD 29 during years of average annual rainfall. During years of below- and above-average annual rainfall, the average water level in NESRS should be 7.5 feet (2.3 m) and 8.8 feet (2.7 m), respectively.	**Caution** **Improving**	Water levels in NESRS have been increasing while remaining below target values. In WY22 and WY23, the average annual water levels were 7.7 feet (2.3 m) and 7.8 feet (2.4 m) NGVD 29, respectively, meeting the below-average annual rainfall target for WY22, but not meeting the above-average annual rainfall target for WY23.

Water Quality

Phosphorus is the limiting nutrient in the Everglades, and total phosphorus (TP) concentrations in surface water and plant tissue are good indicators for water quality conditions. The established water quality metrics include TP at water inflow structures at the park boundary, TP concentrations in the downstream marsh surface water, and TP levels in periphyton tissue and periphyton biomass. An extended reporting period, from WY13 to WY23, was also evaluated to report on long-term trends.

The water quality goal for water inflow structures which release water into the park is to comply with all state and federal standards for TP over the water year defined as October through September. Low water levels in the headwaters of the park, particularly in the L-67A and L-29 canal west of structure S-333, were the major driver of TP concentrations during WY23. There is an indirect relationship between water levels in the L-29 and L-67A canals and TP concentrations: when water levels are low, water delivered to the park has higher TP concentrations. The highest concentrations of TP in water delivered to the park were observed from April through mid-July 2023, consistent with relatively low water levels in the L-29 and L-67A canals. The extended duration of low water levels with relatively high TP concentrations (>10 µg L^{-1}) at inflow structures corresponded with a downstream exceedance of the TP limit for SRS in WY23. Structures S-12A, S-12D, and S-333 that release water to Everglades National Park showed increasing concentrations over the period from WY13 through WY23 at rates ranging from 0.2 to 0.5 µg L^{-1} per year, while the other structures (S-12B, S-12C, and S-356) are exhibiting stable concentrations.

Periphyton floating in water | *NPS Photo*

Phosphorus concentrations across all marsh stations in the park's water quality monitoring network indicated that the the WY23 geometric mean TP concentrations were below the established long-term target of 6 to 8 µg L^{-1}. Only one station situated about 0.7 km downstream of L-29 canal in NESRS was close to the 8 µg L^{-1}, measuring 7 µg L^{-1}, while the rest were 6 µg L^{-1} and less. However, three marsh stations demonstrated increasing concentrations since WY13 including the L-29 canal station, a station in the center of SRS, and a station near the eastern boundary of NESRS. The rates of increase were greatest near the canal (~0.3 µg L^{-1} per year), while the other two locations increased at 0.1 and 0.2 µg L^{-1} per year. Addressing the causes and possible remedies for the elevated TP concentrations delivered

to Everglades National Park is presently underway by federal and state water quality and hydrology experts.

Periphyton is an algal/diatom community that represents a large portion of Everglades' net primary productivity. Periphyton responds quickly to changes in environmental conditions at both small and large spatial scales. Small increases in phosphorus concentrations can decrease periphyton biomass, shift community structure, and adversely impact higher trophic levels. The measurements of periphyton tissue TP indicate unimpacted marsh conditions in SRS and TS since WY13, except in WY13 and WY23 when both areas indicated some level of negative impacts. Periphyton biomass measurements were outside of the desired range in TS during WY13, WY17, WY19, WY22, and WY23. Periphyton biomass measured at stations in SRS indicated some level of impact in 64% of the years since WY13. Attention and consideration to this current trajectory needs to be given to both sloughs, which are the major conduits of water through the park.

Small crayfish on a net, surrounded by vegetation | *NPS Photo*

TOTAL PHOSPHORUS

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Shark River Slough inflow TP concentration – Inflow TP levels to SRS below the target.	**Caution Deteriorating**	Since WY13, inflow TP concentration has exceeded the long-term limit during six years, including WY22 and WY23.
Shark River Slough interior marsh TP concentration – Interior marsh TP levels in SRS below the target.	**Good Condition Deteriorating**	Across interior marsh stations, TP concentration is below the target, but 3 of 11 stations exhibited increased concentrations over the reporting period.
Taylor Slough and Coastal Basins inflow TP concentration – Inflow TP levels to TS and Coastal Basins below the target.	**Good Condition Unchanging**	Inflow TP concentration has been below the long-term limit and the phosphorus target has been met throughout the last decade.
Taylor Slough and Coastal Basins interior marsh TP concentration – Interior marsh TP levels in TS and Coastal Basins below the target.	**Good Condition Unchanging**	Interior marsh TP concentrations are below the target and concentrations have been stable throughout the last decade.

PERIPHYTON

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Shark River Slough periphyton tissue TP content – 75% or more of SRS stations meet desired levels of periphyton tissue TP content (< 200 µg L^{-1}).	 **Good Condition Unchanging**	All but two years since WY13 met the Desired State of Conservation, with more than 75% of monitored stations meeting TP targets. WY23 did not meet this goal.
Shark River Slough periphyton biomass – 75% or more of SRS stations meet desired levels of periphyton biomass.	 **Caution Unchanging**	In six years since WY13, more than 25% of monitored stations failed to meet the desired state for periphyton biomass.
Taylor Slough periphyton tissue TP content – 75% or more of TS stations meet desired levels of periphyton tissue TP content (< 150 µg L^{-1}).	 **Good Condition Unchanging**	In the past decade, 75% or more of stations in TS have met the desired conditions for periphyton tissue TP content.
Taylor Slough periphyton biomass – 75% or more of TS stations meet desired levels of periphyton biomass.	 **Caution Unchanging**	Since WY13, 25% of stations or more in TS failed to meet desired conditions in 5 years, including WY22 and WY23.

The Freshwater Environment

Freshwater Fish and Aquatic Invertebrates

Fish and aquatic invertebrate communities play an important role in Everglades' food webs. Factors that influence the abundance of fish and aquatic invertebrates can cascade up the food web and impact species such as alligators and wading birds. The Desired State of Conservation is to maximize abundance of small-sized freshwater fishes and aquatic invertebrates in a manner consistent with their expected populations in the pre-drainage Everglades ecosystem. Freshwater fish and aquatic invertebrate metrics are reported for SRS and TS separately. The metrics are based on an average of performance measure assessments and observation of status and trends for long-term monitoring sites in Everglades National Park.

In SRS, total fish abundance has increased since WY21 but was still lower than expected at most sites during the reporting period. Some species do appear to be recovering after the last major drying event preceding WY21, when all SRS sites dried. In WY22, bluefin killifish (*Lucania goodei*), a species indicative of long-hydroperiod conditions, made a slight improvement from WY21. Flagfish (*Jordanella floridae*), a species indicative of short hydroperiods, were less abundant than expected. In WY23, total fish abundance in SRS slightly increased from WY22. This was the third consecutive annual increase in total fish abundance

since the drying event that preceded WY21. Previous studies suggest recovery following drying may take at least three years and WY23 is still within three years of when most of SRS dried.

The introduction and spread of invasive species may also be influencing fish and crayfish populations in SRS. The invasive African jewelfish (*Hemichromis letourneuxi*) became abundant in SRS during WY13 to WY18, and some small fishes were less abundant than predicted, given observed hydrologic conditions. Following the collapse of the jewelfish population after WY18, the native species responded to observed hydrologic conditions and began to recover. Since WY20, the invasive Asian swamp eel (*Monopterus albus/javanensis*) has spread into SRS. It poses a potential threat to small fish and crayfish populations. Overall, the condition warrants moderate concern with an unchanging trend. However, given the recent recovery time since the last drying event in addition to the potential impact of invasive species, further investigation is necessary. The next reporting period will be important to determine the aquatic fauna's response to recent hydrologic management changes and invasive species.

In TS, total small fish abundance met hydrology-based targets at most sites in WY22. Through WY23, most sites in central TS have remained inundated since WY15 and total fish abundance has been gradually increasing since that time. However, species vulnerable to predatory fishes (e.g., Everglades and slough crayfishes *Procambarus alleni* and *P. fallax*), have virtually disappeared in TS, an unexpected result. The decline has been attributed to the high relative abundance of the invasive Asian swamp eel that has dominated large fish catches in TS since 2012. This eel can survive drying events, breaking a natural hydrologic limitation of other large fish predators.

The drivers of the observed multi-year inundation are suspected to be related to a combination of climate conditions, water management, and sea level rise at TS. Nonetheless, these drivers may alter hydrology-based targets of abundance and deserve further exploration. Overall, the increased abundance of some fishes, counteracted by the apparent impact of invasive species on native species, warrants concern. Further investigation is needed to increase confidence in this assessment, given the influence of invasive species on target expectations.

FRESHWATER FISH AND AQUATIC INVERTEBRATES

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Shark River Slough overall – Abundance is maximized in a manner that reflects pre-drainage conditions.	 **Caution Unchanging**	Fewer fish were present than expected based on rainfall-derived hydrologic targets. Although there appears to be a small increase in overall total fish abundance, the trend is inconsistent across sites. The short recovery time since the drying at the end of WY20 and potential impact of invasive species is a cause for concern and requires further investigation.
Taylor Slough overall – Abundance is maximized in a manner that reflects pre-drainage conditions.	 **Caution Unchanging**	Although total small fish abundance matched or exceeded predicted hydrologic targets, several expected native species were virtually absent from TS, likely the result of abundant invasive species. The mixed results have been consistent over the past several years.

American Alligators

The American alligator (*Alligator mississippiensis*) once occupied all wetland habitats in the pre-drainage Everglades, from sinkholes in pinelands to mangrove estuaries. Alligators are historically thought to have been most abundant throughout the marl prairies and along the marsh/mangrove ecotone within Everglades National Park, not the central sloughs. Alligators presumably became more common in central sloughs because of reduced flows, lower water levels, shortened hydroperiods in the marl prairies, and elevated salinities in the southern coastal marshes.

Freshly hatched baby alligator | *NPS Photo by L. Oberhofer*

Alligators are a keystone species capable of dramatically altering ecosystems through their roles as apex predators and ecosystem engineers. Adult alligators develop and maintain trails and ponds which provide aquatic habitat connectivity, create essential dry season refugia, and concentrate prey for other predators such as juvenile alligators, piscivorous fish, reptiles, and wading birds. Nest mounds create elevated habitat ideal for egg deposition by turtles, snakes, and lizards while allowing germination platforms for plant species less tolerant of flooding.

Alligators are responsive to hydrologic change and are recognized as important indicators of the health of the Everglades. Restoration metrics focus on nesting effort and success, nest density and distribution, and population demographics (abundance, size, body condition, and sex). The alligator's life history results in a slow demographic response while reproductive metrics respond more rapidly to changing hydrologic conditions. All metrics fluctuate substantially from year to year and are best evaluated over longer periods.

Alligator population demographics in Everglades National Park are monitored via two survey methods: spotlight surveys conducted using airboats and nesting surveys conducted using helicopters. Due to limitations on access by airboat, spotlight surveys are limited to the deeper water habitats of central sloughs. In the pre-drainage Everglades, deeper sloughs were not thought to be the most productive alligator habitats. Changes in alligator abundance observed along these routes may not be representative of the overall system. Alligator nesting surveys conducted by helicopter do not suffer similar geographic limitations and allow access to a larger area with greater habitat variation.

Annual alligator nesting effort, which is the minimum number of alligator nests built and observed during an annual nesting season (June–September), has shown a significant overall increase during the 38-year monitoring period (1985–2023) despite inter-annual fluctuations in effort. High nest-effort years appear to be a response to favorable hydrologic conditions that encourage a larger proportion of females to nest. For most of the monitoring program duration, fewer than 100 nests have been observed each season. However, seven of the nine years where over 100 nests were observed occurred during the past decade, and four occurred between 2018–2022.

Consistent seasonal hydrologic patterns of water levels with infrequent drought conditions stabilize nesting effort, distribution, and success. Fewer instances of extreme changes in water level during nesting season have resulted in more consistent nesting effort with reduced fluctuations in nest numbers. The number of nests in recent years has reached record highs, and the reduction in number of nests during moderate or poor conditions has been smaller and more stable. Nesting efforts in 2018 and 2021 were respectively the third and second highest effort documented during the 38-year

period of record and were followed by comparatively smaller reductions in nesting effort in 2019 (15% fewer nests) and 2022 (32% fewer nests).

Nest distribution remains widespread within the park and has expanded over the 38-year monitoring program. Wider sustained alligator distribution across hydrologic basins of varying hydroperiods may counter the impacts of high- and low-water events on nest success. It also increases habitat heterogeneity and productivity for other species. An easily observable sign that restoration may be enhancing habitat for alligators is that, even during years with poor conditions and low reproductive effort (such as drought years), alligator nest distribution remains widespread rather than contracting into the central sloughs.

Nest success fluctuates and is driven primarily by rainfall variability, water management, and predation. Throughout the monitoring program, nest flooding was the most common cause of nest failure in Everglades National Park, with nest predation only accounting for less than 2% of nest failures. However, in 2021 and 2022, predation exceeded flooding as the primary cause of total nest failure. This increase may be largely attributed to black bears, which were first confirmed as alligator nest predators in the park in 2018. Predation typically occurs earlier in incubation whereas flooding typically occurs later, therefore some predated nests may have been subject to eventual flooding. This emerging relationship between hydrology and predation needs further study to understand impacts to overall nest success rates.

AMERICAN ALLIGATORS

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Positive trend in nesting effort – Increasing trend in nesting effort throughout all freshwater marshes, particularly in peripheral marshes. The target is nesting effort consistent with a restored Everglades ecosystem.	 **Good Condition Improving**	Nesting effort has increased significantly since 1985. Recent trends show more stability during poor to moderate conditions and record numbers during favorable conditions. Nesting efforts in 2021 and 2022 were the second and sixth highest ever recorded.
Positive trend in nest success – Increasing trend in nest success and reduced failure due to flooding of egg cavity. The target is nest success levels consistent with a restored Everglades ecosystem.	 **Caution Improving**	Nest success in Everglades National Park is erratic because of natural and managed seasonal hydrologic fluctuations. Success of nests in 2021 and 2022 was above the 1985–2020 mean. Predation is a growing concern for nest failure and has outpaced failures from flooding.
Positive trend in nest density/distribution – Increasing trend in density of nests across hydrologic basins, particularly within shorter hydroperiod peripheral marshes. The target is nest density and distribution consistent with a restored Everglades ecosystem.	 **Good Condition Unchanging**	Nest density and distribution throughout freshwater hydrologic basins of Everglades National Park have demonstrated an increasing and more stable trend in recent years. Distribution across basins remains widespread even during drought years.
Positive trend in alligator abundance – Increasing trend in abundance for all size classes of alligators within freshwater wetlands. The target is an abundance of alligators consistent with a restored Everglades ecosystem.	 **Caution Unchanging**	Spotlight surveys indicate a continued relative low abundance in all size classes within Everglades National Park. However, surveys may not represent system-wide conditions given that they are generally restricted to central sloughs and because increased water depth may reduce detection probability.

Dancing great egrets | *NPS Photo by M. Beach*

Wading Birds

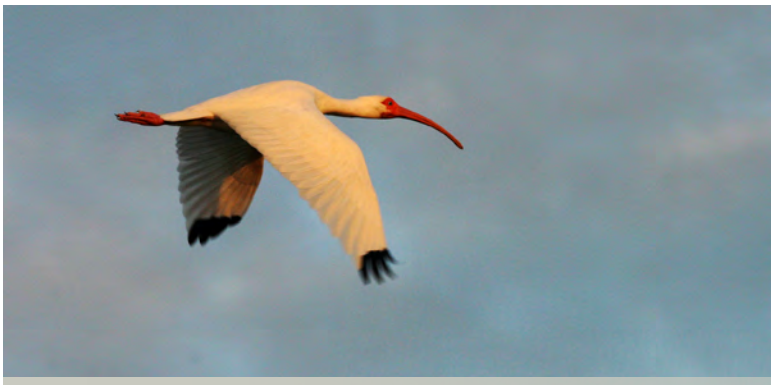
The abundance and diversity of wading birds (particularly herons, egrets, ibises, and storks) is a defining characteristic of the Everglades, and a reason for the establishment of Everglades National Park. Since wading birds are easy to monitor across the landscape and their habitat requirements and historical nesting patterns are well known, they are excellent indicators of environmental conditions. Nesting season for wading birds occurs between December and July, so information is reported in this section by nesting season rather than water year (e.g., December 2021 to July 2022 is nesting season 2022).

In the pre-drainage Everglades, wading birds regularly formed large nesting colonies at the coastal marsh/mangrove ecotone within Everglades National Park, presumably because this was the most productive region in the Everglades ecosystem. By contrast, in the post-drainage Everglades, wading bird nesting numbers were reduced by 70 to 90% throughout South Florida, and the major nesting areas shifted northward out of the park. The decline in nesting numbers within the park, and the shift northward, is thought to be related to altered hydrologic conditions (shallower wet season water depths and shortened durations of flooding) that resulted in degraded nesting habitat.

Nesting effort and distribution seemed to be improving with restoration efforts, with increasing numbers of wading birds nesting within historic coastal ecotone colony sites inside of Everglades National Park. Nesting distribution did not improve during 2022 and 2023, but remained stable, with fewer birds nesting in the park than in the Water Conservation Areas to the north (14% of nesting effort was in the park in 2022, and 23% in 2023). Efforts are still well below the Desired State of Conservation (50% of all wading bird nests located in the park's southern coastal ecotone region) but are higher than the lows of the 1990s and early 2000s (2% to 10% of nests located in the southern coastal ecotone region). Increased nesting

effort has been correlated with high water depth during the pre-nesting wet season which boosts prey production along with gradual water level recession rates during the dry season when most nesting occurs. Under these optimal conditions, aquatic prey increases before the wading birds begin nesting and is gradually concentrated into pools as water levels recede, with the highest prey density occurring when chicks require the highest level of energy for growth and fledging.

In 2018 and 2021, water depth and prey conditions in the western marl prairies and coastal ecotone of Everglades National Park appeared optimal. In response, exceptionally large white ibis supercolonies returned to the park with nesting numbers and fledgling success not observed in 70 years. Ibis supercolonies have made up the bulk of total Everglades National Park nesting numbers in recent years, and they continue to nest in large numbers within several other colonies as well. During 2022 and 2023, ibis supercolonies did not form in South Florida, but the birds continued to nest in greater numbers than in the early 2000s. If optimal hydrologic conditions occur during future nesting seasons, ibis supercolonies are expected to form again.



A flying white ibis | *NPS Photo by R. Cammauf*

Overall nest numbers in Everglades National Park during the 2022 and 2023 nesting seasons were mixed among colonies and among species. Over the long-term, nesting numbers continue to increase for ibis and slightly increase for other species, but continue to decrease for wood storks. Compared to pre-drainage dates, storks continue to nest later in the season. This puts their nests at a high risk of abandonment when rain-driven water reversals occur (i.e., water levels increase during a time when they would normally continue to recede) or when the chicks have not yet fledged before the wet season starts. Stork chicks take longer to fledge than other wading bird species, typically

A group of wood storks perched on a tree | *NPS Photo by L. Oberhofer*

leaving the nests 60 to 65 days after hatching. The longer period spent as nestlings means they are at much higher risk for abandonment when water levels rise, and the adults are unable to find enough food for the chicks. In 2022 and 2023, there was widespread abandonment of stork nests when several water recession reversals occurred before nesting had finished.

Despite increases in white ibis nesting numbers in recent years, the ratio of nesting wood storks and white ibises (tactile feeders) compared to great egrets (sight feeders) remains well below the desired proportion of 32:1, which was a characteristic described in the pre-drainage Everglades. Birds that use tactile methods of foraging require denser aquatic prey, as well as ideal hydrologic conditions to support prey production and foraging. Sight feeders, that see and stalk their prey, can forage under a wider range of environmental settings. While conditions that support ibises are improving, hydrologic conditions and prey numbers in South Florida and Everglades National Park are not yet sufficient to trigger earlier nesting in wood storks.

WADING BIRDS

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Total number of pairs of nesting birds in South Florida – Maintain or increase current total numbers of nesting birds in Everglades National Park mainland colonies to a level consistent with a restored Everglades ecosystem.	 **Good Condition Unchanging**	Since the mid-1980s, absolute size of breeding populations of ibises, storks, and long-legged wading birds have increased in the park. This trend has been stable the past 2 years.
Month of wood stork *(Mycteria americana)* nest initiation – Target is November or December.	 **Significant Concern Unchanging**	Wood storks nested in mid-February during the 2022 nesting season and late January during the 2023 season. The target of November or December nest initiation has not yet been met.
Proportion of nests located in Everglades National Park coastal ecotone region – Target is at least 50% of all wading bird nests located in the southern coastal ecotone region of Everglades National Park.	 **Good Condition Improving**	Nesting in the park did not meet the target in 2022 or 2023 (14% and 23%) but nesting continues to be higher than in the 1990s and 2000s (2% to 10%). The overall proportion is generally increasing.
Mean interval between exceptional white ibis *(Eudocimus albus)* nesting years ("supercolonies") in South Florida including Everglades National Park – Target is 1–2 years with more than 13,000 nesting pairs within a single colony.	 **Good Condition Unchanging**	The trend has shown dramatic improvement in the last decade; however, it has remained stable for the past few years. There were two supercolonies in 2018 and 2021. If conditions are right leading up to the next nesting season in 2025, a supercolony may form again.
Ratio of wood stork and white ibis nests to great egret nests – Ratio target of 32:1, characteristic of the community composition of pre-drainage conditions and thought to be representative of healthy foraging and nesting conditions.	 **Significant Concern Unchanging**	Current ratio and average of the last 3 years is 4:1, slightly lower than the previous years and still well below the 32:1 ratio.

Fire Regime

The Everglades includes several fire-dependent ecosystems, such as pine rockland and marl prairie. In pine rockland communities, fires reduce vegetation density and allow a highly diverse plant community to flourish. In ridge and slough habitat, fires support the mosaic pattern of ridges and sloughs by burning through drier ridges and contributing to soil accumulation. Too little fire will lead to overgrowth of vegetation or a shift in vegetation communities. Too much fire may impact seedling growth, vegetation recovery, or lead to soil loss. Ecosystems under natural fire regimes that maintain historic fire frequency, intensity, severity, and return interval will be more resilient and will recover more quickly from disturbances such as hurricanes.

The Desired State of Conservation is that the effects of fire on the landscape will resemble a more natural or historic fire regime. Fire-adapted habitats should experience predominately low- to mixed-severity fires. The response of vegetation communities following a fire should promote a mosaic of diverse natural habitats, while protecting fire sensitive communities from unwanted impacts. The seasonality, depth, and distribution of water within the Everglades impacts the size and severity of fires. Restoring water flows in Everglades National Park will contribute to a restored fire regime by influencing fuel availability and protecting soils.

For this report, indicators were evaluated using aerial monitoring and satellite imagery for large (>500 acres, 202 ha) fires within the ridge and slough landscape. Everglades National Park is refining methods that allow for satellite-derived spectral indices, like normalized difference vegetation index (NDVI) and the normalized burn ratio (NBR), to assess post-fire burn severity and total area burned within treatment areas. This methodology is expected to improve the park's ability to assess burn severity and coverage.

Natural, unburned areas may become more widespread as restored hydrologic conditions disrupt fuel connectivity, causing the natural spread of fire to become patchier. Thus, the desired mosaic pattern of burned and unburned area in ridge and slough landscapes may need to be re-evaluated. No monitoring was performed during the reporting period to evaluate post-fire vegetation recovery.

Patches of burned and unburned vegetation following a fire | *NPS Photo*

FIRE REGIME

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Mosaic pattern of burned and unburned landscape – Within a burn unit, the targeted range is 75–95% burned and 5–25% unburned.	 **Caution Unchanging**	The ratio of mosaic pattern of burned to unburned area was not within the desired range. Additional prescribed fire treatment during appropriate environmental conditions would help move this towards the desired condition.
Post fire vegetation recovery – Vegetation recovers following fire.	**NA**	Previous analyses suggest that vegetation recovery at one year following a burn was not substantial. No monitoring was conducted for this reporting period. Additional sampling before next reporting period is needed to evaluate this indicator.

The Coastal and Estuarine Environment

Salinity Patterns in Florida Bay

Salinity is one of the primary conditions controlling the major ecological processes in coastal and estuarine ecosystems of Florida Bay and along the Gulf Coast of Everglades National Park. Salinity influences the distribution of aquatic plants and animals, overall biological productivity, and nutrient cycling. In the pre-drainage Everglades, freshwater inflows to Florida Bay were more seasonally and annually persistent. This created lower salinity conditions throughout much of the year, over large areas along the park's coastline from the Gulf of Mexico and throughout much of Florida Bay. In the post-drainage Everglades, most of the historic freshwater flows have been diverted to the northern St. Lucie and Caloosahatchee estuaries or have been used to meet urban and agricultural water supply needs. Consequently, the southern coastal ecosystems receive far less fresh water, and salinities routinely reach and exceed oceanic conditions (35 Practical Salinity Unit, PSU).

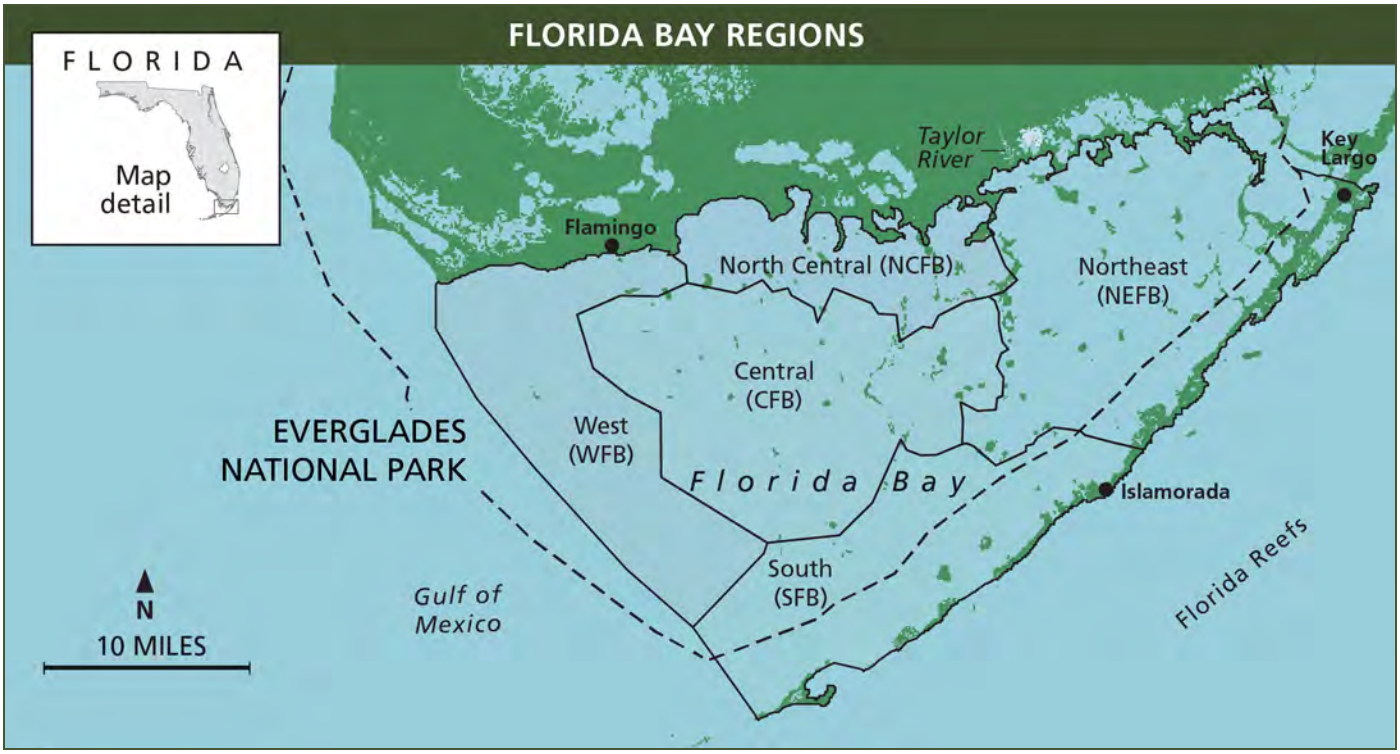
Three metrics are used to track the influence of hydrologic restoration activities on salinities in Florida Bay: the amount of time each year salinities are in the desired range, the difference between observed mean salinities and the desired low-salinity targets, and the frequency of extreme high-salinity events. These targets are based on predicted pre-drainage conditions derived from a combination of paleo-ecological studies and model simulations.

During the WY22–WY23 reporting period, salinities generally did not overlap with desired conditions. Over the previous five-year period, salinities were routinely above the predicted pre-drainage target range for desired conditions, except for the 2021 dry season and 2019 wet season during which several monitoring stations met the desired conditions. Hypersalinity events, while still common, were not as extreme as observed in WY15 and WY16 when values at some stations exceeded 70 PSU. During the current reporting period, salinity in the most isolated basin within North Central Florida Bay (NCFB) reached 50 PSU. Hypersalinity (salinity levels greater than 40 PSU) events also continued to occur throughout the Central Florida Bay (CFB) region. The Northeast Florida Bay (NEFB) region is more isolated from the neighboring basins to the south and is directly connected to TS. This area experienced extended periods of mesohaline (5–18 PSU) conditions throughout the wet season

because of rainfall and runoff. This was possibly a sign of increased freshwater delivery from changes in operations and project features in the neighboring C-111 basin. Ultimately, conditions were variable across the bay, but conformed to the historic spatial pattern of hypersalinity dominating the central and coastal basins late in the dry season, with more moderate conditions throughout the year and in the remaining basins of the bay.

Given that evaporation slightly exceeds precipitation, hypersalinity will be common unless additional managed freshwater flow can be provided to the bay. Currently, managed flow is delivered primarily through TS and, to a lesser extent, through numerous other small creeks and rivers as a result of water deliveries and seepage management along the eastern boundary of Everglades National Park. Progress has been made in southern TS seepage management, and increased freshwater level in the slough can be observed in the data. However, insufficient freshwater delivery to the park during the dry season from the upstream basins allows seasonal saltwater intrusion events to occur. These events can be observed across the coastal landscape but are most closely tracked where saltwater reaches the park's hydrologic monitoring stations located in the usually freshwater reaches of TS. Until the full suite of flow restoration projects is implemented, hypersaline conditions will continue to dominate the Florida Bay landscape and saltwater will continue to impact the neighboring freshwater sloughs.

A wet sawgrass prairie | *NPS Photo by G. Gardner*



Regions of Florida Bay used for reporting salinity and algal bloom indicators.

SALINITY IN FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Amount of time during the year that salinity is in the desired range – Salinity is within the interquartile range of the desired conditions 50% of the time.	 **Significant Concern Unchanging**	Salinity conditions did not meet the desired state at any monitoring station during the reporting period. Salinity was within the interquartile range of desired conditions for less than 14% of days at each station during each WY, and at some stations did not fall within the desired range of conditions at all. Conditions are variable but exhibit no year-to-year trend.
Difference between observed mean salinities and desired mean salinities – The mean salinity is within the variability of the mean salinity of desired conditions.	 **Significant Concern Unchanging**	The mean salinity is above the desired mean salinity throughout the year. The degree of difference over the period of record is variable and largely driven by precipitation. It shows no year-to-year trend.
Occurrence of extreme high-salinity events – Salinity does not exceed the 90th percentile defined by the desired conditions more frequently than 10% of the time.	 **Significant Concern Unchanging**	Salinity exceeds the 90th percentile of the desired conditions more frequently than desired and, while variable, shows no year-to-year trend.

Algal Blooms in Florida Bay

Agal blooms may occur when there is an excess of nutrients in an aquatic system. In Florida Bay, algal bloom episodes have been documented to last from weeks to years. Excess nutrients may be introduced to the water column in a variety of ways. Hypersalinity events causing seagrass die-offs can cause an increase in nutrients as the seagrass decays. Nutrients may also be re-suspended and made available from sediments, particularly in areas which do not have seagrass stabilizing them. Even upstream events, such as the death of coastal mangroves due to hurricane impacts, may serve as a source of nutrients which can be transferred to the bay via freshwater inflows. Some identifiable major events have contributed to the input of excess nutrients to the system, including a seagrass die-off in 2015 and Hurricane Irma in 2017.

Sustained algal blooms can negatively affect seagrass habitat and sponges. Monitoring excess nutrients is important for understanding water quality.

Chlorophyll-*a* (chl-*a*) concentration is often used as an index of the biomass of phytoplankton cells (i.e., the amount of algae growing in a waterbody), and it is used as an indicator of Florida Bay water quality. Higher chl-*a* concentrations correspond to greater bloom intensity and reflect higher nutrient and lower light availability in the bay.

Florida Bay chl-*a* concentrations declined from WY18 to WY22, potentially reflecting recovery from the excess nutrients added to the system following the large seagrass die-off in 2015 and Hurricane Irma in 2017. However, in WY23, chl-*a* concentrations increased and surpassed desired thresholds in NCFB and CFB regions. The NCFB region appears to be relatively more susceptible to algal blooms than other regions of Florida Bay, as shown by high concentrations in WY23, as well as in WY18 and WY19. The CFB region also exceeded desired concentrations in WY23. Conversely, West Florida Bay (WFB), South Florida Bay (SFB), and NEFB had

more stable chl-*a* levels and have met the criteria of the Desired State of Conservation since WY19.

Environmental and regional factors such as freshwater input, wind, and tidal patterns have a role in the spatial distribution and concentration of algal blooms. The blooms generally start in NCFB and flush into other regions, particularly CFB, SFB, and WFB. Due to this dynamic nature, it is difficult to predict the spread and impacts of algal blooms. Thus, trends are reported here as unknown in some regions. Data analysis methods to evaluate trends using more spatially explicit techniques are being refined. Everglades National Park is also working with partners to further investigate the drivers of algal blooms.

An aerial view of Florida Bay | *NPS Photo by L. Oberhofer*

CHLOROPHYLL-a CONCENTRATIONS IN FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
NEFB chl-*a* concentration – Annual median concentration below 1 µg L^{-1}.	**Good Condition Unchanging**	Annual median chl-*a* concentration has remained below 1 µg L^{-1} for each of the last five WYs.
CFB chl-*a* concentration – Annual median concentration below 3 µg L^{-1}.	**Significant Concern Trend is Unknown**	Annual median chl-*a* concentration exceeded 3 µg L^{-1} in WY23 and is the highest concentration recorded from WY18 to WY23.
SFB chl-*a* concentration – Annual median concentration below 1 µg L^{-1}.	**Caution Unchanging**	Annual median chl-*a* concentration has remained below 1 µg L^{-1} for each of the last five WYs. Although the annual median is still within the desired range, higher than normal concentrations were observed in WY23, likely influenced by water movement from NCFB.
WFB chl-*a* concentration – Annual median concentration below 3 µg L^{-1}.	**Good Condition Unchanging**	Annual median chl-*a* concentrations have not exceeded 3 µg L^{-1} in the last five WYs.

Seagrasses in Florida Bay

Seagrass communities of Florida Bay play an essential ecological role in sustaining the overall bay ecosystem. Seagrass beds provide habitat and food for fauna while supporting productivity and biodiversity. They also provide important ecosystem services such as stabilizing sediments and sequestering carbon and nutrients. This helps to improve and sustain water clarity and quality in the bay. Consequently, a robust community of seagrasses improves the overall health of the bay. Turtle grass (*Thalassia testudinum*) is the dominant seagrass species of Florida Bay and is mixed with other species including shoal grass (*Halodule wrightii*) and manatee grass (*Syringodium filiforme*). The Desired State of Conservation for seagrasses in Florida Bay includes the recovery of seagrass beds over most of the bay bottom, and the restoration of a diverse mosaic of seagrass communities composed of species expected to occur based on geographic location in the bay. Everglades National Park and restoration partners conduct extensive monitoring of the abundance and diversity of this critical ecosystem throughout Florida Bay. Following the limited monitoring in 2020–2021 due to the COVID-19 pandemic, monitoring of the entire bay was conducted in 2022.

In 2022, seagrass recovery from the 2015 seagrass die-off event continued to vary spatially across the most strongly affected areas. In CFB, there was evidence of continued recovery despite the setback caused by Hurricane Irma in 2017. Both turtle grass and shoal grass continued to show slow increases in abundance, yielding improved habitat quantity and quality in this region, particularly those basins most impacted by the 2015 seagrass die-off. There is still cause for concern in CFB as improvements were small to moderate and progress may be leveling off when considered across the region. Persistent algal blooms in the region are likely slowing seagrass recovery.

In WFB, total seagrass cover has been increasing since the 2015 die-off event, primarily driven by increases in colonizer shoal grass and modest increases in manatee grass. However, the region showed continuing decline in turtle grass abundance. These patterns may be influenced by algal blooms and elevated suspended sediments that have persistently occurred in this

Turtle grass in Florida Bay | *NPS Photo*

region since Hurricane Irma. Increases in seagrass abundance in the region may reduce suspended sediments in coming years. Despite some encouraging signs, density of the target species remains far below levels prior to the die-off.

Seagrass cover in NEFB, particularly turtle grass, unexpectedly declined in 2022 and the decline remains largely unexplained. Shoal grass generally increases in cover when turtle grass declines, but this did not occur in NEFB, leading to an overall reduction in seagrass cover. Bay-wide, the cover of turtle grass has declined to the lowest levels recorded since consistent monitoring began. In 2022, macroalgae cover across Florida Bay exceeded seagrass cover for the first time. While local improvements in seagrass coverage in some basins, particularly those in the northern part of CFB suggest some cause for optimism, there has not been consistent or widespread improvement, and consequently still cause for concern about seagrass recovery. Further monitoring is needed to increase confidence in assessments of long-term trends.

SEAGRASSES IN NORTHERN COASTAL TRANSITION ZONE OF FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Seagrass abundance – Consistent with restored habitat in the Everglades ecosystem.	 **Caution Unchanging**	Seagrass density largely remained stable in this region.
Seagrass species diversity – Promotion of sustainable habitat that is consistent with a restored Everglades ecosystem.	 **Caution Unchanging**	Seagrass diversity remained largely unchanged. However, low-salinity indicator species like widgeon grass have occurred less frequently in recent years.

SEAGRASSES IN CENTRAL ZONE OF FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Seagrass abundance – Consistent with restored habitat in the Everglades ecosystem.	 **Significant Concern Unchanging**	The die-off event that started in 2015 and subsequent impact by Hurricane Irma impeded the recovery of seagrass in the region. Some small increases in abundance suggest improvement, but overall abundance has not improved substantially.
Seagrass species diversity – Promotion of sustainable habitat that is consistent with a restored Everglades ecosystem.	 **Significant Concern Improving**	There has been limited recovery of some target species in the region following the 2015 die-off event, and species diversity appears stable to slightly improving.

SEAGRASSES IN WESTERN ZONE OF FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Seagrass abundance – Consistent with restored habitat in the Everglades ecosystem.	 **Caution Improving**	The 2015 die-off event strongly impacted some western basins and banks. There has been a slight increase in seagrass cover that may signal recovery and improving stability.
Seagrass species diversity – Promotion of sustainable habitat that is consistent with a restored Everglades ecosystem.	 **Good Condition Unchanging**	Species index scores remained good because the target species remained common. Declines in turtle grass were offset by gains in shoal grass and some manatee grass, leading to slight improvement in diversity.

SEAGRASSES IN NORTHEASTERN ZONE OF FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Seagrass abundance – Consistent with restored habitat in the Everglades ecosystem.	 **Caution Deteriorating**	Seagrass abundance declined unexpectedly in 2022, particularly turtle grass. There was not a clear cause for the decline and water quality remains good. This region has historically been stable, though seagrass cover has never been high.
Seagrass species diversity – Promotion of sustainable habitat that is consistent with a restored Everglades ecosystem.	 **Caution Unchanging**	Declining abundance in turtle grass was not offset by an increase in shoal grass, but overall species diversity remains relatively stable. Increases in manatee grass contributed to maintaining diversity.

SEAGRASSES IN SOUTHERN ZONE OF FLORIDA BAY

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Seagrass abundance – Consistent with restored habitat in the Everglades ecosystem.	**Significant Concern Deteriorating**	Seagrass abundance has continued to be very low in the region since 2011 and declined in 2022.
Seagrass species diversity – Promotion of sustainable habitat that is consistent with a restored Everglades ecosystem.	**Significant Concern Unchanging**	Species composition and diversity remain low, with target species being rare. Shoal grass increased while turtle grass declined.

Estuarine Fish Abundance

The Gulf Coast and Florida Bay estuaries are world renowned for their large and diverse sport fish populations. The angler catch rates of four native sport fishes—snook, red drum, spotted seatrout, and gray snapper—are used as ecological indicators of the condition of South Florida estuarine ecosystems. These species were chosen because they are among the most frequently caught species, they can be found in the region at points in their life, and each relies on a variety of other fish and invertebrate species as prey.

Sport fish catch rates are monitored by Everglades National Park using creel surveys that ask recreational anglers about their catch and fishing practices. Catch per unit effort (CPUE or catch rate) is an indirect measure of fish species abundance that can be calculated from creel surveys to provide information on species trends. The Desired State of Conservation for each of the four sport fishes is to achieve a stable to increasing trend in catch rate, which indicates sustainable recreational use. Within the next reporting period, data analysis to link targets with restoration of freshwater flows and stabilization of salinity will be underway or completed.

Snook catch rates were generally increasing until 2010 when an extreme cold event in January of 2010 (WY11) caused widespread mortality of this sub-tropical temperate fish. The State of Florida imposed a moratorium on snook harvest for two years after the event to allow for population recovery. Snook catch rates remained stable but low between WY11 and WY17, suggesting approximately 6 to 7 years to recover to pre-cold event catch rates. Snook catch rates then had large increases between WY18 and WY21, reaching an all-time high. The past six years have remained higher than any of the previous years during the period of record.

An angler fishes at sunset | *NPS Photo by G. Gardner*

Red drum had consistently declining catch rates in the mid-1980s to 2010 but have experienced several years of large increases in catch rates, including WY11 to WY13 and WY19 to WY20. The increased catch of red drum (and snook) between WY19 and WY20 were undersized fish indicating a recent, large reproductive success. However, outside of these high periods including the last four years, catch rates have dropped to low values similar to those in the mid-1980s through 2010.

Spotted seatrout catch rates have been variable, generally increasing from the late 1970s to mid-1980s, then remaining variable and without a discerning increasing or decreasing trend until 2000. Post-2000, catch rates have continued to be variable and have also been lower than rates from the mid-1980s to 2000. Spotted seatrout catch rates were the lowest on record in WY23. This indicator species should be watched to ensure local population viability.

Gray snapper catch rates have been variable since the mid-1970s. Over the last six years, catch rates have been lower than the 1980s and 1990s, with some of the lowest rates across the full record. WY23 was the third-lowest recorded value.

ESTUARINE FISH (SPORT FISH) ABUNDANCE

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Trend in snook *(Centropomus undecimalis)* CPUE – The target is for the CPUE to reach 2008–2010 levels, or at least exhibit a stable trend.	 **Good Condition Improving**	Snook catch rate has increased substantially since WY17. Catch rates were at an all-time high between WY18 and WY21 and remained high during the WY22–WY23 reporting period. Consistent high catch rates may indicate recovery from the 2010 cold event and additional population growth.
Trend in red drum *(Sciaenops ocellatus)* CPUE – The target is a stable to increasing trend in CPUE.	 **Good Condition Unchanging**	Red drum catch rates peaked in WY11 and WY12, shortly after the 2010 extreme cold event, then declined to a record low in WY17. In WY19–WY20, catch rates briefly increased to levels close to those observed after the extreme cold event but declined again and have been stable since WY21 and similar to those observed prior to the 2010 extreme cold event.
Trend in spotted seatrout *(Cynoscion nebulosus)* CPUE – The target is a stable to increasing trend in CPUE.	 **Good Condition Deteriorating**	Spotted seatrout catch rate declined from the previous reporting period. WY22 and WY23 had the lowest ever recorded catch rates, although they have been relatively stable over the last 20 years.
Trend in gray snapper *(Lutjanus griseus)* CPUE – The target is a stable to increasing trend in CPUE.	 **Caution Deteriorating**	Gray snapper catch rates have been variable but relatively stable over time; however, catch rates have been relatively low between 2018 and 2023.

American Crocodiles

The American crocodile (*Crocodylus acutus*) is an Everglades ecosystem indicator because its life cycle is sensitive to changing patterns of freshwater flow, salinity, and estuarine productivity. Crocodiles were federally listed as an endangered species in 1975 due to habitat degradation and over-hunting. Everglades National Park comprises much of the crocodile range in the United States, and they have been intensively monitored since 1978. After slowly showing signs of population recovery and exceeding expectations of nesting effort, the species was reclassified as threatened in 2007. There are more crocodiles in South Florida now than anytime over the last 45 years.

Crocodile metrics related to hydrologic restoration include population, distribution, nest distribution, nesting effort, and growth and survival from hatchling to late juvenile stages. Upstream water management practices have reduced freshwater inflows which causes increased salinity and decreased estuarine productivity in coastal areas of Florida Bay. As upstream hydrologic restoration projects are completed to bring more natural freshwater flows to the coastal area of Florida Bay, increased crocodile population growth, nesting success, and juvenile survival are expected.

Crocodiles nest late in the dry season. Nesting occurs primarily in elevated, sandy areas along mangrove shorelines and manmade berms. Hatchlings migrate inland from their nesting sites to nursery areas to avoid prolonged exposure to high salinities and to reduce predation risk. The effects of unrestored freshwater flows include decreased prey production and availability, longer hatchling migration to nursery habitat, reduced use of nest sites further from mainland freshwater sources, and impacts to growth, survival, and dispersal of juvenile crocodiles. Sea level rise continues to be a concern for crocodiles within the park as historical nest sites may become inundated faster than new suitable sites become available.

American crocodiles are doing well overall within Everglades National Park. Abundance and distribution have been increasing for decades, and this trend continued in recent years. Nesting

An American crocodile | *NPS Photo by F. Acevedo*

effort has generally increased throughout the park, particularly in the Flamingo/Cape Sable region where historic drainage canals that previously allowed seawater to penetrate the interior brackish wetlands were plugged. Although nesting effort slightly declined in 2022, largely due to reduced nesting in NEFB, 2023 had the largest documented nesting effort in the 53 years of monitoring this species. Crocodiles have been using new nesting areas in recent years with high nesting success.

Hatchling growth and survival within Everglades National Park are considerably higher than outside the park. Predation is believed to be the primary cause of hatchling mortality. Faster growth rates reduce the time spent at sizes most susceptible to predation. Growth rates were variable but high in most regions of the park. Restoration may lead to an increase in populations of animals that prey upon hatchling crocodiles. However, crocodile population size is not likely to be negatively affected, since crocodiles will also benefit from restoration.

An area of concern for crocodile recovery is NEFB which continues to experience reduced flows and periodic hypersaline events. Crocodile abundance and nesting have increased in NEFB at a slower rate than other areas within the park. Crocodile nesting in NEFB peaked from 2012 to 2016 but then exhibited a two-year decline before once again increasing from 2018 to 2021. Following a decline in nesting in NEFB in 2022, which largely accounted for a parkwide decline in nesting that year, nesting effort rebounded in 2023 but remained below the peak period of 2012–2016. Prey production and habitat suitability in this region are expected to benefit from several ongoing restoration projects designed to increase volume and duration of freshwater flow while reducing frequency of extreme saline conditions.

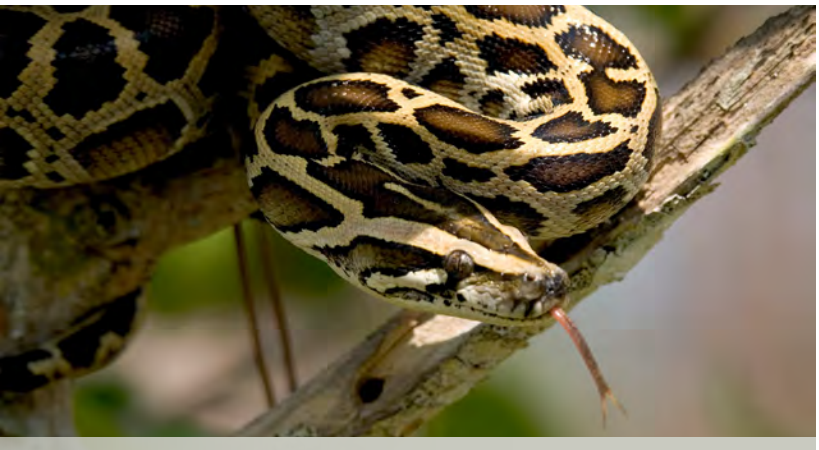
AMERICAN CROCODILES

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Trend in total population – Population is nearing pre-drainage estimates consistent with a restored Everglades ecosystem. Occupation throughout historic range.	 **Good Condition Improving**	Total population is inferred from the other metrics monitored. Range for species occurrence and nesting effort has continued to expand within, and beyond, Everglades National Park in recent years. The species now occurs throughout their historical range in the United States and is likely moving towards historical abundance.
Trend in reproduction – Increasing trend in nesting effort, distribution, and success in Everglades National Park, including historical nesting sites in NEFB. Increasing trend in growth and survival of juvenile crocodiles, consistent with a restored Everglades ecosystem.	 **Good Condition Improving**	Reproductive effort within the park has exhibited an increasing trend. More nests were documented in 2023 than in the prior 53 years of monitoring effort. Nest success varies by habitat and region yet is typically high in the park with few total failures. New nesting areas have been documented in recent years.
Trend in hatchling- juvenile growth and survival – Reduced salinity regimes occur, encouraging rapid hatchling growth rates (approaching mass ≥ 200 g 3–4 months post-hatching) and allowing juveniles to more rapidly reach total length ≥ 75 cm.	 **Good Condition Unchanging**	Recent analysis indicates hatchling growth remains high, but changes have been hard to detect. Reduced survey effort makes detection and analysis of short-term or annual changes in growth and survival less certain.

Invasive Species

Invasive, or nonnative species, are problematic for the Everglades ecosystem. As an example, there are more than twice as many established invasive lizard species as there are native lizards. The number and severity of invasive plant and animal species within Everglades National Park are a large-scale problem needing a consistent high level of resources to effectively manage. This threat to the Outstanding Universal Values (OUVs) is expected to persist for many years.

Everglades National Park places the highest management priority on (1) nonnative species that are the most invasive and expected to cause the greatest ecological harm to native plant and animal communities; (2) early detection and rapid response (EDRR) to new invasive plant and animal populations; and (3) research to improve management of invasive species. The park is working to maintain and expand existing successful invasive species management programs, but the scale of the problem, the lack of available control tools, and the limited resources have prevented establishment of control programs for some invasive species. The park does not have jurisdictional authority over nearby areas from which new invasive populations may originate, nor does the park have the ability to generate policies that may prevent new introductions. Instead, the park engages in formal collaborations with federal, state, and local partners through participation in the Everglades Cooperative Invasive Species Management Area Steering Committee and the Florida Invasive Species Council. The result of these partnerships is regular coordination of management actions and research priorities for multiple taxa, as well as a synergy of resources across agencies.



A Burmese python in a tree | *NPS Photo by R. Cammauf*

Invasive Plants

Approximately 1,040 plant species have been reported in Everglades National Park. Approximately 270 of these are nonnative and approximately 68 are considered invasive according to the Florida Invasive Species Council's 2023 Plant List. The number of invasive plants and the threat of invasive plants from adjacent lands are increasing. Within the park, melaleuca, Australian pine, Old World climbing fern, Brazilian peppertree, and shoebutton ardisia are the five most widespread species requiring intensive and ongoing management via chemical control, biological control (e.g., natural predators of the species), and mechanical control (e.g., physical removal) methods. The Desired State of Conservation for these key invasive plants and their management approaches are species-dependent and reflect available funding for control, current treatment technologies, and their biology, distribution, and accessibility in the park. Melaleuca, Australian pine, Brazilian pepper, and Old World climbing fern were aerially monitored in 2019–2020, and systematic surveys are now conducted on a five-year interval. Other invasive species inhabit the understory or have localized distributions that make it difficult to confidently estimate changes in area covered by these taxa.

Melaleuca receives the most management attention of any invasive plant in the park via the application of chemical and biological control agents. The total area infested by melaleuca decreased within treatment areas during the reporting period, but there was an increase of low-density areas that were not within the current treatment rotation. In 2024 and 2025, the park plans to treat the remaining initial infestations of melaleuca, keep the area already at maintenance level in a treatment rotation, and treat a portion of the low-density outlier areas.

Australian pine is second in terms of the amount of effort dedicated to management. Chemical treatment of Australian pine took place in the southeastern Saline Glades region of the park in 2022. This resulted in a decrease in total area during the reporting period.

Some infestations of Old World climbing fern have been treated using biological control agents (mites and moths). Prescribed fires have also been conducted in the fire-adapted plant communities infested with Old World climbing fern, but landscape-level chemical treatment of Old World climbing fern did not occur during the reporting period. The remoteness of infested areas, where helicopter access is typically required, substantially increases treatment costs and limits management options. Similarly, the plant's biology requires more frequent retreatment than melaleuca and Australian pine. Results of aerial surveys indicated that the total area infested with Old World climbing fern has declined during the reporting period. The reason for the decline is uncertain.

Flower of a melaleuca tree | *USGS Photo*

Management of Brazilian peppertree is generally limited to areas near man-made disturbances (e.g., roadsides, former farmlands) and in areas where melaleuca, Australian pine, and shoebutton ardisia treatment is occurring. A biological control option (Brazilian peppertree thrips) became available in 2019 and was released in Everglades National Park in 2021 and 2022. There are additional releases planned for

The saline glades with invasive Australian pine trees | *NPS Photo*

the next few years. The effectiveness of the biological control agent is still being studied. Mechanical control is expensive and, like Old World climbing fern, retreatment must be frequent. Overall, there was a slight decline in the total area infested with Brazilian peppertree and its distribution. The reason for this decline is unclear.

Management of other invasive plants is limited to areas of high concern such as visitor-use areas, as well as habitats for threatened and endangered species. The effectiveness of chemical and biological control approaches differs by species. Though many infestations were treated during the reporting period (e.g., latherleaf and lead tree), there is insufficient information to assess changes to the total area with greater than 1% cover of these invasive plants.

Early detection of new invasive plant populations is achieved through active monitoring as part of the Corridors of Invasiveness project conducted by NPS partners at the South Florida/Caribbean Inventory and Monitoring Network. This monitoring occurs on a five-year rotational basis and did not occur during the reporting period but will be included within the next reporting period. Park biologists also actively monitor for new invasive plant populations at disturbed and modified sites and passively monitor during other activities. During the reporting period, no new invasive plants were reported.

INVASIVE PLANTS

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Percent cover of melaleuca *(Melaleuca quinquenervia)* – Less than 1% cover per km² present in currently infested areas and the area of infestation is not expanding.	 **Caution Improving**	Melaleuca decreased within treatment areas, but there was an increase in low-density untreated areas.
Percent cover of Australian pine *(Casuarina equisetifolia)* – Less than 1% cover per km² present in currently infested areas and the area of infestation is not expanding.	 **Caution Improving**	Australian pine decreased in total infested area during the reporting period, but the desired conditions have not yet been met.
Percent cover of Old World climbing fern *(Lygodium microphyllum)* – Less than 5% cover per km² present in currently infested areas and the area of infestation is not expanding.	 **Significant Concern Improving**	The total area infested by the Old World climbing fern declined during the reporting period, but the cause of the decline is unknown.
Percent cover of Brazilian peppertree *(Schinus terebinthifolius)* – Less than 5% cover per km² present in currently infested areas and the area of infestation is not expanding.	 **Significant Concern Improving**	Management is limited to specific areas of high priority. A new biological control was approved and released in 2019. The effectiveness of this new biological control is still being studied. Overall, the area of infestation is declining slightly for unknown reasons.

INVASIVE PLANTS (CONT.)

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Percent cover of additional collective invasive plant species – Less than 1% cover per km^2 present in currently infested areas and the area of infestation is not expanding.	**Significant Concern Deteriorating**	Management efforts for these species are currently limited to areas of high concern, such as those with high visitor use or areas with threatened and endangered species. The overall area affected by these plants is increasing.

Invasive Animals

Invasive animals continue to present significant challenges in Everglades National Park, and preventing the arrival and establishment of new species remains the preferred course of action. Freshwater fish, marine fish, and herpetofauna remain the main concern for introduction and establishment of invasive animals to the park. The upstream canal system and adjacent developed areas along the eastern park boundary serve as the fronts of most invasions.

The Desired State of Conservation for nonnative freshwater fish is to reduce the rate of new introductions and maintain a relative abundance of less than 2% of the total abundance of freshwater fishes. Management tools to contain or suppress nonnative fishes in open waters are limited. Park efforts focus mainly on monitoring for early detection and long-term trends that inform water management decisions and limit spread. Nonnative fish introductions are primarily a result of dispersal from waters outside of the park jurisdiction. Everglades National Park collaborates and supports federal and state partners to perform specific actions that help curb invasions including environmental DNA sampling for early detection of invasive fishes in and near the park, periodic sampling of canals adjacent to and near the park, and research to characterize detection bias among invasive fishes using different sampling approaches.

Nile tilapia | *USGS Photo*

During the reporting period, one new nonnative fish was observed within park boundaries. In January 2023, a park employee observed and photographed a zebra tilapia (*Heterotilapia buttikoferi*) in a viewing pond at the Ernest F. Coe Visitor Center. There have been no other reports of zebra tilapia in or around the park, although the species is well-established further northeast in Miami-Dade County. Another recent invader, Nile tilapia (*Oreochromis niloticus*), has become more common during the reporting period and continues to be observed in greater frequency in the park. Three other nonnative fishes, the Midas cichlid (*Amphilophus citrinellus*), goldline snakehead (*Channa aurolineata*), and grass carp (*Ctenopharyngodon idella*), have not yet been found inside the park though they occur or have been detected in adjacent canal systems. Several other invasive fishes have established populations in the broader South Florida canal system and could pose a risk to spread into Everglades National Park.

The relative abundance of invasive freshwater fishes in SRS has remained below 2% during this reporting period. The relative abundance of invasive fish fluctuated around 2% (1.7% in WY22 and 2.2% in WY23) in TS. The Asian swamp eel (*Monopterus albus*/

javanensis) remains abundant, and where it has become particularly abundant in TS, it has been implicated in the virtual disappearance of several native fish and crayfish species known or thought to be vulnerable to fish predators. The swamp eel appears to be spreading throughout the park's freshwater areas and is a concern for the ecosystem. Parkwide monitoring efforts covering additional freshwater habitat found invasive fishes at 40% of monitoring sites in WY22 and 47% of monitoring sites in WY23. Invasive species represented 2.7% and 3.2% of the total catch at these sites in WY22 and WY23, respectively. This was an increase in the number of sites where invasive species were observed in WY21 (approximately 15%). Mayan cichlid (*Mayaheros urophthalmus*) and Asian swamp eel were the most caught invasive fishes in Everglades National Park through WY22 and WY23.

The Indo-Pacific lionfish is the only notable marine invasive animal species in and around Everglades National Park. The Desired State of Conservation is to minimize the number and reduce the spatial distribution of lionfish. Lionfish surveys did not occur during 2022. However, incidental observations of lionfish, as well as the absence of lionfish at many known sites where the species had been documented, suggests that lionfish remain present at low abundance within marine areas. Previous surveys suggest that the number and spatial distribution of lionfish in the park are low, not increasing, and possibly decreasing, though survey data are limited and restricted to submerged habitats with hard bottoms and man-made features. These are the only habitats where lionfish have been captured in Everglades National Park thus far, and they are relatively scarce. However, lionfish are known to occupy a wider range of habitats that occur at greater frequencies in the park, including estuaries and mangroves.

The management metrics for invasive reptiles and amphibians include minimizing or eliminating new introductions and containing or suppressing known invasive species within Everglades National Park. Recent studies suggest that all previously documented invasive reptile and amphibian species continue to persist

Indo-Pacific lionfish | *USGS Photo*

across their formerly known range in and around the park. Burmese pythons (*Python bivittatus*) have been established in the park for decades, and their distribution extends far beyond park boundaries. Burmese pythons were captured in record numbers during the reporting period in part because of state-supported paid removal programs in the park. Everglades National Park is aggressively pursuing additional collaborations with federal, state, and local partners to improve long-term python management and research coordination. For example, the park supports an Interagency Python Management Plan that was completed during the reporting period. Similarly, park scientists co-authored a synthesis of Burmese python research published in 2023 that identified best-management practices and laid the groundwork for future research.

A population of Argentine black and white tegu lizards (*Salvator merianae*) was established east of Everglades

National Park over 15 years ago and has now spread into the park. Park staff are coordinating with federal and state partners to implement an aggressive population-suppression program but continue to capture hundreds of tegus in and around the park. The Northern African python (*Python sebae*) is also established outside the park but is rarely observed (only 7 were removed from outside park boundaries during the reporting period).

Additional nonnative herpetofauna species have expanded their range in recent years, and these species present potential threats of incursion into park boundaries and are a focus of EDRR. The Everglades Invasive Reptile and Amphibian Monitoring Program did not detect any new populations during the reporting period despite weekly surveys coordinated by university partners. Park biologists continue to increase education and outreach efforts and develop improved EDRR protocols for the park. As a result, reports of nonnative reptiles continue to increase, including Peter's rock agamas, northern curly-tailed lizards, green iguanas, and Cuban knight anoles. New species detected during the reporting period were a red-footed tortoise, black spiny tailed iguana, and California kingsnake, although these individuals are not believed to be currently breeding in the park. Individuals are removed, when possible, but available methods (e.g., hand capture and trapping) are not always ideal solutions for removal. New techniques are always being assessed to aid in control of these emerging populations.

INVASIVE FRESHWATER FISH

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Rate of new introductions of nonnative fish – A decreasing rate over time.	 **Significant Concern Unchanging**	Records of invasive fishes occupying canals adjacent to Everglades National Park suggest an increased risk of new introductions. A new invasive freshwater fish (zebra tilapia) was observed once in the park.
Relative abundance of nonnative fishes in SRS – Freshwater fish assemblage contains less than a 2% relative abundance of nonnative individuals.	 **Caution Unchanging**	Invasive species are present at less than the 2% threshold of relative abundance at monitored sites. Even though sampling excludes large invasive fishes, observations suggest that some large species continued to spread throughout Everglades National Park freshwaters during this reporting period.
Relative abundance of nonnative fishes in TS – Freshwater fish assemblage contains less than a 2% relative abundance of nonnative individuals.	 **Significant Concern Unchanging**	Invasive species are present and relative abundance remained above the 2% threshold at monitored sites. The sampling method excludes large invasive fishes that have very high abundance and have been implicated in reduced abundance of crayfish and certain small native fishes.
Relative abundance of nonnative fishes park-wide – Freshwater fish assemblage contains less than a 2% relative abundance of nonnative individuals.	 **Significant Concern Unchanging**	The park-wide sample method differed from previous years, and relative abundance in Everglades National Park was not available this reporting period. However, the data do show that the frequency of occurrence of invasive fish has increased in the reporting period.

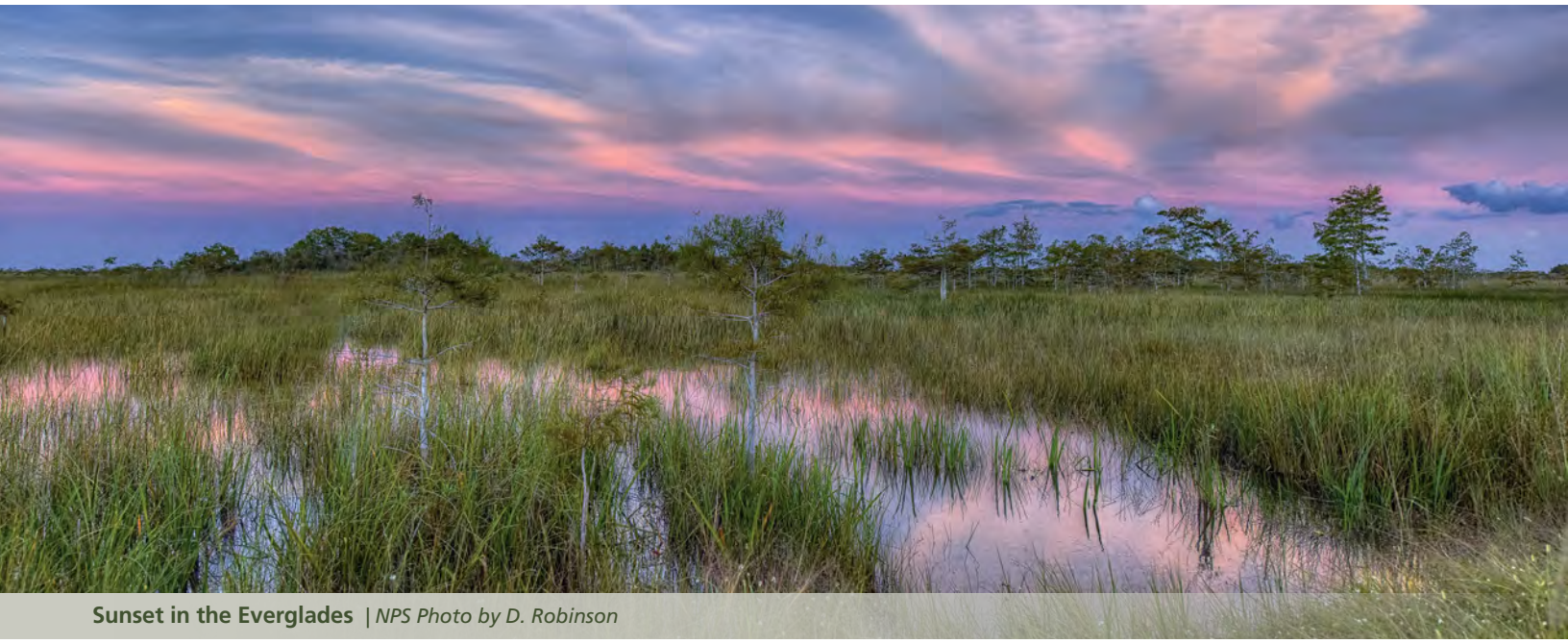
INVASIVE MARINE FISH

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Lionfish density – Minimize the number of lionfish in Florida Bay.	**Caution Unchanging**	Density of lionfish is low in Everglades National Park compared to surrounding habitat types (complex reef and deeper waters).
Biomass of prey species – Minimize the impact from lionfish on post-settlement native fish and invertebrate populations.	**Caution Unchanging**	The impact on prey species by increasing lionfish density or distribution is potentially large, but current estimates of lionfish density and distribution are not expected to significantly affect biomass of prey species.
Distribution of lionfish – Minimize the spatial distribution of lionfish.	**Caution Unchanging**	Limited data suggest the distribution of lionfish has not increased within park boundaries, perhaps because available habitats are not as suitable as those found in adjacent waters. Nonetheless, lionfish can occupy any habitat type within marine waters of Everglades National Park.

An aerial view of Everglades National Park wilderness | *NPS Photo by L. Oberhofer*

INVASIVE HERPETOFAUNA

DESIRED STATE OF CONSERVATION	2024 ASSESSMENT	RATIONALE
Rate of new herpetofaunal introductions in and around Everglades National Park – Minimize and eliminate these introductions to the park.	**Significant Concern Deteriorating**	New species continue to expand their range in South Florida. There is a need for additional comprehensive preventive regulation.
Containment and control of established populations: Burmese python – Contain and decrease the population.	**Significant Concern Deteriorating**	Available evidence suggests Burmese pythons occupy an increasingly large range.
Response efforts to known invasives adjacent to Everglades National Park: Northern African python – Eliminate known invasives adjacent to the park prior to establishment in Everglades National Park.	**Caution Deteriorating**	Multiple verified observations of Northern African pythons have occurred during the reporting period. There is little evidence to infer whether the population can be eradicated or contained.
Response to recent introductions to Everglades National Park: Argentine black and white tegu – Effectively address introductions to the park and eliminate populations of incipient invasives.	**Significant Concern Deteriorating**	Though containment efforts increased during the reporting period, the geographic extent of the population continues to expand within Everglades National Park.



Sunset in the Everglades | *NPS Photo by D. Robinson*

Pa-hay-okee boardwalk trail | *NPS Photo by F. Acevedo*

Corrective Measures: Moving Toward the Desired State of Conservation

Regional projects are currently being implemented as corrective measures to restore the Greater Everglades ecosystem (including Everglades National Park, Biscayne National Park, and Big Cypress National Preserve).

Beginning in the late 1980s, the federal government began a series of actions to restore the South Florida ecosystem. Ultimately, these efforts laid the groundwork for the development of the Comprehensive Everglades Restoration Plan (CERP) approved by Congress in the Water Resources Development Act (WRDA) of 2000.The CERP, a state/federal partnership, detailed 68 projects that would remove barriers to flow, store water to re-hydrate wetlands, restore flows to the Greater Everglades ecosystem including Florida Bay, and provide water storage features for the needs of agriculture and municipalities while maintaining flood control for developed areas. The CERP's main goal is to restore, protect, and preserve the natural systems of South Florida by delivering the right amount of clean water to the right places at the right times. The most recent total cost estimate of the CERP is $23.2 billion, and full achievement is expected to take more than 50 years to implement.

Prior to the CERP in the mid to late-1990s, the federal government began constructing two major water engineering projects: the Modified Water Deliveries (MWD) and C-111 South Dade projects. These projects were designed to improve water deliveries to and reduce groundwater seepage losses from Everglades National Park. As part of the MWD project, in 2009, the federal government began work on Tamiami Trail (US-41), a 143-mile (230 km) historic roadway completed in 1928 to connect the expanding west and east coast cities of

Tampa and Miami. The portion of the roadway that passes through the Everglades has long been recognized as a barrier that restricts water flows south into northeastern Everglades National Park. This project is focusing on raising and reconstructing the roadbed to allow additional water to flow into the park.

By 2014, the U.S. Army Corps of Engineers (USACE) completed construction on a one-mile (1.6 km) eastern bridge and partially raised the 10.7-mile (17.2 km) roadway, as part of the MWD project. In May 2019, the Tamiami Trail Next Steps (TTNS) Phase 1 project completed 2.3 miles (3.7 km) of bridging and adjacent roadway improvements. Construction of the final TTNS Phase 2 (TTNS2) project began in October 2020 and will raise/reconstruct the remaining 6.7 miles (10.8 km) of roadway with features to further improve water conveyance, roadway safety, and stormwater treatment. Construction completion on the TTNS2 is expected in early 2026.

The TTNS Phases 1 & 2, estimated to cost a total of $240 million (2010 estimate), represents a successful partnership between federal and state agencies, merging funding and expertise to achieve important regional transportation, sustainability, and Everglades restoration goals. Following completion of TTNS Phase 1, the Combined Operational Plan (COP) was developed to effectively utilize the new infrastructure and implement a new Tamiami Trail Flow Formula (TTFF) tying flows into Everglades National Park to conditions in Water Conservation Area 3A (WCA-3A). The COP was implemented September 1, 2020.

Great blue heron | *NPS Photo by G. Gardner*

To reduce further conflict over the seepage of water out of Everglades National Park into neighboring developed areas, the South Florida Water Management District (SFWMD) worked on the construction of a project to prevent flooding in the vulnerable Las Palmas community (also known as the 8.5 Square Mile Area, 8.5 SMA). The construction of the 7.3-mile (11.7 km) underground seepage barrier along the eastern boundary of the park is designed to prevent shallow groundwater and elevated surface water from affecting areas downstream of normal groundwater flow, especially in the Las Palmas community. Protecting this vulnerable area from flooding means much higher volumes of water can be allowed to flow into the park without increase of flooding risk. The seepage wall is 65 feet (19.8 m) deep, reaching a low permeability, semi-confining unit of the aquifer, a regionally expansive zone of sediments of low permeability. The final 5 miles (8 km) of the seepage barrier, a component of the Central Everglades Planning Project (CEPP), was completed in early 2024.

In the late 1990s, as a result of a federal water quality consent decree, the State of Florida began work on the Everglades Construction Project and Long-Term Plan, building a series of constructed wetlands called stormwater treatment areas (STAs) and implementing best management practices (BMPs) in the Everglades Agricultural Area (EAA), upstream of WCA-3A, to reduce nutrients entering the Everglades ecosystem from the agricultural areas south of Lake Okeechobee. In 2012, the State of Florida and the U.S. Environmental Protection Agency (USEPA) reached a consensus on new restoration strategies to meet the Clean Water Act's requirements in the Everglades. Based on months of scientific and technical discussions, restoration strategies expanded water quality improvement projects to achieve the phosphorus water quality standard established for the Everglades. These water quality improvement projects are expanding the STAs by 6,200 acres (2,510 ha) and building 20,000 acres (8,093 ha) of shallow

Road on top of 8.5 SMA seepage barrier | *NPS Photo by A. Atkinson*

water storage features through construction of flow equalization basins (FEBs). The FEBs provide a steady flow of water to the STAs to achieve optimal water quality treatment performance. The new strategies also include additional sub-regional source controls—where pollution is reduced at the source—in areas of the eastern EAA where phosphorus levels in stormwater runoff have been historically higher.

The 68 projects of the CERP were bundled into larger plans. The ones most relevant to the park include the CEPP, the Western Everglades Restoration Plan (WERP), the Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER), and the Southern Everglades Study.

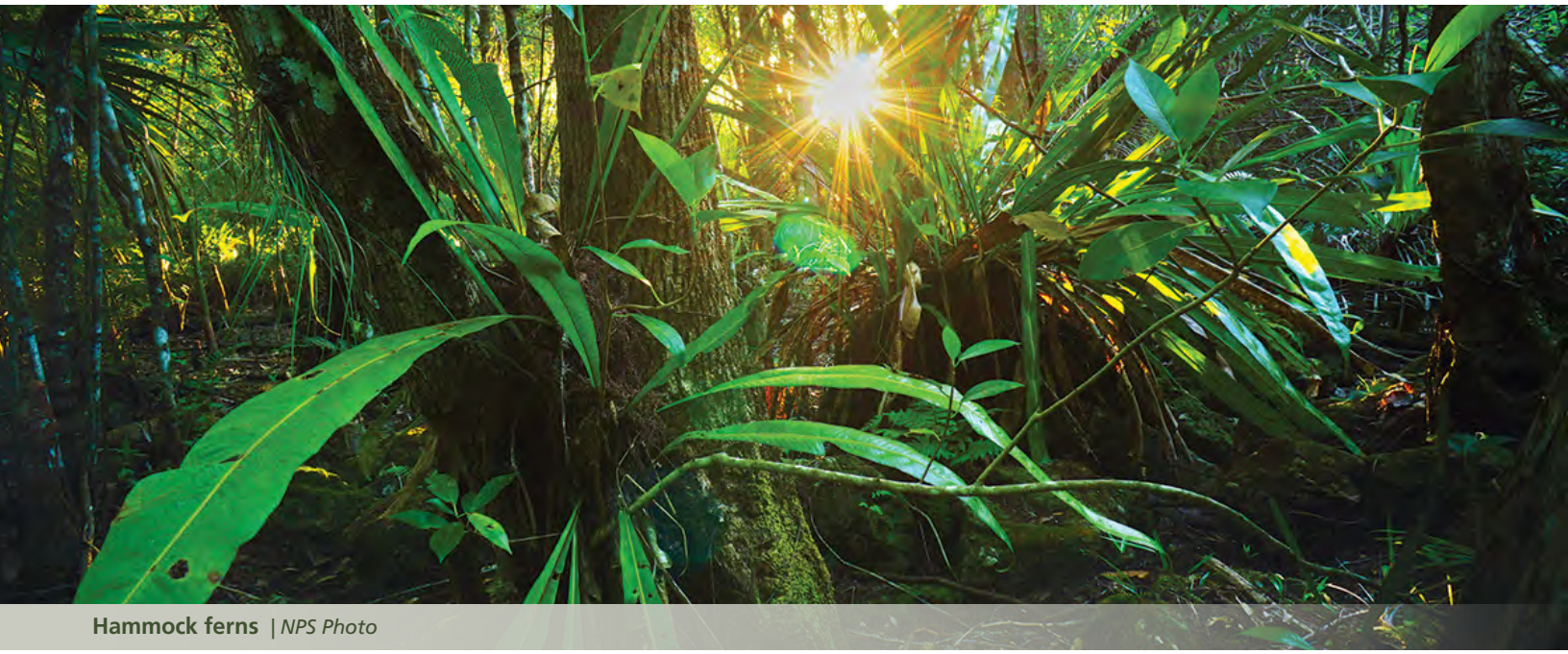
- The CERP CEPP was authorized in 2016. The goals of the CEPP are to improve the quantity, timing, and distribution of water in the northern estuaries, central Everglades, WCAs, and Everglades National Park to restore habitats and ecological function. The CEPP is a combination of several key CERP components and includes conveyance, decompartmentalization (the removal of levees and canals), and seepage management projects to deliver and distribute water to WCA-3B and Everglades National Park, while moving additional water south, storing it, and treating it before going to the park. During the last few years, there was a significant increase in federal and state budgets dedicated to CERP resulting in acceleration of several CEPP features. The CEPP1.0, in the planning phase, is the first update to the water control plan to take advantage of the first CEPP constructed features.
- The CERP Western Everglades Restoration Project (WERP) seeks to improve the quantity, quality, timing, and distribution of water in the western Everglades in the effort to re-establish ecological connectivity, reduce the severity and frequency of wildfires, and restore low nutrient conditions. The project is now pending authorization in the next WRDA cycle.
- The CERP Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) builds upon the work from two prior CERP projects in south Miami-Dade County: the Biscayne Bay

Coastal Wetlands Phase 1 and the C-111 Spreader Canal Western projects. BBSEER project objectives focus on improving freshwater wetland water levels, ponding duration, flow timing, and ecological and hydrological connectivity in the Southern Glades, eastern Panhandle of Everglades National Park, and other parts of the ecosystem. BBSEER is expected to increase water deliveries in the eastern panhandle of Everglades National Park which should slow the encroachment of the white zone, expand viable wildlife habitats, and may contribute to improved salinities in Northeast Florida Bay.

- The CERP Southern Everglades study is currently in the pre-planning phase and is anticipated to be authorized in the WRDA 2028. This collection of CERP projects along the eastern buffer of WCA-2, WCA-3, and Everglades National Park is intended to store water during the wet season and then deliver water to the park during the dry season. As in the original CERP, these projects involve constructing underground reservoirs and restoring wetlands along the eastern boundaries of WCAs and Everglades National Park. This project will have an important impact on providing freshwater flows to the park and to Florida Bay during drought events.

The four projects described above are regional in scope and multidecadal in implementation. Together they are intended to make structural and operational changes to the water management system that should restore significant ecological function, ecosystem resilience, and fish and wildlife abundance to the Greater Everglades ecosystem. On-the-ground implementation of features (such as removal of levees, filling of canals, or addition of flow-ways), and changes to water operations (such as water control plans that allow more water to reach the park) are expected to bring about positive change in hydrologic and ecological indicators of ecosystem integrity within the park.

In 2006, the United States proposed, and the World Heritage Committee accepted, these projects as benchmarks toward recovery of Everglades National Park. Individual elements of these large projects were identified as corrective measures that, when implemented as originally conceived and described, are expected to achieve specific, measurable, and positive changes to the integrity indicators, including both hydrologic and ecological metrics, within Everglades National Park and the Greater Everglades ecosystem.



Hammock ferns | *NPS Photo*

Spatterdock | *NPS Photo*

Corrective Measures: Constraints

The landscape of South Florida is one of the largest, most highly engineered, and closely operated water management systems in the world. It was designed, and is currently operated, to provide flood protection and water supply to the urban and agricultural areas of Miami, Fort Lauderdale, and West Palm Beach. All the previously mentioned large-scale projects assure that legal levels of flood protection, as well as water availability for people, will not be diminished because of implementation of restoration project features. In the very important case of Northeast Shark River Slough (NESRS) in Everglades National Park, flood-protection features such as the constructed seepage barriers are critical for the implementation of restoration features that bring water back to areas that have been dry for decades.

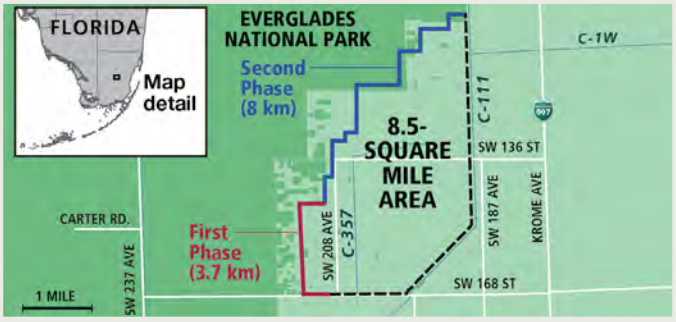
These flood protection and water supply constraints are integral to the work restoring a more natural system. The emphasis and conditions related to flood protection and water supply can evolve rapidly as urban development and agriculture changes occur in South Florida. Although the overall purpose and vision of large-scale restoration projects remain the same, this backdrop of shifting constraints (e.g., legal issues, economic concerns, changes in land use, sea level rise) require regular adjustments to the scope and timing of the implementation of corrective measures.

Corrective Measures: Progress

Corrective measures were established in 2006 to track progress on engineered restoration features. Table 3 includes the original 2006 benchmarks and corrective measures, the status of those measures in 2024, and the plans for the next two years. The column, "Park Need," describes the ultimate need for restoration and the basis for the corrective measure such as protection of the built system (flood protection), delivery of water in consonance with rainfall patterns, nutrient reduction, removal of barriers to flow, and increases in water levels in Everglades National Park.

TABLE 3. Status of Corrective Measures.

THREATS 1 AND 2:
Alterations to the natural hydrologic regime, and adjacent urban and agricultural growth

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Public ownership of lands in the East Everglades is a prerequisite to reestablishing water flows in NESRS.	**1A:** Complete East Everglades Expansion Area land acquisition (approximately 44,000 ha, 440 km^2).	**1A:** Land acquisition is 100% complete. The three commercial airboat operations and two radio tower sites along Tamiami Trail were also brought into federal ownership. The airboat operations now serve as concessioners, operating under multi- year agreements with the NPS.	**1A:** The park and the Florida Department of Transportation (FDOT) are working toward completing several related small wetland restoration projects at the purchased sites along Tamiami Trail.
The inhabited area adjacent to Everglades National Park, called the 8.5 SMA, must be protected from flooding to allow water flows into NESRS. 	**1B:** Complete flood mitigation features in the 8.5 SMA.	**1B:** Construction of a seepage wall along the 8.5 SMA was completed in 2024. The 7.3-mile (11.7 km), 65 feet (19.8 m) deep seepage barrier along the eastern boundary of the park is designed to prevent shallow groundwater and elevated surface water from affecting areas downstream of normal groundwater flow. This feature will allow additional fresh water to be brought into Everglades National Park without flooding the adjacent developed area of the 8.5 SMA. This seepage wall reaches a low permeability semi-confining unit, a regionally expansive zone of sediments of low permeability. Results are showing low to no flooding east of this barrier while keeping water in the park and providing flood mitigation for the 8.5 SMA.	**1B:** NA

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Updating the COP to support CEPP objectives and increase deliveries to NESRS, while maintaining flood control and water supply requirements as necessary.	**1B:** Complete the Combined Structural and Operational Plan (CSOP), a water control plan for the MWD and C-111 South Dade Projects. This Corrective Measure is the same as Corrective Measure 2B.	The COP is an evolution of the CSOP and builds on the Transition Plan with a TTFF designed to increase flows to NESRS. The COP was completed in 2019. The TTFF, dictating the amount of water flowing into Everglades National Park under certain conditions, was used for the first time in June 2020.	During the next two years, the COP will be updated with the CEPP1.0 to operate new infrastructure projects including the TTNS2 and CEPP South projects as well as integrating the Lake Okeechobee System Operating Manual (LOSOM). These projects will improve water deliveries to NESRS, while maintaining flood control, freshwater flow to Biscayne National Park and other water supply requirements.
Removal of barriers to water flow within WCA-3 upstream of Everglades National Park is needed to enhance sheetflow and marsh connectivity into NESRS.	**1C:** Construct water conveyance structures on the L-67A, L-67C, and L-29 canals and levees. In 2006, both the MWD project, and the CERP WCA-3 Decompartmentalization and Sheetflow Enhancement Project (Decomp) included projects to degrade levees and fill canals within WCA-3, north of the park.	**1C:** The L-67A, L-67C, and additional L-29 water conveyance structures are now integrated within the CEPP. Design of three structures S-631, S-632 and S-633 and a gap in L-67C levee south spoil removal is underway.	**1C:** Timeline for construction completion of the S-631, S-632, and S-633 structures should coincide with the completion of TTNS2 project (2026) to allow for increased water levels in the L-29 canal, from a maximum of 8.5 feet (approximately 2.5 m) to 9.7 feet (approximately 2.9 m), and to shift flows to WCA-3B, then to NESRS through the new bridges. Removal of the L-29 levee is planned to be completed by 2031.

Wood storks and other wading birds in the marsh | *NPS Photo*

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Removal of barriers to water flow along the Tamiami Trail is needed to enhance sheetflow and marsh connectivity into NESRS. Both bridges and modifications to the roadway are needed to raise water levels in Everglades National Park while avoiding water damage to the road itself.	**1C:** Tamiami Trail bridging and roadway modifications.	**1C:** In 2013, the USACE completed a one-mile (1.6 km) bridge and limited reconstruction of the Tamiami Trail roadway components of the MWD project. An additional 2.3-mile (3.7 km) bridge was completed in 2019 as the first phase of the TTNS project. The second phase was awarded in August 2020, construction began in April 2021, and substantial completion of the project is expected in early 2026. The Tamiami Trail roadbed is being raised and reconstructed to allow water levels in the canal north of the road to be raised to facilitate the higher water levels and flow volumes expected with implementation of the CEPP. This project includes six, 60-foot (18 m) slab bridges to improve water distribution, a stormwater treatment system, and improved parking for the Miccosukee Tribe Tigertail Camp residents. The NPS and the FDOT are working toward completing several related small wetland restoration projects to provide mitigation for impacts from the roadway.	**1C:** The TTNS2 project is expected to be completed in early 2026. Since the Tamiami Trail roadway is being raised as part of the TTNS2 project, the NPS concessions located along the Trail are currently executing projects to increase the elevation of their businesses. Protecting the remaining five developed sites along Tamiami Trail from flooding is required to significantly increase water flows into NESRS. Flood protection plans for these sites are currently being implemented (through a combination of government and private actions). Furthermore, the NPS hired a contractor to develop plans to raise the elevation of the Osceola-Poole Camp. Camp members, Miccosukee Tribe of Indians of Florida Tribal staff, and park staff have been working together and conducting coordination meetings since April 2020. In the next two years, the camp will be raised as necessary for implementation of the CEPP.
Water in NESRS and Taylor Slough needs to be retained inside Everglades National Park via seepage management features. This water should flow through the historic sloughs, increasing water depths and hydroperiods in the park. Currently, lowered water levels in urban and agricultural areas to the east draw large amounts of water out of the park via seepage.	**2A:** Complete C-111 land exchange between the SFWMD and the NPS. This is required to construct the C-111 detention areas. **2B:** See 1B.	**2A:** A land exchange between the SFWMD and the NPS was approved by Congress in 2006. The land exchange is complete, and no additional real estate is required for completion of the C-111 detention area projects.	**2A:** NA

Tamiami Trail | *NPS Photo*

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Continued from previous page.	**2C:** Complete the construction of C-111 detention-area features from the 8.5 SMA south to the area known as the Frog Pond. The detention areas reduce seepage losses along the portions of the eastern Everglades National Park boundary. An existing pump station (S-356), constructed by the MWD project, helps retain water in NESRS. The CERP included an Everglades National Park Seepage Management project that would add additional S-356 pump stations and a subsurface seepage barrier by 2015.	**2C:** The C-111 detention areas were completed. A subsurface seepage barrier beyond the 7.3 miles (11.7 km) along the 8.5 SMA was completed in 2024. The construction of an expanded S-356 pump station is scheduled for completion in 2030.	**2C:** Seepage wall benefits will be evaluated while also checking impacts on Miami wellfields and Biscayne National Park.

Coastal plains near Flamingo | *NPS Photo by D. Turffs*

White pelicans | *NPS Photo*

THREAT 3: INCREASED NUTRIENT POLLUTION

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Water entering Shark River Slough (SRS) and Taylor Slough (TS) must be low in nutrients, with total phosphorus (TP) concentrations in surface water targeted to < 8 and 6 µg L^{-1}, respectively as established by a federal consent decree. Concentrations of TP above these levels have been shown to result in imbalances in flora within these sloughs. Water needs to be cleaned upstream of Everglades National Park, via improvement of agricultural practices, implementation of STAs, and/or localized efforts. Reduction of nutrient loading will contribute to healthier freshwater Everglades wetlands, as well as a healthier estuary in Florida Bay.	**3A:** Implement upstream water quality source controls or BMPs and construct man-made wetlands or STAs to achieve the long-term TP limits for water flowing into SRS and TS. In 2008, a federal court found that delay in achieving the State of Florida Phosphorus Threshold Rule (less than 10 µg L^{-1}) was a violation of the Clean Water Act. The court directed the USEPA to develop a plan for compliance for runoff from the EAA.	The State of Florida constructed 45,000 acres (18,210 ha) of man-made STAs that were fully operational in 2012. Since 2012, the Florida Restoration Strategies Plan has expanded the STAs by 6,200 acres (2,510 ha) and added more than 20,000 acres (8,093 ha) of FEBs. While the Restoration Strategies Plan is not expected to be fully realized until 2025, the park has seen substantially improved water quality throughout much of the wetlands marsh. Other projects, such as the Broward County Water Preserve Areas, WERP, and the CEPP with the EAA Reservoir show promise for further improving water quality in Everglades National Park.	The NPS will continue to closely monitor the implementation of Restoration Strategies and other projects to ensure that water flowing into Everglades National Park is reaching the low TP levels as established by a federal consent decree. By April 2026, the SFWMD will remove sediments and install low sill weirs in the canal network upstream of one (S-333) of nine inflow structures for SRS. The S-333 structure has been shown to have considerably elevated TP concentrations at low water levels, a pattern believed to be related to sediment resuspension. Removal of these sediments will reduce one source of elevated TP and weir installation will prevent further build-up of these nutrients.

THREAT 4: IMPACTS TO THE PROTECTION AND MANAGEMENT OF FLORIDA BAY

Park Need	Corrective Measure (Established in 2006)	Status of Corrective Measure in 2024	Plans for the Next 2 Years
Increasing natural freshwater flows from NESRS and TS into the downstream estuaries will contribute to healthier and more diverse seagrass communities and increase fish and invertebrate productivity in Florida Bay.	**4A:** Complete construction of the C-111 Detention Area features from the 8.5 SMA to the Frog Pond and implement CSOP operations. Implementing rainfall-driven pumping operations based on marsh water levels as envisioned in the CSOP will reduce the likelihood of pumping nutrient enriched water into Everglades National Park marshes.	**4A:** Construction was completed in 2024 on the 8.5 SMA seepage barrier along the eastern boundary of the park. These features as well as the S-356 pump station are functioning to provide flood mitigation to the urban/agricultural areas and to return seepage water to Everglades National Park. Expansion of the S-356 pump station is planned to be completed in 2030. The COP, an evolution of the CSOP, is implemented and a TTFF designed to increase NESRS inflows is being used. The State of Florida implemented a Florida Bay Project along the eastern boundary of the park that might increase the likelihood of high nutrient loadings into TS.	**4A:** During the next two years, the COP will be updated with CEPP1.0 to operate new infrastructure projects including TTNS2, several CEPP South projects, and the LOSOM. This action will improve water deliveries to NESRS, while maintaining flood control and water supply requirements. The NPS will continue to carefully monitor water quality, soil chemical characteristics, and periphyton biomass in TS and in NESRS to track any changes in phosphorus levels and in the ecology of the system.
	4B: Complete the C-111 Spreader Canal and revise water management operations to include rainfall-driven operations.	**4B:** Construction of Phase 1 of the C-111 Spreader Canal project (Frog Pond Detention area and Aerojet seepage control features) was completed. The next phase of the C-111 Spreader Canal western project is now under consideration within the BBSEER project that is currently in planning.	**4B:** During the next two years, the NPS will carefully monitor the BBSEER planning process for the C-111 Spreader Canal western project.

The progress to restore the Everglades and resolve the four major threats negatively affecting Everglades National Park for many decades is summarized below:

THREAT 1: Alterations of the hydrologic regime

RESPONSE: All required East Everglades land acquisitions werecompleted in 2016, and the flood mitigation components needed to protect the 8.5 SMA were completed in 2024 with the construction of 7.3 miles (11.7 km) of a seepage wall. In 2019, construction was completed on all the MWD and C-111 South Dade foundation project components with the implementation of the COP.. Everglades National Park is currently receiving increased water volumes and improved flow distribution benefits within NESRS and TS because of these projects. Upcoming next generation restoration projects, such as the TTNS2 roadway improvement project, the WERP, and the CEPP with the EAA Reservoir show great promise for additional improvements to water flows into the park.

THREAT 2: Adjacent urban and agricultural growth

RESPONSE: All planned MWD and C-111 flood mitigation and water detention areas including pumping stations were completed. A subsurface seepage barrier 65 feet (19.8 m) deep and 7.3-mile (11.7 km) long was constructed along the 8.5 SMA to decrease seepage and provide flood protection to the adjacent area. The final plan might add a 20-mile (32 km) long seepage management system extending from north of the 8.5 SMA south to the Frog Pond area.

Hydrologic monitoring station | *NPS Photo*

THREAT 3: Increased nutrient pollution

RESPONSE: The State of Florida constructed 45,000 acres (18,210 ha) of constructed STAs that were fully operational in 2012. Since 2012, the Florida Restoration Strategies Plan has expanded the STAs by 6,200 acres (2,510 ha) and added more than 20,000 acres (8,093 ha) of FEBs. These FEBs have been added to regulate the rate of flows and reduce nutrients before the water enters several of the STAs. While the Restoration Strategies Plan is not expected to be fully realized until 2025, the park has seen substantially improved water quality throughout much of the freshwater marsh. Other projects, such as the Broward County Water Preserve Areas, the WERP, and the CEPP with the EAA Reservoir show promise for further improving water quality in Everglades National Park. By April 2026, SFWMD will also remove sediment and install low sill weirs in the canal network upstream of one (S-333) of nine inflow structures for SRS. Structure S-333 has been shown to have considerably elevated TP concentrations at low water levels, a pattern believed to be related to sediment resuspension. Removal of these sediments will reduce one source of elevated TP and will prevent further build-up of harmful nutrients.

THREAT 4: Impacts to the protection and management of Florida Bay

RESPONSE: Implementation of the MWD and C-111 projects together with the COP has resulted in desired higher water levels and longer flooding durations in the wetlands in NESRS and TS. These projects created a slightly higher flow gradient that directs water flow into Florida Bay. By 2019, the expanded C-111 detention areas and two new C-111 Spreader Canal Western pump stations were in place, adjacent to TS headwaters. These features reduced seepage losses from TS and have slightly increased water flows into Florida Bay. As the next phase of upstream flow restoration projects begins (particularly the TTNS2 and the CEPP), larger volumes of fresh water will be delivered through NESRS and TS and ultimately into Florida Bay. The Southern Everglades Study, in planning, will also have critical benefits of bringing additional fresh water to NESRS and to TS during dry years.

Sawgrass meets the pine rocklands | *NPS Photo by F. Acevedo*

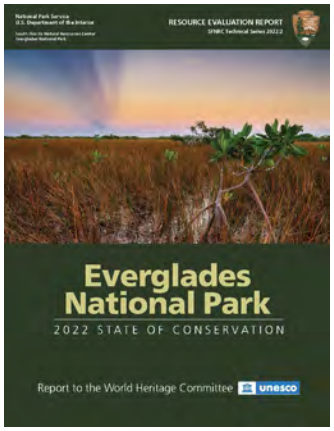
Suitability of Timeframe for the Implementation of Corrective Measures

Three large-scale water management projects (the Modified Water Delivery (MWD), C-111 South Dade, and the Everglades Construction Project all authorized by 1994) are now operational and the Combined Operational Plan (COP) is in use. As anticipated, these corrective measures are only the initial steps toward delivering the volumes of clean water needed to achieve the previously stated Desired State of Conservation. Additionally, since 2000 new science has emerged to enhance understanding of the specific water flow and water quality targets needed to achieve long-term restoration goals in Everglades National Park. In response, the 2015 State of Conservation report added additional large-scale water management projects to the corrective measures needed to achieve the Desired State of Conservation. These projects include the State of Florida's Restoration Strategies Plan to further improve water quality and the Central Everglades Planning Project (CEPP) that includes the Everglades Agricultural Area (EAA) Reservoir project to redirect Lake Okeechobee discharges southward into the Everglades. While both these projects are progressing, their full benefits are not scheduled to be in place before 2030. Meanwhile, ecological integrity indicators detailed in this report show variable performance, with improvements anticipated as the Comprehensive Everglades Restoration Plan (CERP) reaches completion.

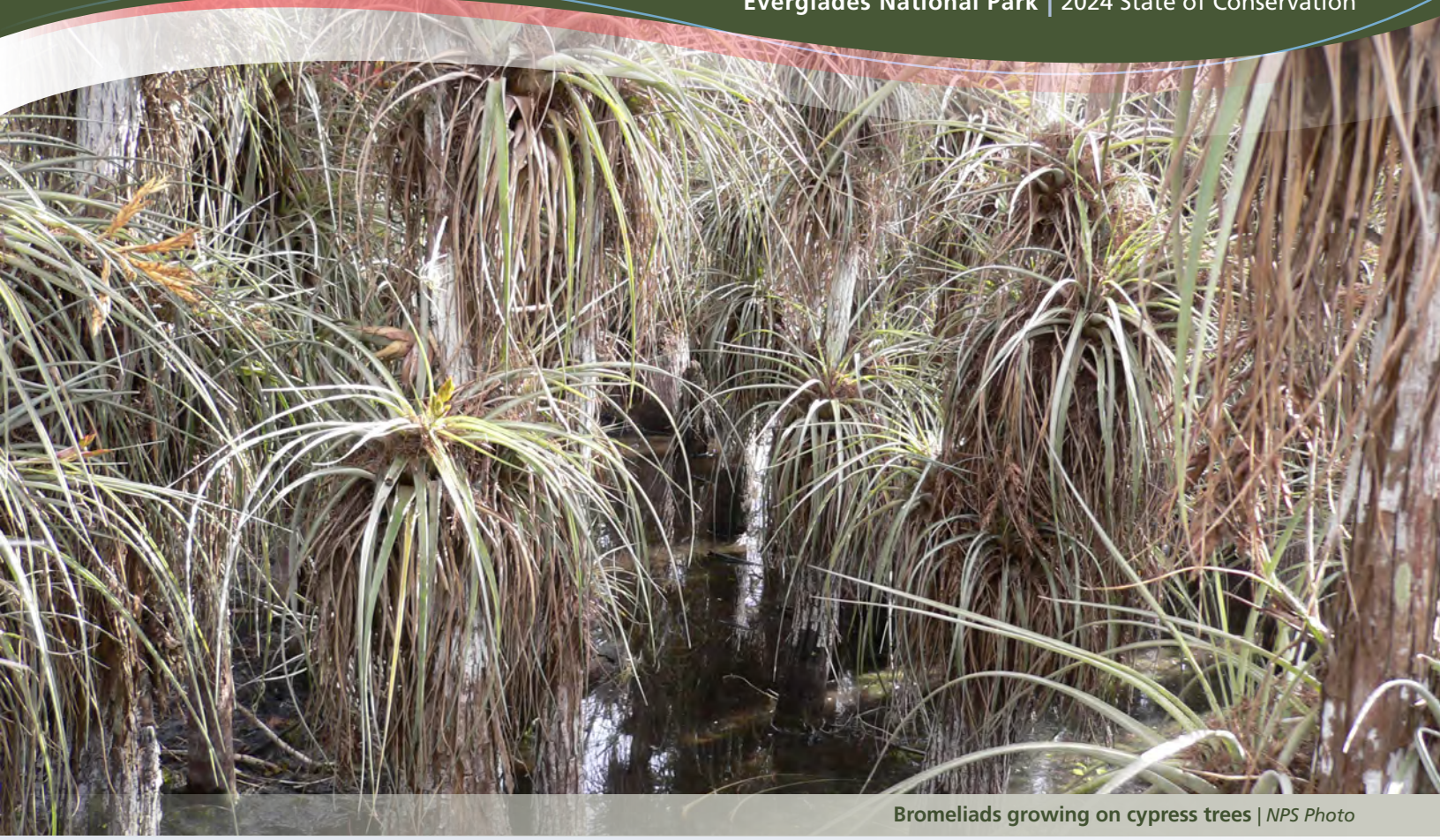
The expeditious implementation of corrective actions is required to halt any further impairment and start the recovery process of the ecosystem. In 2022, the Bipartisan Infrastructure Law and other appropriations provided nearly $1.1 billion capacity for the U.S. Army Corps of Engineers (USACE) to accelerate Everglades restoration, enabling them to simultaneously move

forward on multiple projects including: (1) initiating and fully funding construction of the Broward County Water Preserve Areas C-11 impoundment (corrective measure 3A), (2) completing the Project Implementation Report (PIR) for the Biscayne Bay and Southeastern Everglades Restoration (BBSEER) project (corrective measure 4B), (3) finishing the Project Implementation Report (PIR) for the Western Everglades Restoration Plan (WERP) (corrective measure 3A), and (4) starting and fully funding the construction of the CEPP South S-356 pump station feature (corrective measures 2C and 4A).

The NPS will continue to track progress in achieving the corrective measures and impacts on indicators of integrity that define the Desired State of Conservation. At the same time, the status and trends of a larger set of system-wide ecological indicators are also being evaluated for the entire South Florida ecosystem in the Department of the Interior's Strategy and Biennial Reports to Congress, which focus on broader Everglades restoration progress. These reports are produced by the South Florida Ecosystem Restoration Working Group and Science Coordination Group, for dissemination by the South Florida Ecosystem Restoration Task Force: https://www.evergladesrestoration.gov/progress-report-1. The World Heritage State of Conservation reports produced by Everglades National Park updates a subset of these system-wide indicators and synthesizes information as it relates specifically to the park: https://www.nps.gov/ever/learn/nature/worldheritage.htm.



A water control structure in a canal | *NPS Photo by L. Oberhofer*



Bromeliads growing on cypress trees | *NPS Photo*

Other Current Conservation Issues

Below is a list of other current conservation issues identified by the State Parties which may impact the property's Outstanding Universal Value:

Nonnative and Invasive Species

Florida's subtropical climate, major ports of entry, and extensive pet and agricultural industries make it highly susceptible to biological invasions. Invasive plant and animal infestations continue to be a significant threat to Everglades National Park's ecological integrity. The NPS and Everglades National Park places the highest management priority on: (1) invasive species that cause the greatest ecological harm to native plant and animal communities, (2) early detection and rapid response (EDRR) of new invasions, and (3) research to improve invasive species management.

Current data indicate that many additional nonnative species are present in the urban and agricultural areas outside the park boundaries, although they have not yet been found inside the park. However, park staff have continued to document several new species in the park during the reporting period. In the past 2 years, the presence of the invasive Mexican bromeliad weevil (*Metamasius callizona*), often referred to as the "evil weevil" due to its destruction of native bromeliad populations, has been confirmed. Additionally, one new nonnative fish species (see the "Invasive Animals" indicator section) was found in the park during the reporting period. Acknowledging that the scale of the threat continues to exceed available resources, Everglades National Park is focused on tracking existing and new invasions, investing in research, and working with park partners and the public on education, outreach, and prevention. The park is still in the early

Mangrove tree in an inland sawgrass marsh | *NPS Photo by G. Garnder*

stage of establishing formal corrective measures and quantitative targets with respect to nonnative species.

Climate Change

Over the past century, human modifications to the South Florida landscape have brought significant changes to the greater Everglades ecosystem. In the coming century, it is expected that climate change will bring numerous compounding effects of sea level rise, rising temperatures, and a shift in precipitation to Everglades National Park. These impacts would present an unprecedented challenge to the ability of park staff to protect natural resources and provide visitor experiences. The following background information highlights the major environmental components of climate change reported by the Intergovernmental Panel on Climate Change (IPCC) in 2022 along with forecasts and consideration of the vulnerability of park natural resources.

TEMPERATURE—The increase in global annual average air temperature associated with climate change is expected to be at more than 2.7°F (1.5°C) in the next two decades. These temperature changes will have a direct physiological impact on flora and fauna and potentially alter the geographic ranges of species that are now near their upper thermal limit. The greatest known recent effect of increased temperature in the region has been coral reef mass mortality from bleaching events, mainly impacting the Florida Keys.

EVAPORATION—With increasing temperature, evaporation from wetlands and coastal waters also will increase, consequently increasing the potential for wetland drying, fire, soil oxidation, soil elevation decreases, and hypersalinity events in Florida Bay and coastal wetlands.

RAINFALL—The IPCC projects a decrease in average annual rainfall in the subtropics and an increase in extreme high rainfall events. The timing of seasonal rainfall may also shift. A shift in rainfall coupled with an increase in evaporation brought about by rising temperatures could result in long-term deficits of fresh water in Everglades National Park.

SEA LEVEL RISE—There is a high certainty that sea level rise rates will accelerate in the coming decades and greatly alter the landscape and ecology of the Everglades. About 60% of Everglades National Park lands are less than 3 feet (1 m) above sea level, and land slope is only about 1.5 inches (3.8 cm) per mile (1.6 km) from the coast. With such a flat, low-elevation landscape, the park is highly vulnerable to sea level rise, storm surges, and saltwater intrusion.Observed data from tide gauges across South Florida reveal that sea levels have been rising at an accelerated pace. The extent of saltwater inundation and ecological condition may greatly depend on the stability of coastal soils and rates of soil accretion, with potential land elevation loss or gain.

HURRICANE AND STORM SURGE—Hurricanes and associated storm surges greatly alter the Everglades landscape by flooding, wave and wind energy, erosion, sediment deposition, and chemical alterations (e.g., low dissolved oxygen, hyper- and hypo-saline, or high turbidity). These conditions may bring about long-term changes to plant and animal populations and communities. Progression of climate change is likely to lead to more hurricanes that have stronger winds, more rain, and higher storm surges.

CARBON DIOXIDE CONCENTRATIONS AND ACIDIFICATION—Increasing concentrations of carbon dioxide (CO_2) in the atmosphere can stimulate photosynthesis and potentially alter plant communities and net primary production. Potential effects in the Everglades are uncertain. Uptake of elevated atmospheric CO_2 by the oceans has decreased oceanic alkalinity and pH, which can have strong negative effects on marine biota. However, there is little evidence that such effects are strong in South Florida and local projections do not exist.

Implementing corrective measures and restoring a greater quantity and more natural distribution of water flow to the remnant Everglades have long been considered necessary to secure the continued health of the ecosystem and to mitigate the effects of a changing climate. Given the wide-ranging impacts listed above,

Scientist collects dragonfly larvae for mercury sampling | *NPS Photo*

however, the need for restoration of freshwater flows gains new importance as a countermeasure to both protect the freshwater Everglades against saltwater intrusion and secure more time for organisms to adapt to changing conditions. Thus, the need to make swift progress on current restoration efforts has perhaps never been greater to protect the Outstanding Universal Value (OUV) of the park.

Building resilience of the Everglades ecosystem to face climate change will require scientifically informed management actions both within and beyond park boundaries. During the next three years, the park will develop a roadmap for near-term and long-term futures under climate change. The effort will center on developing a strategy for restoration and management efforts coordinated by experts from both government and academia. Specific topics will be investigated mainly to inform and help the NPS make decisions within the resist-accept-direct (RAD) framework under changing climatic conditions. The topics will be placed in the context of restoration and will include discussions around freshwater delivery needs and land management strategies that serve to maintain salinity levels in Florida Bay, a healthy mangrove/marsh ecotone interface, and marl prairie and ridge and slough habitats.

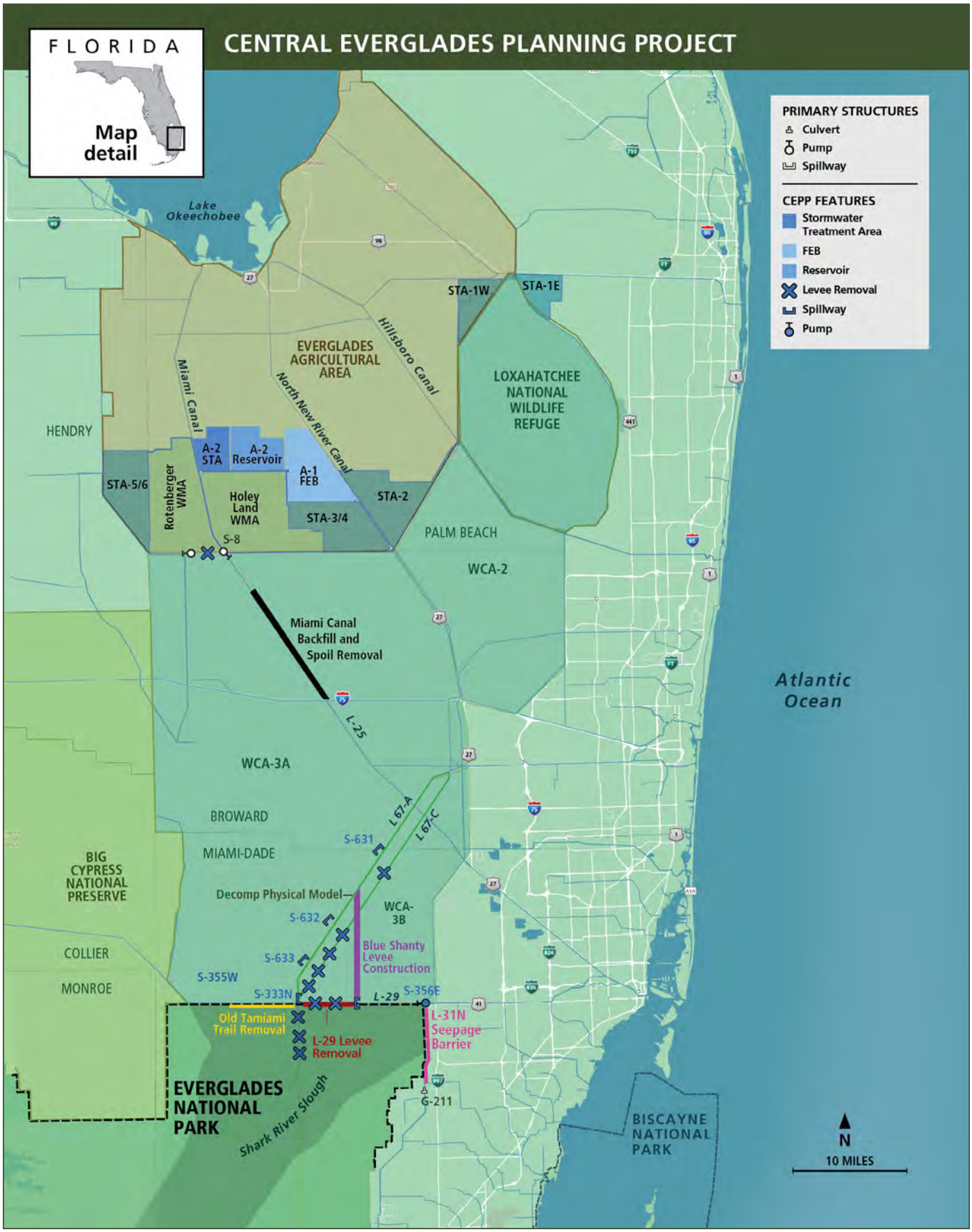
Methylation of Mercury

High concentrations of mercury (Hg) have entered the ecosystem through atmospheric deposition and exist in Everglades National Park. Most of this mercury gets into the atmosphere through emissions from coal-fired power plants. Once mercury is deposited, sulfate-reducing bacteria in the Everglades convert mercury into toxic methylmercury (MeHg). This process is affected by many factors such as the sulfur cycle, ecosystem pH, and the presence of dissolved organic matter. Once MeHg is formed, it can be bioaccumulated and biomagnified through the food web. As algae and plants grow, MeHg becomes incorporated into tissues. Ingestion of these tissues by bacteria and invertebrates concentrates the MeHg. As top predators feed on contaminated prey, MeHg becomes concentrated in higher trophic levels of the food chain. In top-level predators, the concentration of MeHg may have increased to as much as a million times the concentration present in the water.

Scientists collect fish for mercury sampling | *USGS Photo*

In Florida's freshwater ecosystems, the highest concentrations of MeHg occur in top-level predators including alligators and large-bodied fish like largemouth bass, bowfin, and gar. MeHg can be transferred to birds and terrestrial mammals that feed on aquatic insects and fish. Recent research revealed that total mercury concentrations in about 88% of samples of small fish collected in SRS from 2008 to 2018 exceeded the protection threshold set by the U.S. Environmental Protection Agency (USEPA). The work also showed that total mercury concentrations in the water and in small freshwater fish of Everglades National Park remained relatively consistent throughout the 10-year study period.

In the park, high MeHg levels correspond to areas with longer hydroperiods and peat soils in Shark River Slough (SRS) that receive water from the canals along the northern park boundary. These canals provide a source of both dissolved organic carbon and sulfate in concentrations known to support methylation. Current water management actions are designed to shift the proportion of water inflow along the northern boundary into Northeast Shark River Slough (NESRS) that could alter or shift Hg methylation and bioaccumulation risk. In WY24, Everglades National Park reinstated a spatially comprehensive Hg assessment study that will be available for the next reporting effort to compare with the study results from 2008 to 2018.


CENTRAL EVERGLADES PLANNING PROJECT
FLORIDA
Map detail
PRIMARY STRUCTURES
Culvert
Pump
Spillway
CEPP FEATURES
Stormwater Treatment Area
FEB
Reservoir
Levee Removal
Spillway
Pump
Lake Okeechobee
STA-1W
STA-1E
EVERGLADES AGRICULTURAL AREA
Hillsboro Canal
North New River Canal
Miami Canal
LOXAHATCHEE NATIONAL WILDLIFE REFUGE
HENDRY
A-2 STA
A-2 Reservoir
A-1 FEB
STA-5/6
Rotenberger WMA
Holey Land WMA
STA-3/4
STA-2
S-8
PALM BEACH
WCA-2
Miami Canal Backfill and Spoil Removal
L-25
WCA-3A
BROWARD
MIAMI-DADE
L 67-A
L 67-C
S-631
BIG CYPRESS NATIONAL PRESERVE
Decomp Physical Model
S-632
WCA-3B
S-633
Blue Shanty Levee Construction
COLLIER
S-355W
MONROE
S-333N
L-29
S-356E
Old Tamiami Trail Removal
L-29 Levee Removal
L-31N Seepage Barrier
EVERGLADES NATIONAL PARK
Shark River Slough
G-211
Atlantic Ocean
BISCAYNE NATIONAL PARK
N
10 MILES

National Park Service | U.S. Department of the Interior

RESOURCE EVALUATION REPORT

SFNRC Technical Series 2024:1

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