Site 1 Impoundment
Ecological Monitoring Plan

Introduction

The ecological monitoring plan has been designed to monitor both structural and non-structural components of the proposed Site 1 Impoundment and affected areas. Structural monitoring will occur within the impoundment itself to collect operational data. This includes criteria for monitoring inflow and outflows, as well as annual capacity. Refer to the Draft Operational Manual for monitoring details. The non-structural monitoring will occur within the project's zone of influence in order to ascertain the effects of the proposed impoundment on the natural system. All data that is collected will be analyzed and utilized by RECOVER to determine if structural or operational changes are needed as a part of the adaptive management process.

Project-Level Monitoring

For project-level performance, impoundment water stages, water quality, and releases (flow) will be monitored by the SFWMD and USACE as part of the Operational Manual and Water Quality Monitoring Plan. Although the Site 1 Impoundment project is not a component designated to improve water quality, the project does have specific water quality requirements in order to discharge waters under the Clean Water Act administered by the State of Florida Department of Environmental Protection. The Water Quality Monitoring Plan includes water quality data collection at the two outflows, the spillway, and the inflow to the impoundment. It also includes sampling within each impoundment cell. In addition to water chemistry, sampling of sediments and fish tissue are also included. Refer to the Water Quality Monitoring Plan for more details. The operational plan will monitor inflow and outflow at the pump stations, as well as stage levels within the impoundment, for storage capacity and operational triggers. Refer to the Operational Plan for more details.

System-Wide Ecological Monitoring

Most of the system-wide ecological monitoring will be conducted for the Site 1 Impoundment by RECOVER as part of the Monitoring and Assessment Plan (MAP). The specific parameters of interest to the Site 1 ecological subteam includes mapping vegetation within the project's zone of influence, including the LNWR, WCA-2, and estuarine portions of the Hillsboro Canal. Additionally, wading birds will be monitored as part of the MAP.

Other system-wide monitoring is occurring under other monitoring programs conducted by various County, State and Federal agencies that will be available to the RECOVER adaptive assessment team to evaluate ecosystem responses. The MAP lists, and the team is aware, of other ongoing monitoring conducted and used for system-wide assessments and adaptive management, such as monitoring and recording of water stages within the Everglades, including WCA-1 and WCA 2A, and snail kite monitoring throughout the WCAs. The monitoring program for the Site 1 Impoundment will rely on the MAP and on-going efforts for assessment of system-wide effects for the purposes of demonstrating the projects success in contributing to the CERP and for the RECOVER team's process of adaptive assessment.

Monitoring of Site 1 Impoundment Ecological Indicators

As part of the benefits calculations in the PIR, the ecological subteam identified certain indicators that would represent effects of operations of the site 1 Impoundment. Currently these indicators are proposed for monitoring as part of the MAP by the RECOVER AAT. In developing the project-level monitoring plan, efforts to supplement the MAP with additional monitoring sites and increased frequency existed by the team. However, the duplication of RECOVER efforts and the inability to separate Site 1 Impoundment impacts from other projects impacts to the system led to the conclusion RECOVER was the best team to evaluate and adapt operations in the system. Since RECOVER is proposing to monitor all the attributes effectively in the project's zone of influence, with the exception of the downstream estuary, the team has deferred project level monitoring of these attributes to RECOVER. This will enable the RECOVER team to evaluate success of CERP projects cumulatively in realizing regional benefits and adapt operations as needed. However, the team recommends the RECOVER MAP include additional Monitoring for the estuarine environment.

A brief description of the monitoring plans for indicators influenced by the Site 1 Impoundment, based on the ecological indicators evaluated for project benefits, is as follows:

Cattail Monitoring

The RECOVER MAP includes vegetation mapping of the Greater Everglades Region. RECOVER will be purchasing aerial photography to determine changes in the extent of cattail distribution as flow patterns, flow volumes, hydroperiods, and water quality are modified. The photography will be purchased by RECOVER and the Statement of Work (SOW) will be issued by the SFWMD. Vegetation communities will be mapped with a ¼ hectare minimum mapping grid unit (MMU) from 1:24,000 scale color infrared aerial photography. Each distinct vegetation community will be designated according to the Vegetation Classification System for South Florida National Parks. Each ¼ hectare grid cell shall be labeled with at least one dominant vegetation classification, utilizing the most detailed level of classification possible to accurately portray the existing plant community. Color, tone, texture, shape, height, pattern, size, and location will be used to interpret the photographs. It is the intent of the RECOVER mapping effort to identify vegetation down to the species level wherever possible when that specific plant species is the dominant component of the grid cell being classified. Those grid cells containing exotic species of concern and cattail (Typha spp.) shall be classified accordingly as monotypic (> 90%), dominant (50% – 89%), or sparse (10% - 49%). It is possible for a grid cell to have more than one label, e.g. when cattail or an exotic is less than 50% and the remaining vegetation can be classified as some other dominant species or community. Labeling will be based on determining the aerial extent of the dominant classification through the best professional judgment of the photo interpreter. Photography will be interpreted and ground-truthed to produce vegetation maps at five-year intervals. Sampling sites include the entire coverage within the LNWR and WCA-2. Ground-truthing will be randomly sampled sites along the Ridge and Slough topography.

Tree Island Monitoring

Aerial photography of the greater Everglades as stated above will be purchased by RECOVER at a scale of 1/24,000. Photography will be interpreted and ground-truthed to produce vegetation maps at five-year intervals. Changes in the extent and orientation of tree islands as flow patterns, flow volumes, hydroperiods, and water quality are modified will be monitored. Sampling sites include mapping of the entire LNWR and WCA-2. Ground-truthing will occur at randomly sampled sites along the Ridge and Slough topography.

Periphyton Monitoring

In addition to vegetation mapping using the aerial surveys described above, RECOVER will be sampling periphyton mats annually during the late wet season at the location of each throw trap sample and within each cell and each landscape unit when regional populations of marsh fishes are sampled. One-meter square throw traps will collect periphyton. The cover of floating, epiphytic, and benthic periphyton within each of the throw traps will be visually estimated and archived using a digital photograph, after which biovolume will be measured, and a relatively homogenized subsample will be collected for laboratory analysis. Lab analysis of periphyton will include a determination of chlorophyll a, biomass, percent organic matter, and tissue phosphorus, nitrogen, and carbon using standard methods (USEPA 1983, Soloranzo and Sharp 1980). Periphyton will be analyzed for dominant algal species, indicator diatom species, and percent of mat biovolume consisting of non-filamentous blue-greens. Counts, identifications, and biovolumes of soft algal species will be determined using standard methods (Bahls 1993, Stevenson and Lowe 1986, Porter et al. 1993, Klemm and Lazorchak 1994). Diatom counts, identifications, and biovolumes will be determined using standard methods (Gaiser and Johansen 2000, Stevenson and Bahls 1999). For a more detailed description of laboratory analysis and QA/QC, see Periphyton Production, 3 Year Project Data Collection, SFWMD. The sampling sites for periphyton are based on the stratified random sampling design of the aquatic fauna regional population monitoring in MAP.

In addition, sampling within subunits of the stratified sampling will take place. Within each subunit, 6 (tentatively, possibly ranging from 5-12) primary sampling units (PSUs) will be established at the beginning of the monitoring. These PSUs will be squares, tentatively sized at 500m*500m (possible ranges from 250m*250m to 1km*1km). In order that all locations within a subunit have the same probability of inclusion, a grid of points spaced at 500m intervals (or the linear dimension of the PSU) will be superimposed over the target population, any square defined by those corners with any area within the subunit will be given an equal probability of inclusion. [This procedure eliminates the edge effect with unrestricted random center coordinates for PSUs of reduced inclusion probabilities for points near the edges of the subunits.]

For each PSU, the aerial extent of slough will be mapped via interpretation of wet-season aerial photography, and the total area in m^2 determined. This aerial determination will be repeated every 3-10 years, depending on the frequency of aerial photography. Within each PSU, each year uniform random coordinates for 3 (possibly 2-5) secondary sample points or throwtrap locations (TTs) within the currently delineated slough area will be generated via the rejection method (drawing sequential random coordinates and rejecting those falling outside slough areas until the required number of slough points are obtained). During the mid- September - early-November sampling window, field crews will obtain $1m^2$ throwtrap samples at each TT.

Aerial photography encompassing the entire Everglades system will be conducted on a five-year time scale. Periphyton tissue nitrogen, carbon analyses, and species identifications will be conducted every five years to correspond with the years of vegetation photography. In addition, periphyton will have a three-year sampling plan, taken annually during late wet season (Sept – Nov). Periphyton biovolume, biomass, percent organic matter, chlorophyll *a*, and tissue phosphorus and species composition will be measured annually at the stratified random sampled landscape units and possibly seasonally, at selected sentinel sites.

Snail Kite Habitat and Demographics

Aquatic Vegetation: The exact hydroperiods that promote *Eleocharis* (Hair Grass) and *Rhynchospora* (Beaksedge) dominated wet prairies are location-dependent, but generalities have been described to help guide water management (Bennetts et al. 1998, Kitchens et al. 2002). Specifically, based on Bennetts et al. (1998), optimal snail kite foraging habitat supporting emergent wet prairie vegetation is maintained in areas where water levels fall below ground surface between 1-in-3 and 1-in-5 years (156-260 weeks average flood duration). Because wet prairies have been described as preferred foraging habitats for snail kites, monitoring of aquatic vegetation to document community dynamics will be important to describe the abundance and location of potential foraging habitat as they change throughout the implementation of the Site 1 Impoundment. To assess the result of water management on maintenance and distribution of wet prairie habitat, yearly vegetation monitoring will occur in the LNWR and WCA-2A.

Several landscape changes are also being monitored to document ecosystem responses that relate to nesting and foraging habitat for the snail kite. These include changes in the extent of sloughs and sawgrass ridges and changes in the extent and distribution of cattail and other plant communities. Landscape patterns will be monitored using a combination of transect and sentinel site sampling designs and a stratified random design as described in the MAP (Sections 3.1.3.1 and 3.1.3.10) and in the above periphyton sampling plan. Aerial photo interpretation of these landscapes will be used as is described above.

Woody Vegetation: Woody vegetation, including the spatial extent and species composition of tree islands, will be monitored to determine the abundance and distribution of appropriate nesting habitat for snail kites. To assess the result of water management on maintenance and distribution of woody vegetation, yearly vegetation monitoring should occur in the LNWR and WCA-2A. Methods for monitoring woody vegetation will follow those described for aquatic vegetation above.

*Snail Kite Demographics, Movement, and Habitat Studies***:** Demographic surveys of snail kites, including nesting surveys and juvenile survivorship, are currently monitored throughout the LNWR, WCA-2A, and other WCAs under cooperative efforts and work orders administered by the USACE, USGS, and the University of Florida. Demographic and movement studies of snail kites are used to determine population responses and are critical to assessing impacts as a result of changes to the hydrologic regime to snail kite nesting success and foraging behavior.

Surveys include nesting success sampled 6 consecutive times March through June at 2-3 week intervals. In addition, juveniles are tracked for survivorship, and adult bird calculations are reported for population counts and distribution. These reports are prepared annually and are available for quantification of actively successful nesting and identification of population increases in the areas of interest for Site 1 Impoundment.

Wading Birds

Peter Frederick does annual nesting surveys in WCA -2 & WCA-3, counting the number of nests on all individual rookery islands. The MAP will continue and expand these surveys (see p. 3.1-41 of MAP). The MAP will also continue the monthly SRF (systematic reconnaissance flights) over the WCAs, Holey Land WMA, STA1W, BCNP, and ENP. These surveys have been on-going from Jan-June each year since 1985. The SRF protocol is a standard aerial transect counting technique employed with a systematic sampling design, and is used to survey foraging wading birds. Wading bird distribution and abundances will be monitored with monthly systematic reconnaissance flights over the Greater Everglades Wetlands. These spatially explicit surveys have been conducted monthly from January to June since 1985 (Bancroft et al. 2002). They represent one of the most comprehensive and systematic databases available for evaluating biological responses to the Everglades restoration.

Systematic reconnaissance flights are designed as a means of recording variability in the numbers and spatial distribution of wading birds over time and linking them to variability in hydrology and other more static features of the landscape. The systematic reconnaissance flight protocol is a standard aerial transect counting technique employed within a systematic sampling design (Porter and Smith 1984, Bancroft et al. 2002). The systematic reconnaissance flights, which continue today, are conducted by the USACE and Everglades National Park. These surveys cover the WCAs, Everglades National Park, Big Cypress National Preserve, and other landscape units within the Greater Everglades Wetlands. Sampling sites include the LNWR & WCA-2.

Estuarine Habitat Monitoring

In the Boca Raton Inlet and Lake Boca Raton area, the restoration expectation is to improve the spatial extent of seagrasses, corals and sponges, downstream of the G-56 structure. Current salinity readings at estuarine stations range from 0.25 ppt to 34.5 ppt. Since seagrass communities decline at salinity readings between 11 and 14 ppt, the reduction in flows at the G-56 should result in salinity readings at Stations 1 and 33 of between 11 and 28 ppt over the course of the rainfall year. Total Phosphorous and total Nitrogen have been associated with algal blooms, which affect live bottom communities by decreasing clarity and PAR readings among other variables. Since seagrasses and other live bottom communities require light to flourish, excess nutrients have a detrimental effect on these communities. Historic data at Broward County stations numbers 1 and 33 indicate median Total Phosphorus levels of 125 ppb and 80 ppb, respectively. These numbers are significantly higher than the countywide estuarine median of 48 ppb. Median total nitrogen at these sites has been recorded at 100 and 81 ppm, respectively. Median estuarine total nitrogen is 89 ppm. Thus, we anticipate that the reduction in flows at the G-56 will result in lower median levels and annual average levels closer to countywide conditions, but expect the most improvements to be realized with Total Phosphorus. In addition, the reduction of flows should reduce the high end (e.g., 75^{th} percentile) concentrations that are seen as far downstream as the Hillsboro Inlet.

The project team recommends that RECOVER adopt additional monitoring into the MAP in order to assess system-wide benefits to the estuary at the confluence of the Hillsboro Canal and Intracoastal Waterway and immediate reaches. In reviewing existing monitoring plans developed by County, State, and Federal agencies, including the MAP, this area only receives quarterly monitoring by Broward County. In the opinion of the interagency team, the Broward County monitoring efforts are not frequent or thorough enough to make a system-wide determination of individual project success or CERP projects cumulatively. The opportunity exists to partner with Broward County in supplementing additional monitoring. A brief description of the teams' proposal developed for the proposed Site 1 Impoundment is described below. However, for effects of all CERP projects on the specific resources in the estuary, additional surveying or monitoring may be of interest.

Protocol: Broward County water quality monitoring stations are sampled quarterly for salinity, temperature, pH, specific conductance, total nitrogen, total phosphorous, chlorophyll a, pheophytin, fecal and total coliform by Broward County. Sites currently proposed by RECOVER for monthly monitoring are all within southern Broward County, and specifically for dissolved oxygen, conductivity, pH, secchi, salinity, PAR, temperature, alkalinity, turbidity, TSS, color, TP, TKN, NH3, NO2+3, silicate, SRP, chlorophyll, and quarterly, phytoplankton communities. The team recommends augmenting this sampling plan with northern sampling sites in Broward County with monthly sampling at Stations numbers 1, 2, and 33 specifically.

The quantification of nutrient loads or flow-weighted mean nutrient concentrations entering and leaving the greater Everglades area will be evaluated using this existing network of inflow and outflow stations currently operated by the SFWMD. As such, water quality data will be gathered monthly and continuously and will be examined for reductions in TP, which is critical to restoring estuarine habitat.

Sampling Sites: Recommend RECOVER sampling at Broward County sampling at Stations numbers 1, 2, and 33 in Figure 1. SFWMD structures S-39 and G-56 are currently monitored by the SFWMD.

Frequency: Continuous monthly sampling for TP, quantification of nutrient loads or flow-weighted mean nutrient concentrations by WMD at inflow/outflow station. Quarterly monitoring for salinity, temperature, pH, specific conductance, TN, TP, chlorophyll a, pheophytin, fecal and total coliform by Broward County. Recommending MAP monitoring to increase the current sampling at Broward County monitoring sites to monthly.

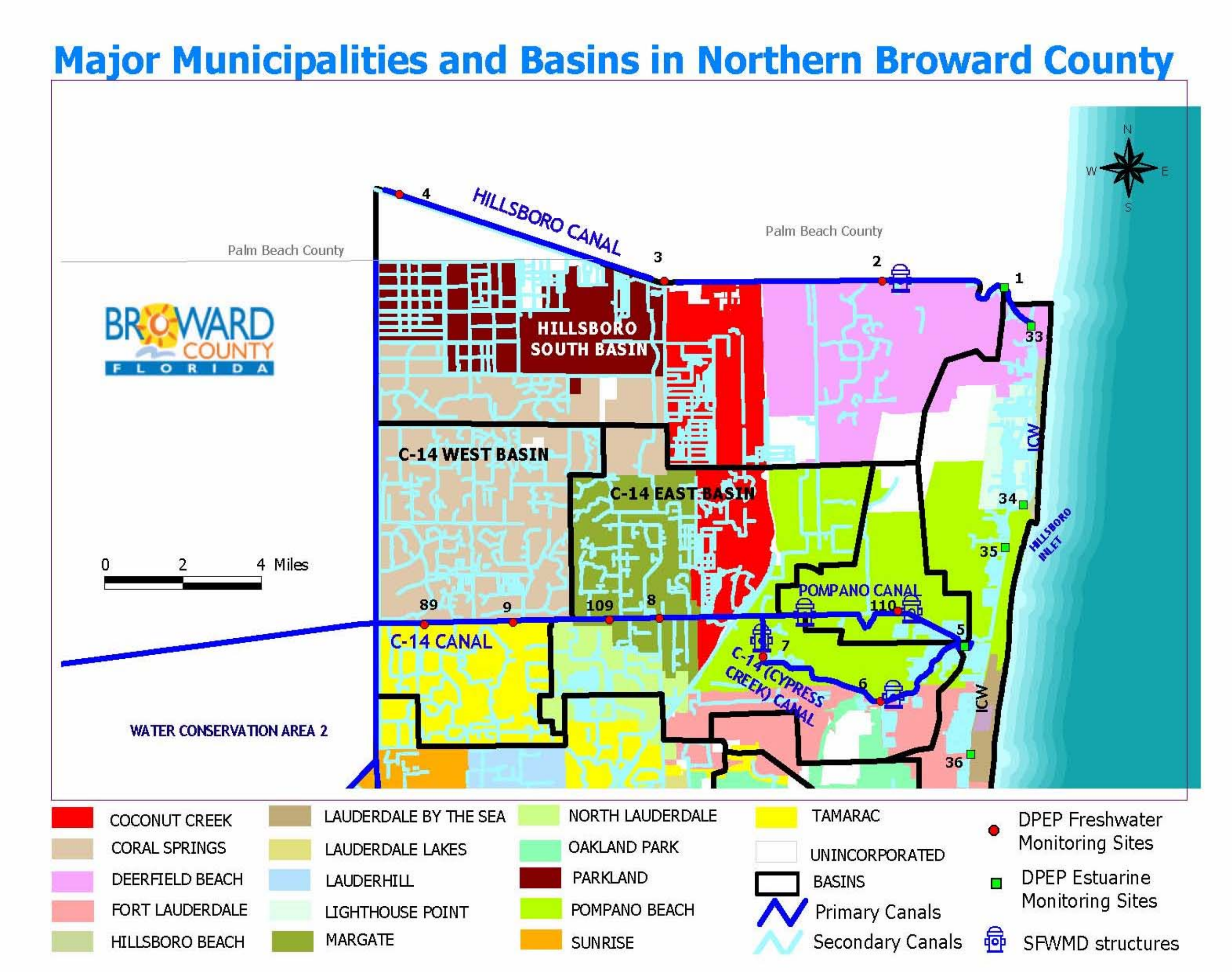
Water Stages within the Natural System

The Site 1 Impoundment should make more water available in the Natural System; therefore, providing for higher stage durations of water during dry periods. As such, the stage durations within the LNWR and WCA-2A will be indicative as to whether the Site 1 Impoundment has the proper design and is functionally operating. A stage monitoring network is already in place to monitor water stages within the greater Everglades system. The network is a cooperative effort by the SFWMD, Corps, USGS, and Everglades National Park.

Conclusions

Project level performance will be monitored using the operational monitoring and water quality monitor at the project site and the Hillsboro canal to ensure the project is operating as designed and constructed, and in compliance with all regulatory requirements and permits. System-wide monitoring will be achieved by relying on the RECOVER Monitoring and Assessment Plan and other ongoing monitoring activities for water stages and snail kite nesting success and foraging substrate. The sub-team has requested through the official coordination process with the RECOVER Assessment Team for RECOVER to adopt additional monitoring for water quality within the estuarine portion of the Hillsboro Canal in order to determine effects within the downstream estuaries. Although the MAP has sampling sites throughout many of the estuarine communities in Palm Beach and Broward Counties, the sub-team believed sampling sites within the downstream reaches of the Hillsboro Canal and northern estuarine resources in Broward County were lacking. Additional sampling site would be necessary to determine system-wide effects and utilize adaptive management for these areas.

FIGURE 1: Broward County Water Quality Monitoring Stations



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