



RECOVER Evaluation Team: Lake Okeechobee Performance Measure Synthesis



Andrew Gottlieb¹, Bruce Sharfstein¹, Andy Rodusky³, and Tom James³
¹South Florida Water Management District, Everglades Restoration Planning Offices, West Palm Beach, FL, USA
²South Florida Water management District, Okeechobee Division, West Palm Beach, FL USA

Abstract/Background:

Lake Okeechobee (LO) performance measures (PMs) are focused on the Lake's offshore, nearshore and littoral zones. LO evaluations also provide insight into linkages between the Lake, its upstream basins and tributaries and its downstream receiving bodies; especially the east and west coast estuaries (St. Lucie and Caloosahatchee) and the Greater Everglades. Similar to the other RECOVER regional sub-teams, Lake Okeechobee developed a suite of hydrologic, water quality, and ecological/biological performance measures (PMs) to evaluate the contribution of specific project alternatives to the system-wide goals of the Comprehensive Everglades Restoration Plan (CERP).

This synthesis poster provides an overview of the existing suite of PMs used to evaluate LO, provides an overview of the team's proposed PM updates, and identifies existing needs and gaps.

The following bulleted list identifies the existing suite of accepted PMs for the LO region.

- Hydrology (Lake stage envelope and extreme high and extreme low lake stage)
- Water Quality (TP, TP-TN mass ratios, and Chlorophyll a concentrations)
- Ecology (1) Diatom: Cyanobacteria ratio, 2) Emergent and submerged vegetation mosaics, 3) Fish population density, age structure and condition and 4) Macroinvertebrate community diversity and distribution)

Although RECOVER has accepted each of the PMs (listed above) and monitoring and assessment is in place to support the associated science, evaluations of LO performance (projections of various project alternatives) are generally limited to the three components of the lake stage envelope and Water Quality (using the LO Water Quality Model).

Geographic Domain:

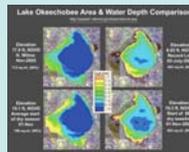
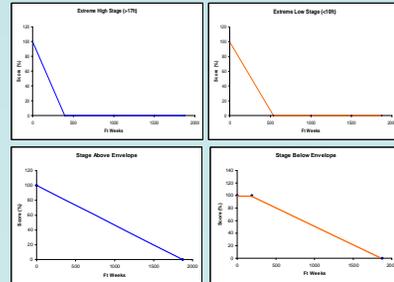


Figures: 1A) LO geographic domain with highlighted littoral zone and 1B) littoral zone sediment and vegetation photos

Hydrology PMs:

- Lake Stage Envelope
- Extreme High Lake Stage
- Extreme Low Lake Stage

Stage	J	F	M	A	M	J	J	A	S	O	N	D
19	3.5	4	4.5	5	6	6.5	6.5	6	5.5	4.5	3.5	3.5
18.5	3	3.5	4	4.5	5.5	6	6	5.5	4.5	3.5	3	3
18	2.5	3	3.5	4	5	5.5	5.5	5	4	3	2.5	2.5
17.5	2	2.5	3	3.5	4.5	5	5	4.5	3.5	2.5	2	2
17	1.5	2	2.5	3	4	4.5	4.5	4	3	2	1.5	1.5
16.5	1	1.5	2	2.5	3.5	4	4	3.5	2.5	1.5	1	1
16	0.5	1	1.5	2	3	3.5	3.5	3	2	1	0.5	0.5
15.5	0	0.5	1	1.5	2.5	3	3	2.5	1.5	0.5	0	0
15	0	0	0.5	1	2	2.5	2.5	2	1	0	0	0
14.5	0	0	0	0.5	1.5	2	2	1.5	0.5	0	0	0
14	0	0	0	0	1	1.5	1.5	1	0	0	0	0
13.5	0	0	0	0	0.5	1	1	0.5	0	0	0	0
13	0	0	0	0	0	0.5	0.5	0	0	0	0	0
12.5	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
9.5	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
8.5	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
7.5	0	0	0	0	0	0	0	0	0	0	0	0



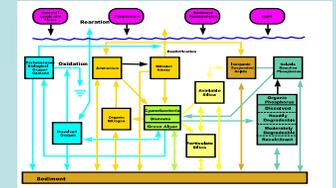
Figures: 2A) Lake Okeechobee stage envelope, where the vertical axis is stage in feet NGVD and the horizontal axis is in months of the year. The shaded central area is the stage envelope (target). In this example, the hydrographs for two alternatives are represented in blue and orange. The brown and green traces represent LO stages in 2001 & 2004, respectively. Actual calculations will be performed on a weekly time step based on absolute deviation (ft) above or below the envelope (rather than in discrete 0.5 ft increments). Figure 2B shows the standardized scoring for the four components of the LO stage envelope. Figure 2C provides estimates of the total area of the lake as a function of stage.

Water Quality PMs:

- Water Quality Mosaics using the Lake Okeechobee Water Quality Model (LOWQM)

Goal- In lake arithmetic average P values at or below 40 ppb. Pelagic TN:TP long-term average mass ratio higher than 22:1. Fewer than 5 percent of values collected during the routine monitoring program with greater than 40 ppb chlorophyll a.

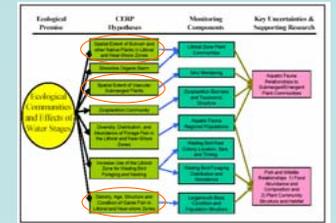
Figure 3: Diagram of the enhanced Lake Okeechobee Water Quality Model (LOWQM). Green and light yellow boxes indicate enhancements from the previous version.



Ecological PMs:

The Ecological PMs noted below currently have monitoring and assessment components (Figure 4) but do not have predictive tools available for application during CERP evaluations.

- Vegetation Mosaics
- Fish Population Density, Age Structure, and Condition
- Macroinvertebrates



Relationship of Interim Goals and Total System PMs to Lake Okeechobee PMs

Interim goals are a means by which restoration success of the Comprehensive Everglades Restoration Plan may be evaluated at specific intervals along the Plan timeline. As part of the interim goals reporting process, RECOVER is developing Total System (TS) PMs that link related metrics across regional modules. Total system PMs provide a system wide overview of performance by linking local performance to a regional or system wide context.

The list of proposed TS PMs is provided below, along with the related LO metric (in parenthesis).

- System-wide flows (water budget including flows to estuaries and Greater Everglades)
- Nutrient Patterns (Surface water P loading concentrations)
- Landscape/Community Mosaics (Vegetation mosaics including submerged aquatic vegetation and littoral zone vegetation)
- Crocodilians (alligators)
- Aquatic fauna (fish and macroinvertebrates)
- Wading birds

Conclusions/Next Steps:

Hydrology:

Refinements to the Lake stage envelope PM should focus on the timing and slope of the curve to optimize positive effects on key species; SAV, wading birds, small nites and fish (and potentially estuarine oyster populations). Additionally, the stage envelope calculator needs to be updated to address short duration excursions above or below the envelope by defining a minimum threshold duration for each count event.

Water Quality:

Three concerns for future development of modeling for LO are spatial variability and emergent and submerged aquatic vegetation. To address these deficiencies, the information and parameters developed in the LOWQM are being used to assist the development of a spatially explicit 3-D hydrodynamic, sediment and water quality model (Lake Okeechobee Ecosystem Model (LOEM), The LOEM will run at shorter time scales (less than 10 years) and is being calibrated and validated to more extensive (spatially and temporally), short term (5 years or less) data sets.

Ecology:

Proposed changes include the elimination of the diatom:cyanobacteria ratio listed below in response to non-restoration related increases in this ratio over the last 5 years and the inclusion of a predictive tool that relates lake stage and water quality to colonizable submerged aquatic vegetation habitat. In addition, recent quantitative experimental data on bulrush (*Scirpus californicus*) growth and reproductive responses to lake stage and water quality may lead to the development of a predictive tool that links bulrush spatial extent to these parameters.

References:

Havens, K.E. 1997. Water levels and total phosphorus in Lake Okeechobee. Lake and Reservoir Management 13:16-25.
 Havens, K.E., T.L. East, A.J. Rodusky and B. Sharfstein. 1999. Littoral periphyton responses to nitrogen and phosphorus: an experimental study in a subtropical lake. Aquatic Botany 63: 267-290.
 Havens, K.E., M.C. Harwell, M.A. Brady, B. Sharfstein, T.L. East, A.J. Rodusky, D. Anson, and R.P. Maki. 2002 Large scale mapping and predictive modeling of submerged aquatic vegetation, in a shallow, eutrophic lake.
 James, R.T., V.J. Bierman, Jr., M.J. Erickson and S.C. Hinz. 2005. The Lake Okeechobee Water Quality Model (LOWQM) enhancements, calibration, validation and analysis. Lake and Reserv. Manage. 21(3):231-260.