A fundamental premise of Everglades restoration is that the ecosystem must be managed from a system-wide perspective. The suite of system-wide ecological indicators was chosen based on their collective ability to reflect the ecosystem in terms of response to restoration over space and time. Their purpose is to report on the general status of the ecosystem as a whole and show how the key ecological components respond to implementation of restoration projects.

The stoplight colors shown in this report for each indicator integrate across all of the areas where that indicator is monitored. This integration includes both areas where restoration actions have occurred and where they have not occurred, thus representing a system-wide view. Because many restoration actions to date have been fairly small-scale, or focused on just one component of the ecosystem, we have not yet seen collective positive trends in the suite of indicators (see indicators at a glance on page 68). There are, however, examples where local restoration actions have resulted in the type of positive ecological responses that we expect to one day see system-wide. We have selected four case studies that illustrate how some ecological indicators are responding to smaller-scale operations or early stages of larger restoration actions. Arranged geographically from the north to south (see project map), they are as follows:

- Kissimmee River Restoration Project
- Lake Okeechobee Restoration
- C-111 Spreader Canal Western Project
- Cape Sable Canals Restoration
The Kissimmee River Restoration Project: A Long-Term Project Shows Promising Interim Results

The Kissimmee River Restoration Project (KRRP) is one of the largest and most ambitious river restoration projects in the world (see map). The project, to be completed in 2019, will restore a full suite of ecosystem values to more than 40 square miles of river channel and floodplain habitats at a cost of approximately $800 million. The restoration will backfill more than 22 miles of the flood conveyance canal that replaced the once naturally meandering, complex river channel, effectively reconnecting approximately 40 miles of historical river channel into one continuous stretch of river. In the restored system, river inflows will be allowed to mimic natural conditions, inundating floodplain habitats in response to season and rainfall.

An intermediate inflow regime has allowed for monitoring of the environmental response of important ecological indicators during the two of four planned phases of backfilling that have been completed so far. Perhaps surprisingly, even though hydrologic conditions do not yet match those of the historical system, dramatic responses are being seen in important ecosystem components.

Monitoring of environmental response is a crucial aspect any restoration project, and the KRRP monitoring plan investigates a suite of 25 performance measures covering physical, chemical, and biological aspects of the ecosystem. Interim monitoring results indicate that restoration targets for some performance measures already have been met. For example, the density of winter wading birds is showing tremendous response to interim restoration. A target value of 30.6 birds/km2 has been achieved in most monitoring periods. In contrast, while a large-scale target for restoration of wetland plants has been met, a finer-scale wetland plant target of re-establishing the broadleaf marsh community across 50% or more of the flood plain has not and will likely require the more complete implementation of historical hydrologic conditions that will accompany project completion.

Demonstrating the interim success of a project of this physical scale and time-frame is vital to maintaining forward momentum both within the technical team and at management and policy level. The interim progress simultaneously illustrates the effectiveness of the investment of resources and makes clear that achievement of the full suite of anticipated benefits is dependent on a continued commitment to project completion and performance measure monitoring.

For a more detailed version of this case study, see the 2014 System-Wide Ecological Indicator Report.
Lake Okeechobee: Lowered Lake Reveals Important Ecological Lessons

Lake Okeechobee and its surrounding wetlands lie at the center of the Greater Everglades watershed that stretches from the Kissimmee River through the Everglades and finally into Florida Bay (see map). Lake Okeechobee provides natural habitat for fish, wading birds, and other wildlife, and is also a key component of south Florida’s water supply and flood control systems. The lake’s health has been threatened in recent decades by excessive inflow of nutrients from agricultural and urban activities and also by harmful high and low water levels. Restoration of the lake is a priority within Everglades restoration efforts.

Since 1994 we have had the opportunity to see how ecological conditions in Lake Okeechobee respond to a variety of managed lake stages, hurricanes, and drought. In April 2008, a new and lower lake regulation schedule was implemented for Lake Okeechobee, designed to keep the water level of the lake approximately one foot lower compared to the previous schedule, and even lower than earlier regulations required. As a result, for most of the past 6 years, the Lake level has remained within or below an ecologically preferred range of 12.5 to 15.5 feet above sea level.

The best indicators of habitat quality in a hydrologically restored lake are considered to be emergent aquatic plants in the marsh and submerged aquatic vegetation in the nearshore zone. Generally speaking, the total extent of vegetated acres is a good proxy for environmental conditions of Lake Okeechobee.

Analysis of marsh plant data, collected along transects since 2003, reveals that under lower lake-level conditions, the area of the southern and western shoreline zone colonized by emergent aquatic plants expanded, as did the nearshore area colonized by submerged aquatic vegetation, resulting in an increase in total vegetated acres in the shoreline and nearshore zones, suggesting an improvement in available habitat. Other taxonomic groups, including periphyton, sport fish, and wading birds are also showing increased abundance under the generally lower lake levels.

Of course, achieving ecologically beneficial lake levels by simply draining large volumes of water from Lake Okeechobee when needed, as currently takes place, entails serious negative consequences for both water supply and for east and west coast estuaries that consequently receive environmentally damaging high flows from the lake. A regional restoration solution is required that will both permanently improve lake levels and protect the estuaries. Bi-directional northern watershed storage to better control lake levels, coupled with additional water projects that improve water quality and allow excess water to once again flow southward through the Everglades ecosystem, are important goals of both the CERP and the CEPP.

For a more detailed version of this case study, see the 2014 System-Wide Ecological Indicator Report.
The C-111 Spreader Canal Western Project: Single Project Promises Benefits to Many Species

The C-111 Spreader Canal Western Features Project (Project), which is a component of CERP, was developed to protect and restore the hydrology and ecology of southeastern Everglades National Park (ENP), including Florida Bay. This Project, combined with the earlier C-111 South Dade Project, constructed a nine-mile hydraulic ridge oriented north-south along the ENP eastern boundary to minimize seepage into the C-111 Canal and retain rainfall and natural water flows within Taylor Slough, benefitting up to 252,000 acres of wetlands and coastal habitat. The South Florida Water Management District completed construction of the Project in February 2012 and it became operational in late June 2012.

The Project is anticipated to increase flow in Taylor Slough and decrease discharge out of the C-111 canal through the S-197 structure. The increase in flow through Taylor Slough is expected to result in higher water levels in the Taylor Slough watershed, lower salinities in northern Florida Bay, an expansion of brackish and freshwater submersed aquatic vegetation, greater growth and abundance of the emergent aquatic vegetation community, increased abundance of the freshwater prey-based fish communities, increased nesting success rate for spoonbills, increased growth and survival of juvenile crocodiles, and increased adult crocodile abundance and nesting. Decreased discharge through the S-197 structure will reduce large point-source discharges into Biscayne Bay, which can devastate sessile marine organisms by rapidly lowering salinity.

Water Years 2013 and 2014 (see Hydrology Overview for definition of Water Year) provided the first opportunities to assess the effect of the Project by examining flows, water levels, and downstream salinity. Flows at Taylor Slough Bridge in 2013 were almost 60 percent greater than the historical average, wet season flows were the highest recorded in the last 20 years, and the ratio of C-111 discharge to Taylor Slough flow was the lowest it has been in 20 years. Salinity levels measured downstream of Taylor Slough in Little Madeira Bay were found to be significantly lower after Project completion. However, because both the regional rainfall and rainfall over the local Project footprint were above average in WY2013, downstream effects cannot yet be conclusively linked to the Project.

With only 1-2 years of post-project data, it is only possible at this point to describe correlations between changes in hydrology, ecological responses, and project implementation. However, with the positive post-project hydrologic conditions cited above, measures of submerged aquatic vegetation, number of prey fish species, spoonbill nesting success rate, and crocodile abundance have all shown signs of improvement. These positive initial results are in keeping with our conceptual models and predictions made in advance of project implementation. Additional years of monitoring will be required to determine the Project's contribution to changing ecological indicators, verify cause-effect relationships, and allow us to more effectively use this information as feedback to Project operations.

For a more detailed version of this case study, see the 2014 System-Wide Ecological Indicator Report.
Restoring more natural patterns of freshwater flow and salinity in coastal estuaries is an important goal of Everglades restoration (refer back to Sub-Goal 1-A, Get the Hydrology Right page 6). As restoration projects are completed, freshwater from upstream areas will be delivered southward through the system. In the meantime, in the Cape Sable and Flamingo area of Everglades National Park, a canal restoration effort has been plugging canals that were built in the early twentieth century. These canals have allowed tidal energy and saltwater to intrude into interior areas where it did not historically occur, causing erosion, marsh degradation, and filling the region’s largest lake with sediment. This project gives us a glimpse into a future where ecological improvements will result from restoration actions. Two important species of the area that has been impacted by saltwater intrusion via canals are the American crocodile (Crocodylus acutus), which as juveniles are very sensitive to salinity levels, and Roseate Spoonbills (Ajaia ajaja), which depend on prey fish sensitive to salinity levels and tidal fluctuations.

Park managers, recognizing the need to address the changes created by the canals, plugged the East Cape, Homestead, and other interior canals in 1956 with earthen dams along the marl ridge to prevent further salt water intrusion and loss of freshwater to tide. Many of these dams eventually failed and a series of restoration efforts using stronger materials has followed over the decades and continues to the present time. The Buttonwood canal in the Flamingo area was plugged with a concrete structure in the mid-1980s and has remained in good condition. Now, many years after the canals were first dug, we have studied crocodiles and spoonbills at Cape Sable and Flamingo, where canal restoration actions were implemented, and compared the results to northeastern Florida Bay, an area which once provided the core habitat of the American crocodile in Florida but which now suffers from high salinity levels due to the shortage of freshwater flow through the altered system. Monitoring data collected in Florida Bay over recent decades on various aspects of crocodile life-history (occurrence, hatchling survival, growth, and nesting) show a repeating pattern. The animals have fared best in the Buttonwood canal area (where the successfully dammed canal has led to relatively stable lower salinity), next best in the area of other restored canals (including East Cape and Homestead canals where dams have failed and had to be restored over time), and worst in northeastern Florida Bay (where salinity levels have yet to benefit from restoration of freshwater flow). These results lend preliminary support to the hypothesis that restoring the hydrology of an area can result in ecological improvements.

Further, Audubon Florida scientists found that when the East Cape and Homestead canals were repaired in 2011, greatly reducing tidal influence at inland sites, prey availability increased and low salinity species became more prevalent. The number of Roseate Spoonbills that nest and feed near these sites had plummeted following the damaging 2005 hurricane season but began to increase again after the canals were dammed, restoring more natural conditions.

The canal plugging project in Everglades National Park serves to illustrate that even relatively small restoration efforts may produce meaningful ecological results and can serve to inform larger restoration projects. Because crocodiles and spoonbills in Everglades National Park have been monitored for many years, data needed to analyze response to canal restoration were available. Long-term monitoring of salinity, crocodiles, spoonbills, and their prey in these areas is vital to the assessment and fine-tuning of the restoration process. For a more detailed version of this case study, see the 2014 System-Wide Ecological Indicator Report.