South Florida Ecosystem Restoration Task Force

LEADERSHIP • PARTNERSHIP • RESULTS

2018 Biennial Report

EvergladesRestoration.gov

Restoring America's Everglades

Appendix B
System-wide Ecological Indicators

System-wide Ecological Indicators

The South Florida Ecosystem Restoration Task Force has established a suite of 11 system-wide ecological indicators to assess current ecosystem health and provide a means to track ecosystem response to restoration. This suite of system-wide ecological indicators and the green-yellow-red "stoplight" graphics were developed specifically as a communication tool to provide a big picture view of the ecosystem's health and response to restoration in a non-technical format. The system-wide ecological indicators and stoplight illustrations provided herein represent a summary of broader and more detailed science assessments available in companion reports, including the 2018 System-wide Ecological Indicators for Everglades Restoration, the Restoration Coordination and Verification (RECOVER) team's 2019 Systems Status Report, and the South Florida Water Management District's (SFWMD) 2018 South Florida Environmental Report.

Details of the process for developing each indicator were published in a special issue of the scientific journal Ecological Indicators (Volume 9, Supplement 6, and November 2009). The process for selecting the indicators and an explanation of how the indicators relate to other factors being monitored were described in previous biennial reports. The suite of system-wide ecological indicators was chosen for its collective ability to comprehensively reflect ecosystem response to restoration in terms of space and time (Table 1). For example, periphyton responds to change very rapidly at both small and large spatial scales, while crocodilians respond more slowly to change at intermediate and large spatial scales. As indicators, they cover different aspects of the ecosystem.

As with the 2016 Biennial Report, the ecological indicator sections are brief and describe only composite results for the previous reporting period (Water Year 2016) and the current reporting period (Water Year 2018). Readers looking for more detailed information on regional status and changes in these indicators will find it within the full report (2018 System-Wide Ecological Indicators Report available at Evergladesrestoration.gov).

Hydrologic Context for Water Years 2017 and 2018

The following discussion provides a basic introduction to the south Florida water cycle and a basic description of conditions during the reporting period: Water Years 2017 (May 1, 2016 to April 30, 2017) and 2018 (May 1, 2017 to April 30, 2018). A more detailed discussion of south Florida hydrology is available in the 2018 System-wide Ecological Indicators for Everglades Restoration report.

The Everglades has a hydrologic cycle, also called a water cycle, uniquely its own. Throughout most of the continental United States to the north, water levels generally rise and fall in tune with the four seasons. There, water levels typically peak during the spring as snow melts and front-driven storms move through, and ebb in the fall at the end of the hot summer stretch. The water cycle of subtropical south Florida and the Everglades, however, is fueled by only two seasons, wet and dry, leading to a reversal of its seasonal high and low water marks. In contrast with conditions to the north, water levels in the Everglades peak in the fall, coinciding with the end of the wet season, and ebb in the spring, coinciding with the end of the dry season when large expanses of wetlands dry out.

Table 1. System-wide Ecological Indicators

- Invasive Exotic Plants
- Lake Okeechobee Nearshore Zone Submerged Aquatic Vegetation
- Eastern Oysters
- Crocodilians (American Alligators and Crocodiles)
- Fish & Macroinvertebrates
- Periphyton
- Wading Birds (White Ibis & Wood Stork)
- Southern Coastal Systems Phytoplankton Blooms
- Florida Bay Submersed Aquatic Vegetation
- Juvenile Pink Shrimp
- Wading Birds (Roseate Spoonbill)

Summer Wet Season
The wet season begins in late spring, usually around Memorial Day. It is characterized by consistently hot and humid weather, the daily buildup of spectacular cumulonimbus cloud formations, and resultant heavy thunderstorms that are often local and short-term in nature. Other larger systems—including early season storms enhanced by lingering spring-time instability in the upper atmosphere, mid-latitude cyclones, and tropical storms—periodically spike the Everglades with regionally expansive rains.

In response to these meteorological inputs, the Everglades become flooded with an ankle-to waist-deep, slow-moving pool of water through summer and fall, leaving only the high-ground tree islands and hardwood hammocks above water. The term sheetflow is used to describe this shallow and spatially expansive wetland plain that, unlike a lake or bog, flows like a stream, only much more slowly, almost imperceptibly slowly to the human eye. Spanning from horizon to horizon, this sheet of water flows south through a maze of tree-island-dotted ridges and sinuous low-lying sloughs, giving rise to the name River of Grass coined by Marjory Stoneman Douglas in 1947.

Winter Dry Season
The weather turns mild during the winter half of the year, marking an end to the regular buildup of afternoon thundershowers and tropical storms and thus initiating the dry season, an approximate 6 to 7 month period dominated by a slow shallowing of standing water. As the dry season ensues, more and more land emerges. Water first recedes from the highest perched pinelands and other tree islands. Drainage of the marl prairies follows next, leading to an eventual retreat of water into the lowest-lying sloughs and marshes. The rate of recession may be slowed or even temporarily reversed by sporadic winter rains that are typically brought on by the descent of cold continental air masses from the north. Lower winter evaporation rates also hinder the rate of recession, though it rapidly picks up again in spring as daylight hours and air temperatures increase evaporation.

Although south Florida is generally considered a wet area by merit of its abundant average annual rain total of 52.7 inches in the SFMWD region (with a 70/30 percent wet/dry season split) and its often flooded wetland views, drought and wildfire play vital roles in maintaining the region's unique assemblage of flora and fauna. The ecological health of the Everglades is intimately tied to seasonal and inter-annual fluctuations of the water cycle and is impacted by a combination of:

- Natural processes
    - Rainfall
    - Evaporation
    - Overland flow
    - Groundwater infiltration
- Climatic oscillations
    - El Niño/La Niña
    - Climate change
- Water management manipulation associated with operation of the Central and Southern Florida Project (C&SF) project and other drainage works for the purpose of:
    - Flood protection
    - Urban and agricultural water supply
    - Environmental protection

Each water year is different in the Everglades, and the hydrologic cycle is characterized by large interannual variation – in other words, seldom do we experience average years.

The previous two water years (WY) illustrate this variation well and are summarized next.

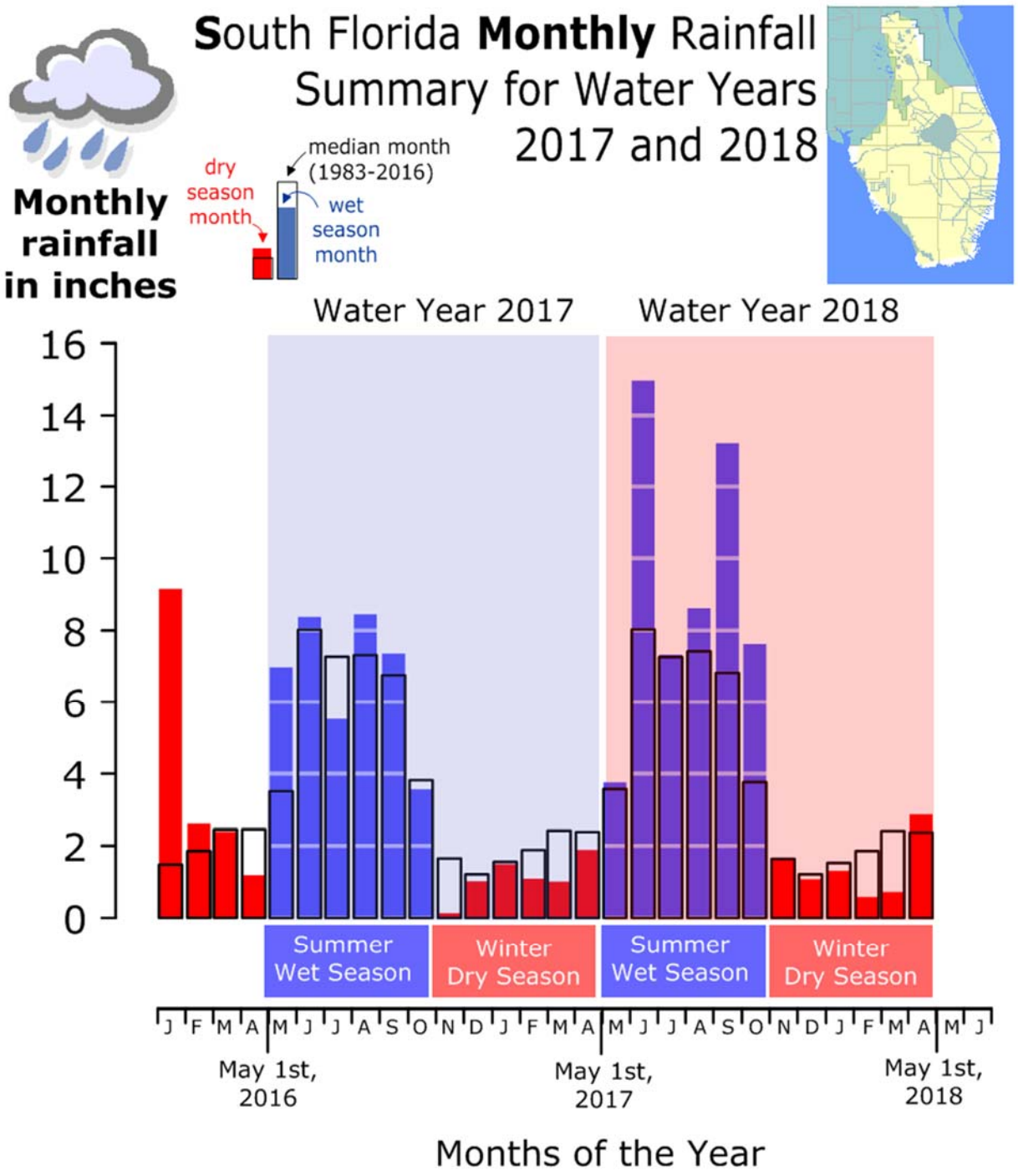

Figure 1. Summary of monthly rainfall in WY 2017 and WY 2018 throughout the South Florida Ecosystem. The graph was produced using daily rainfall data provided by the SFWMD. SFWMD meteorologists compute a daily rainfall value for the fourteen major basins and district-wide from rain gage measurements. See http://www.gohydrology.org/p/about.html for more information.

Water Year Summaries

Water Year 2017 (May 1, 2016 to April 30, 2017)

Water Year 2017 featured a ”normal” wet season and “below average” dry season — 40 inches of rain fell across south Florida during the six-month (May through October) summer wet season with 7 inches falling in the six month (November through April) dry season that followed, for an annual total of 47 inches. This is nearly a 6-inch rainfall deficit from the SFWMD’s annual average of 52.7 inches.

Accordingly, wetlands and waterways of the Everglades filled up through the summer wet season and reliably receded during the winter dry season months. The biggest boost of rain came in August [and in particular in Water Conservation Areas (WCA) 1 and 2 where 12 inches were recorded for the month] resulting in slough water depths to crest at a 2 foot depth through much of the Everglades by early October, more or less coinciding with vast wetland’s normal annual peak — but one that, too, was also short lived.

To combat high water conditions, the Florida Department of Environmental Protection (FDEP) issued an emergency final order (EFO No:16-0286) on May 11, 2016, authorizing the SFWMD and the U.S. Army Corps of Engineers (USACE) to take immediate action to deviate from permitted water management practices to move significant volumes of flood water out of the WCAs. The FDEP authorized temporary operation deviations to the SFWMD, and the USACE to maximize benefits to the environment and to minimize detrimental impacts such as harmful flooding and degradation of water quality, with the overarching goal of lowering WCA water levels below their respective regulatory discharge zones.

Continuing a decade-long trend of anomalously low tropical storm activity, October (a month which historically accounts for a quarter of Florida’s hurricane-strength storms) had little rain to offer, thus ushering in an early start to a winter recession of water, and one that would last particularly long. Of note and continuing a two-decade trend, the spring dry down was especially pronounced in the Big Cypress Swamp as evidenced by Corkscrew Swamp’s central marsh drying out and the outbreak of a large wildfire in Big Cypress National Preserve.

Water Year 2018 (May 1, 2017 to April 30, 2018)

Water Year 2018 was a year of wet and dry extremes featuring a “record rainy” summer wet season and, in a repeat of the previous year, and a “below average” dry season. A whopping 55 inches of rain fell across south Florida during the six-month (May through October) summer wet season (the long-term average is 38 inches) and 8 inches fell in the six- month (November through April) winter dry season that followed, for an annual total of 64 inches. This is nearly an 11-inch rainfall surplus from the SFWMD’s annual average of 52.7 inches.

Despite the bountiful summer rains, a sweltering May actually started Water Year 2018 off on a rather dry note with a continuation and deepening of the drought from the previous water. Reminiscent of the saying “all droughts end in flood,” an epic three-day onslaught of rain in early June ushered in an “instant” wet season across all of south Florida and set the stage for the “record rainy” wet season to come. Abundant tropical moisture and regular afternoon storms combined with the exclamation points of Tropical Storm Emily, Hurricane Irma, and Tropical Storm Philippe to produce a wet season that went down in the history books with rarely seen events, including water sheetflowing over a few miles of Turner River and Wagonwheel Roads after the June deluge and a brief overtopping of the Tamiami Trail between Forty and Fifty Mile Bend in the days following Irma for the first time since 1995.

The “instant” wet season stayed well above average for most areas of the ecosystem from June into January, peaking for much of the summer 1-2 feet above normal levels, causing even high-ground tree islands in the WCAs and pine flatwoods of the Big Cypress Preserve to submerge for multiple months.

A series of emergency measures was taken to alleviate the unusual bounty of summer water, some of which had negative connotations — such as mandatory releases from Lake Okeechobee to the

Caloosahatchee and St. Lucie estuaries to protect the integrity of the lake's perimeter levee as it is being repaired — whereas others had a positive Everglades restoration note. Most notable in that regard were three efforts focused on spreading the water out: (1) to the East, water managers sent water through the new one-mile bridge into Everglades National Park's (ENP) Northeast Shark River at an unprecedented scale; (2) to the West, the newly-constructed Merritt Pump Station went into action to spread water into downstream Picayune Strand; and (3) in the center, a series of pumps was utilized for a second straight year to send water west across the L-28 levee into Big Cypress National Preserve.

The FDEP issued an emergency final order (EFO No:17-0867) on June 23, 2017, authorizing SFWMD and the USACE to take immediate action to deviate from permitted water management practices to move significant volumes of flood water out of the WCAs. The FDEP authorized temporary deviations from authorized operations for ten permits, six issued to the SFWMD and four issued to the USACE, to maximize benefits to the environment and to minimize detrimental impacts such as harmful flooding and degradation of water quality, with the overarching goal of lowering WCA water levels below their respective regulatory discharge zones. In addition, the FDEP also issued an Emergency Final Order for Hurricane Irma on September 5, 2017, in response to the imminent or immediate danger to the public health, safety, and welfare of the citizens of the State of Florida posed by Hurricane Irma.

The meteorologic pendulum swung to the dry side of the spectrum for the winter, producing both good and bad results. On the positive side, the paucity of winter rains (combined with a high summer climb) set the stage for a remarkably fast, if also steady and prolonged, water recession that sparked a frenzy of foraging and nesting activity among wading birds across the Everglades. Super colonies of wading birds were observed for the first time in ENP in decades. Wood stork rookeries were reported in Big Cypress National Preserve for the first time since the 1990s. On the negative side, the Big Cypress half of the ecosystem was plagued by an unusually long wildfire season as a result of the lack of timely winter rains. Fires in Picayune and Big Cypress National Preserve generated plume clouds of smoke across the region throughout March, April, and into May.

System-wide Ecological Indicators

Helpful Hints for Reading the Indicators

Within the system-wide indicator tables, the "Current Status" column contains the most recent indicator information, which for most indicators is the end of WY 2018 (May 1, 2017 to April 30, 2018). The "Previous Status" column contains information for WY 2016 (May 1, 2015 to April 30, 2016). Status is shown using green, yellow, and red stoplight colors as explained below.

Ecological Indicator	Previous Status WY 2016	Current Status WY 2018
Invasive Exotic Plants	Y	Y
Lake Okeechobee Nearshore Zone Submerged Aquatic Vegetation	R	R
Eastern Oysters - **Modified (Northern Estuaries only)**	R	R
Crocodilians (American Alligators & Crocodiles)- **Modified (DOI Lands Only)**	R	R
Fish & Macroinvertebrates (WCA-3 and ENP only)	R	R
Periphyton - **Modified (no species composition)**	Y	Y
Wading Birds (White Ibis & Wood Stork)	R	R
Southern Coastal Systems Phytoplankton Blooms	Y	R
Florida Bay Submersed Aquatic Vegetation	Y	Y
Juvenile Pink Shrimp - **Modified (no sampling)**	B	B
Wading Birds (Roseate Spoonbill)	R	R

Stoplight Color Legend

RED — (R) Substantial deviations from restoration targets creating severe negative condition that merits action. Well below restoration target.

YELLOW — (Y) Current situation does not meet restoration targets and may require additional restoration action. Below restoration target.

GREEN — (G) Situation is within the range expected for a healthy ecosystem within the natural variability of rainfall. Continuation of management and monitoring effort is essential to maintain and be able to assess "green" status. Meets restoration target.

BLACK — (B) No data or inadequate amount of data were collected due to reductions in funding.

Invasive Exotic Plant Indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	Y	Y

The status of the invasive exotic plant indicator (Doren et al. 2009) was below the restoration target (yellow stoplight) at the end of WY 2016 and remains below the restoration target at the end of WY 2018. Though there continue to be positive results for some invasive plant species in some ecological systems, others showed negative results as measured by abundance and/or geographic distribution.

The region-wide interagency effort to manage the highly invasive melaleuca tree remains a national example of coordination success. Melaleuca distribution and abundance within the Everglades Protection Area decreased 54% in areas with intermediate to high infestation levels between 1995 and 2015 (LeRoy Rodgers, SFWMD, unpublished data). However, the overall geographic distribution of the species has increased and in some areas populations previously under control have resurged, largely due to inadequate resources for management.

Old World climbing fern continues to present significant challenges to restoration. Long-term data confirm continued increases in abundance and geographic range throughout the region. Substantial impacts to forested wetland ecosystems are attributed to the colonization of this vining fern, which displaces native plant species, degrades wildlife habitat, and promotes destructive wildfires. Expansion of Old World climbing fern is particularly severe in the floodplain swamps of the Kissimmee River basin, Everglades tree islands of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR), and cordgrass marshes of ENP. Current conditions in these areas do not meet restoration criteria. Since 2014, the State of Florida and Department of Interior have increased coordination and control measures for Old World climbing fern and melaleuca at the LNWR. While significant challenges remain, this interagency effort is slowing the expansion of these species and localized areas are now well managed.

Invasive plant species continue to threaten restoration of native plant communities in the Kissimmee River floodplain. Numerous invasive exotic plant species have expanded in the restored floodplain (Rodgers et al. 2017). Several invasive grass species (e.g. paragrass, *Urochloa mutica*) and several species of water primrose (primarily *Ludwigia peruviana*) have developed into large nearly single species stands preventing recovery of maidencane and broad leaf marsh plant communities. New research to develop herbicide control techniques compatible with restoration initiatives is underway.

Given the diversity of south Florida's invasive species and their varied impacts, managers must prioritize responses. Science-based assessments help inform managers of predicted impacts of invasive species and associated impediments to restoration success. Management approaches that combine a variety of treatment and control techniques as a means of mitigating invasion impacts are proving useful. For example, integrating herbicide treatments, fire, and biological controls through the Comprehensive Everglades Restoration Plan (CERP) Biological Control Implementation Project is improving overall management outcomes for some invasive species. Continued improvements in invasive species management through coordinated planning, construction, and operation phases of restoration efforts (see CERP Guidance Memorandum 062.00, 2012) are necessary to promote more cost-effective management.

The greatest threats to invasive plant management success in the Everglades are: (1) insufficient resources to address invasive species in critical areas; and (2) the continued establishment of new invasive species. Experience gained over the last two decades confirms that containing and reducing populations of highly invasive species often requires substantial initial investment of resources as well as commitment to long-term maintenance control of the populations as restoration proceeds.

The invasive plant indicator remains below the restoration target.

LAKE OKEECHOBEE NEARSHORE ZONE SUBMERGED AQUATIC VEGETATION (SAV) INDICATOR

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	R	R

The status of the Lake Okeechobee Nearshore Submerge Aquatic Vegetation (SAV) indicator was well below the new RECOVER approved restoration target (red stoplight: for more details, see the full report here) at the end of WY 2016 and remains well below the restoration target at the end of both WY 2017 and WY 2018. Submerged aquatic vegetation covered less than the 50,000-acre target threshold during the annual summer mapping exercise in both WY 2017 and WY 2018, and also was below the new interim goal of 35,000 acres during both WY 2017 and WY 2018. The total number of acres covered by SAV did increase slightly during WY 2018 (26,429 ac) as compared to WY 2017 (19,513 ac), although it has decreased significantly after Hurricane Irma in September of WY 2018.

Since its establishment in 2008, the Lake Okeechobee Regulation Schedule (LORS) has generally kept the lake within or below the ecologically preferred range of 12.5 to 15.5 feet above sea level. That changed in WY 2017 when El Niño generated very wet conditions in January and February and after Hurricane Irma in September through most of December in WY 2018. As a result, the lake stage went above 16 feet at the end of January and remained above 15.5 feet until the middle of March in WY 2017 and went above 17 feet in October and remained above 15.5 feet until late December in WY 2018. Most of the sentinel sites when sampled in November 2016 and 2017 and February 2016 and 2018 had associated losses of SAV.

Based on annual SAV coverage data collected since 2000, maintaining lake stage within the ecologically beneficial stage envelope, in terms of water depth and temporal ascension and recession rates, provides good conditions to maximize nearshore SAV coverage. When lake stages have been significantly above the ecologically beneficial stage envelope, SAV coverage has declined. Significant deviations below the envelope may cause temporary reductions in SAV coverage but lead to substantial regrowth afterwards and are critical for recovery after high lake stages. Restoration activities that provide a significant increase in water storage in the Lake Okeechobee watershed, thereby allowing the lake to more closely follow the timing and depths of an ecological beneficial stage envelope, should enhance SAV coverage and density in the nearshore region. However, even with better control of lake stage, periodic events such as tropical storms and seasonally increased turbidity and droughts will continue to influence nearshore SAV coverage.

The six recently developed ecological performance measures and data to develop them, summer cyanobacteria abundances (July 1994 and 2000-2011 and June 1995), January and February (1997-2005) bluegill and red-ear sunfish creel data, summer (July and August 2000-2013) nearshore *Chara* and vascular SAV (2000-2012) areal coverage, and spring (March and April) and fall (September and October) epiphyte (2003-2005 and 2009-2012, lives on plants) and epipedon (2003-2005, 2008-2010, lives on bottom soil surfaces) algae abundances have been approved by the RECOVER approval process. A revised littoral region emergent aquatic vegetation (EAV) performance measure consisting of areal coverage for nine taxa is currently under review by the RECOVER approval process. The EAV taxa also have interim goals and targets for helping with Lake Okeechobee restoration.

The Lake Okeechobee SAV indicator remains well below the restoration target.

Eastern Oysters (*Crassostrea virginica*) Indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE (Modified Northern Estuaries only)	R	R

The status of the eastern oyster was well below the restoration target (red stoplight, for more details, see the full report) at the end of WY 2016 and remains well below the restoration target at the end of WY 2018. This summary reports on the status of the eastern oyster in the Northern Estuaries (Caloosahatchee River Estuary, St. Lucie Estuary, Loxahatchee River Estuary, and Lake Worth Lagoon). Monitoring in the Lake Worth Lagoon could be impacted by a lack of consistent funding. Efforts to continue have succeeded thus far on an ad hoc basis, but a long term source of funding for this effort is needed.

Restoration activities that provide additional water storage in the Lake Okeechobee watershed, the St. Lucie and Caloosahatchee watersheds, as well as storage south of the lake, will help to reduce the severity of excess freshwater discharges from Lake Okeechobee, minimize huge fluctuations in salinity, enable oyster populations to thrive, and lead to increased oyster population densities. Too much fresh water impacts reproduction, larval recruitment, survival, and growth, while too little fresh water impacts the survival of oysters due to predation and higher prevalence and intensity of the *Perkinsus marinus* pathogen.

Increased rainfall and freshwater inflows associated with the 2015/2016 El Niño event and the subsequent effects on estuarine salinity were the driving force behind patterns in oyster survival, abundance and health in WY 2017. Oysters in the St. Lucie Estuary (SLE) were the most severely impacted as salinities remained at sub-optimal levels from May through October 2016. Although there was not a complete oyster die-off related to the low salinities, oysters were extirpated from the most upstream stations by July 2016. In addition, larval recruitment rates were low throughout the year suggesting that most of the larvae were either killed outright by low salinities or physically flushed downstream by the high flow rates. In contrast, although salinity was highly variable, it generally remained within the optimal range through late 2016 in the Loxahatchee River Estuary (LRE) and in Lake Worth Lagoon (LWL). The benefits of this extended period of optimal salinities are reflected in the high live oyster densities present at stations in both the LRE and LWL.

In WY 2018, salinities were relatively high in May but decreased abruptly in June and remained low for the remainder of the calendar year. This was less pronounced in the LRE and at the two most downstream stations in the Caloosahatchee River Estuary (CRE). The primary cause of these low salinities was the extremely powerful and intense Hurricane Irma which hit Florida in early September. Excessive rainfall and runoff associated with the storm increased Lake Okeechobee water levels and subsequently those waters were released into the SLE and CRE. Flow rates into the CRE and SLE during the months following the storm were among some of the highest recorded since 2005. Those excessive freshwater inputs and the resultant low salinities caused a massive oyster die-off in the SLE and at the two most upstream stations in the CRE. The timing and duration of the event (late in the year) exacerbated the effects of the storm and prolonged the recovery period in the SLE by suppressing larval recruitment during the last few months of the spawning season. In the LRE and LWL, where the salinity regime is generally higher, there were minimal negative effects on oyster density and recruitment; however, recruitment rates in both estuaries were somewhat depressed in the months following the storm.

The oyster indicator remains well below the restoration target.

Crocodilians (American Alligators & Crocodiles) Indicator

STATUS	PREVIOUS (WATER YEAR 2016	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE (Modified USDOI lands only)	R	R

A full system-wide status assessment for crocodilians for WY 2016 - WY 2018 cannot be provided because some survey routes have not been sampled since funding was suspended in WY 2012. However, surveys have continued on U.S. Department of the Interior (USDOI) lands (LNWR, Big Cypress National Preserve, Crocodile Lake National Wildlife Refuge, Biscayne National Park, and ENP). Funding for surveys in WCA-3A and 3B was restored in WY 2016 and if funding continues, will be included in the WCA-3 2020 assessment.

The status of the crocodilian indicator in the areas listed above remained well below the restoration target (red stoplight) in WY 2017 and remains well below the restoration target at the end of WY 2018. The overall score for USDOI lands has remained well below the restoration target for five consecutive years. There are fluctuations from year to year, but overall this result reflects low relative densities of alligators, variable alligator body condition, and low crocodile growth and survival. In addition, estimates of crocodile relative density have shown a negative trend over time from 2004-2015.

Data collected for both alligators and crocodiles are being used in the RECOVER 2019 System Status Report (SSR) and alligator surveys in Northeastern Shark River Slough support monitoring of Modified Water Deliveries and the Tamiami Trail Bridge projects.

Data are being used to develop a better understanding of the relationship between hydrology, salinity, and alligator relative density and body condition and salinity and crocodile growth, survival, relative density, and body condition. Data collected from 1978-2015 in ENP show that high salinity conditions during the dry season strongly reduced crocodile growth rates. In addition, as salinity increases, estimates of crocodile relative density decreased. Refined statistical techniques are allowing us to get better estimates of crocodile survival. This new analysis will be incorporated to update crocodile survival targets. See the 2018 System-wide Ecological Indicators for Everglades Restoration for more details and a list of publications.

Alligator body condition and relative abundance should respond positively (increase) in areas where restoration projects restore multi-year hydroperiods and more natural fluctuations in water depths. Positive responses to Modified Water Deliveries and the Tamiami Trail bridge projects are anticipated over the next five years.

Completion of projects such as the C-111 Spreader Canal, designed to improve freshwater flow and water delivery to Florida Bay, will improve conditions and is expected to result in an increase in growth, survival, relative density, and body condition of crocodiles. Over the next five years, increases in crocodile performance measures and other metrics similar to what have been observed in the Cape Sable area where restoration projects have improved conditions for crocodiles and other indicators are anticipated.

The crocodilian indicator remains well below the restoration target.

Fish & Macroinvertebrates indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	R	R

The status of the fish and macroinvertebrates indicator assessed in ENP (Shark and Taylor Sloughs) and WCA-3A and WCA-3B was well below the restoration target (red stoplight) in both WY 2017 and WY 2018. This indicator contains multiple components (see Full System-wide Ecological Indicators Report) and those in Shark River and Taylor Sloughs in ENP that are sensitive to hydrological drying have been below targets for both years. This is in contrast to the same indicators in WCA-3A and WCA-3B, where they have been within expectations based on rainfall. There is continued evidence that Shark River Slough and Taylor Slough dried more than required to meet the rainfall-based restoration targets, even with the high rainfall in the 2018 wet season. This is because of the persistent effects of over-drying from past years and because the dry season of the 2018 water year was relatively dry.

The regional relative abundance of nonnative fish has exceeded 2% in Shark and Taylor sloughs, but not WCA-3A in this reporting period. The relative abundance of nonnative fishes dropped this year compared to the 2015 and 2016 water years. The most common nonnative fish were African jewelfish in Shark River Slough and Mayan cichlids in Taylor Slough. Asian swamp eels and spotfin spiny eels were also collected, but only in Taylor Slough. While in the last assessment there was statistically supported evidence that these nonnative fish were impacting native species by causing decreases in both density and biomass, this was not so clearly the case in the current assessment period. The long-term impacts of these new species remains to be determined.

The Fish & Macroinvertebrates indicator remains well below the restoration target.

Periphyton indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	Y	Y

The system-wide status assessment for periphyton for WY 2016 was based on a combined quality, quantity and composition metric (using periphyton total phosphorus content, ash-free dry biomass, and percentage endemic diatoms, as previously reported). The status report for WY 2018 is based on quality and quantity only because funding for endemic diatoms was not provided. Surveys were conducted in LNWR, ENP (Shark River Slough and Taylor Slough), and WCA-2 and WCA-3.

The status of the periphyton indicator in the areas listed above remained below the restoration target (yellow stoplight) in WY 2016 and 2017 (overall score = 77% in both years). This score has remained relatively consistent for the last nine consecutive years. The most recent nine years (WY 2009-2017) are slightly improved from the prior two years (WY 2006-2008). There are fluctuations from year to year, but overall this result reflects low biomass of calcareous periphyton mats, higher periphyton total phosphorus content than expected background levels, and a higher number of “weedy” diatom taxa inhabiting the mats (indicative of enrichment). Some temporal trends are noted at some subsets of sites, but there is no consistent trend at the regional or full-system scale

Data collected for periphyton are being used in the RECOVER 2019 System Status Report (SSR) and more comprehensive studies are being conducted in the Northeastern Shark River Slough and Upper Taylor Slough in conjunction with the Modified Water Deliveries and the Tamiami Trail bridge projects.

Data are being used to develop a better understanding of the relationship between hydrology, phosphorus and conductivity on periphyton abundance, quality and composition. Periphyton communities in Shark River Slough and Taylor Slough are consistently healthy except within 2 km of inflows, where phosphorus enriched communities continue to be detected. Signals of enrichment are also evident in the near-coastal regions of both sloughs where phosphorus enrichment is resulting from marine water intrusion. Periphyton in the WCAs show impairment near canal inputs of phosphorus, but also where water levels have remained higher than anticipated, especially in southern WCA-3A, where calcareous mats are absent. In addition, the northern boundary of LNWR appears to also have impacted periphyton communities, likely due to exposure to higher conductivity inflows.

Modeling studies have been used to predict periphyton condition under alternative restoration scenarios. These studies assume that the stormwater treatment areas are allowing water flowing into the Everglades Protection Areas to achieve phosphorus limits. Model outcomes suggest that the Modified Water Deliveries and the Tamiami Trail bridge projects will improve periphyton community attributes as long as inflowing water meets the phosphorus criterion.

Although completion of these projects should improve water flow into ENP, water flow volumes are unlikely to be sufficient to reverse marine water intrusion into freshwater wetlands at the marsh-mangrove ecotone until the full CERP is completed. For this reason, the Everglades Landscape Model is being expanded to predict periphyton condition in these regions. Over the next five years reductions in periphyton condition in the coastal ecotone regions due to saltwater and phosphorus exposure are anticipated.

The periphyton indicator remains below the restoration target.

Wading Birds (Wood Stork & White Ibis) indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	R	R

The status of the wading birds indicator was well below the restoration target (red stoplight) in the previous reporting year (WY 2016) and the current reporting year (WY 2018) in all but one indicator. Normal water levels in calendar year 2016 and early 2017 were followed by a reasonable drying pattern, resulting in strong but not exceptional nesting in spring 2017. Nest starts were relatively early for Wood Storks (December for some nests) and the second highest nesting numbers for Wood Storks in 18 years were recorded. Because the end of the WY (April) falls inconveniently in the middle of the wading bird nesting season, the water year reporting reflects the previous spring nesting. For this reason, this report is on the spring 2017 nesting season, with appropriate comments on the 2018 season.

Three of the four key restoration parameters for wading birds (see full 2018 System-wide Ecological Indicators Report for Everglades Restoration) remained in the red, or poorest response category. Although there was some progress on timing of nesting in 2017 for Wood Storks, the indicator is a five- year average and the single result from 2017 did not move that dial appreciably. The mean interval between exceptional ibis nesting years now routinely exceeds target levels and has in both 2017 and 2018 nesting years.

While still ongoing, it is possible to make some inferences about the 2018 nesting season which will be reported on in WY 2019. Nesting by storks was early (December and January) and largely successful. Exceptional numbers of ibises have begun nesting on a normal schedule (March and April) and, notably, several very large colonies have formed in the coastal zone in ENP. These trends of more nesting in the coastal zone and earlier nesting are both positive developments that are likely to affect the averages of those two indicators. The proportion of tactile to visual foragers does not seem to be strongly affected in 2018.

Overall, both 2017 and 2018 spring nesting events occurred under good water and weather conditions and had reasonable to exceptional responses. This might be predicted as a result of the weather patterns alone, however, and it is not clear that any of the positive results are directly attributable to restoration actions. These responses of wading birds are what would be predicted (trends are stable to negative) since large scale restoration of hydrological conditions that should positively affect birds has not yet taken place.

The wading birds indicator remains well below the restoration target.

Southern Coastal Systems Phytoplankton Blooms indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	Y	R

Phytoplankton blooms, commonly called algal blooms, are an indicator of water quality. In the context of Everglades restoration, the bloom indicator is cautionary, helping to ensure that restoration actions cause no indirect harm to coastal ecosystems via water quality degradation. The status of the Southern Coastal Systems Phytoplankton Blooms Indicator was generally poor in Southern Coastal Systems (SCS) waters in WY 2017 and WY 2018, with the overall SCS-wide score being yellow in WY 2017 and red in WY 2018. Conditions varied greatly in WY 2017. While good (green) conditions occurred in 4 of 10 SCS zones, north-central and western Florida Bay, where seagrass mass-mortality occurred in the previous year (WY 2016), and Biscayne Bay were areas of concern. The only very poor score (red) in WY 2017 was in northern Biscayne Bay. In WY 2018, very poor conditions were widespread, with red scores in 5 of the 10 zones, including north-central and northeastern Florida Bay and Biscayne Bay. It is of concern that northern Biscayne Bay had red scores for the last 5 years and the central Bay had red scores for 4 of the last 5 years.

Causation of generally poor SCS water quality conditions over the past two years appears to be related to two events: the north-central and western Florida Bay seagrass die-off in WY 2016 and Hurricane Irma in September 2017. Prior to the die-off, the bloom indicator showed good conditions for 8 straight years in the north-central bay and 16 straight years in the western bay. In the two years following the die-off, with the release of nutrients from dead seagrasses, the indicator had yellow and red scores in the north-central bay and yellow scores in the western bay. Extremely high salinity conditions in the summer of 2015 contributed to initiating the die-off and Everglades restoration is expected to decrease the risk of such conditions occurring in the future. Hurricane Irma disturbed the entire SCS, mobilizing and transporting nutrients throughout. The mobilization of seagrass die-off associated nutrients by Irma likely had a strong effect on Florida Bay.

Poor conditions in central and northern Biscayne Bay, the most urbanized portion of the bay, have persisted for the last 5 years. Algal blooms have been coincident with seagrass die-off in the northern bay. Causation is not known, but likely is related to local nutrient sources and not to restoration activities.

The phytoplankton bloom indicator is well below the restoration target.

Florida Bay Submersed Aquatic Vegetation indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	Y	Y

The Florida Bay submersed aquatic vegetation (SAV) overall status indicator was Yellow for WY 2017 and WY 2018, below restoration targets for both years. The Composite Index summarizing overall SAV status indicates that the SAV community regressed in several areas due to residual effects of a large-scale die-off event beginning in June 2015 and the impact of Hurricane Irma in September 2017. Die-off occurred primarily in the western sector of the Central Zone and in the Western Zone of the bay. The hurricane impacted the entire bay. In addition to physical loss of tens of thousands of acres of SAV habitat, a release of excess nutrients to the water column by these events caused two prolonged algal blooms which increased turbidity, reduced photosynthesis, and either killed or inhibited regrowth of SAV. The Composite Index is composed of two sub-indices. The Abundance Index, which measures both a spatial coverage component and a density component, was Poor in the Southern Zone, Fair in the Transition, Central and Western Zones, and Good only in the Northeast Zone for both years. The grade of Fair in the Western Zone represents a regression following a Good grade earned the year prior to the die-off. The Abundance Index was reduced by declines in SAV density in the Western Zone. The net effect of these declines is that as of WY 2018, of the five zones in the bay, three are now yellow and one is red for Species Abundance.

The Target Species Index, which combines an indicator for presence of ecologically valuable seagrass species and an indicator for diversity in species composition, showed declines in status in several areas of the bay, falling from green to yellow for desirable species in the Northeast and Transition Zones in WY 2018 and from yellow to red for diversity in the Northeast Zone in both years and the Central Zone in WY 2018. The effect of these declines is that as of WY 2018, four of the five zones are in yellow status for Target Species.

Previous incremental gains in the quality of SAV habitat over several years were reflected in generally improving scores in the late 2000s and early 2010s. The wetter years of 2012 and 2013 resulted in lower salinities, more favorable conditions, and improving SAV status in many areas of the bay. These improvements proved to be precarious and were reversed by two climatological events in 2015 through 2018: prolonged drought and a tropical cyclone. The extreme drought of 2015/16 led to the SAV die-off event in areas of the bay that became most hypersaline (Central) or were most abundant in *Thalassia* (Western). The die-off may have been fortuitously curtailed by the very wet dry season of WY 2016 and the el Niño rains into WY 2017 which brought freshwater to the bay and reduced hypersaline conditions. The algal bloom events that followed, one in the Central and Western bay in WY 2017 and one bay-wide following the hurricane in WY 2018, each subsided within about six months, improving water clarity. Most recent indications are that SAV regrowth is occurring and may show more favorable status in the coming months.

The Florida Bay submersed aquatic vegetation (SAV) remains below the restoration target.

Juvenile Pink Shrimp indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	B	B

Funding was suspended in WY 2012. No data were available for assessment of the juvenile pink shrimp indicator condition at the end of WY 2018.

Wading Birds (Roseate Spoonbill) indicator

STATUS	PREVIOUS (WATER YEAR 2016)	CURRENT (WATER YEAR 2018)
SYSTEM-WIDE	R	R

Overall the stoplight color for the wading bird (Roseate Spoonbills) indicator remains red for WY 2018, though conditions throughout Florida Bay appear to be somewhat improving for spoonbills based on nest production and nesting success in recent years.

The total number of nests in Florida Bay in 2018 was 278 with a 5-year average of 282 nests. Although an improvement over the low point of 191 nests recorded in 2014 (5-year average of 268), the number of nests declined from 367 nests in 2016 (5-year average of 345) and is still well short of the target of 1,258 nests and scores red on the stoplight. The two nesting location metrics were also scored red. Nest numbers in Northwestern Florida Bay (NWFB) dropped from yellow in 2016 (5-year mean of 141) to red (5-year mean of 128 nests with a target of 210). Northeastern Florida Bay (NEFB) declined from 189 nests in 2016 (5-year mean 160) to 58 nests in 2018 (5 year mean 107) and also well short of the 688 nests target making the score red.

The 2016 report predicted that nest production would decline following the cessation of drought conditions, however, there was only a slight decline in NEFB (5-year mean went from 0.96 chicks/nest in 2016 to 0.93 c/n in 2018) and actually increased slightly in NWFB from a 5-year average of 1.33 c/n in 2016 to 1.37 c/n in 2018. Therefore, the stoplight score in NEFB was yellow in 2018 while in NWFB it remained green. In contrast, the Successful Nesting metric (number of years out of the last ten that nest production averaged >1 c/n) remained Green in NEFB (8 successful years in the last 10) and Yellow in NWFB (6 successful years out of the last 10). Overall the Nest Production and Success metric was yellow for both the northeastern and northwestern nesting regions of Florida Bay.

The Mangrove Prey Base Fish Community Structure sub-metric was removed from the calculation of the spoonbill indicator and elevated to a full stand-alone indicator (see full System-wide Ecological Indicators Report) because it is not as affected by on-going sea level rise as the spoonbill nesting indicator.

Three of the five metrics for spoonbills were red with the other two being yellow so overall the spoonbill indicator was red.

The spoonbill indicator remains well below the restoration target.