Lake Okeechobee Performance Measure
Littoral Zone Emergent Vegetation Mosaic

Last Date Revised: XXX/XX/XXXX

Acceptance Status:

1.0 Desired Restoration Condition

The Lake Okeechobee littoral marsh consists of approximately 40,000 hectares bounded by the Herbert Hoover Dike and the 10 foot NGVD bathymetric contour. For ease of identification, the marsh is typically divided into three major units:1) Kreamer, Torry, and Rita Islands in the south; 2) the western marsh north of Fisheating Bay (also referred to as the Indian Prairie Marsh); 3) the western marsh south of Fisheating Bay (Moore Haven Marsh including Moonshine Bay) and north of the southern side of Rocky Point (Figure 1).

The performance target will be achieved when areal coverage of the following key species or species groups resembles historic coverage based on the Pesnell and Brown survey of 1973. This target includes at least 10,000 hectares (ha) of beakrush (*Rhynchospora tracyi*) and/or spikerush (*Eleocharis cellulosa*), and at least 900 ha of bulrush (*Schoeneoplectus californicus*). Cattail (*Typha spp.)* and willow (*Salix caroliniana*) are not to fall outside a range of, 4000-8000 ha and 3000-5000 ha, respectively. Floating leaved plants, including, but not limited to, lily (*Nymphaea spp.*) and lotus (*Nelumbo spp,*), will not exceed 2500 ha. Torpedograss (*Panicum repens*) will not exceed 2000 ha of coverage and other invasive/exotics will not occupy more than 25 ha. The areal coverage of woody vegetation, other than willow, should range from 500 – 1500 ha.

1.1 Predictive Metric and Target

1.2 Assessment Parameter and Target –

Table 1 identifies the primary littoral zone emergent vegetation target. Achieving each vegetative component of the target results in a score of one. Failure to achieve any component results in a score of zero. Scores are additive so that achieving the complete restoration target requires attaining a score of 8. The interim restoration goal is a score of 4, 50% of the full restoration target. The interim goal is slightly higher than the highest recorded score since the 1973 Pesnell and Brown survey and hence should reflect progress towards attaining complete restoration.

A complete mapping of the littoral marsh is recommended to be completed every three to five years with frequency highly dependent on available funding. However, for the years when data from a complete mapping is unavailable annual assessment scoring based on evaluating the plant communities at 23 representative sentinel sites distributed throughout the marsh will occur. There are seven 1 km^2 sentinel sites (each site contains 100 1 ha grids) and sixteen 0.5 km^2 sentinel sites (each site contains 50 1 ha grids) (Figure 1). Target numbers of sentinel site grids (hectares) for each vegetative group are given in Table 2. Examples of the scoring approach for the 2003 and 2007 vegetation maps are presented in Table 3.

Sentinel site mapping alone is not an adequate approach to assessing the ecological status of the emergent marsh since the sentinel site concept is dependent on the assumption that those sites are representative of the emergent vegetation mosaic in the entire marsh; an assumption that requires confirmation, and possibly readjustment periodically based on whole marsh mapping results.

Figure 1 Lake Okeechobee littoral marsh showing the approximate geographic distribution of mapping units and the location of representative sentinel sites

Table 1: Littoral zone emergent vegetation mosaic targets for whole marsh mapping:

Vegetation Target	Hectares
Bulrush	**900 or greater**
Beakrush/Spikerush	**10,000 or greater**
Cattail	**4000 – 8000**
Willow	**3000 – 5000**
Floating leaf	**2500 or less**
Torpedograss	**2000 or less**
Other Invasive Exotics	**25 or less**
Woody Vegetation, Not Willow	**500 - 1500**

Table 2. Littoral zone emergent vegetation mosaic targets for sentinel sites

Vegetation Target	Hectares
Bulrush	**30 or greater**
Beakrush/Spikerush	**375 or greater**
Cattail	**150 – 300**
Willow	**110 – 190**
Floating leaf	**90 or less**
Torpedograss	**75 or less**
Other Invasive Exotics	**0**
Woody Vegetation, Not Willow	**15 - 60**

Table 3. Sample scoring based on the Lake Okeechobee 2003 and 2007 vegetation maps and sentinel site grids extracted from those maps.

		2003		2007	
Lakewide Vegetation Target	**Target Area(Hectares)**	ha	Score	ha	Score
Bulrush	900 or greater	145	0	0	0
Beakrush/Spikerush	10,000 or greater	826	0	7546	0
Cattail	4000 – 8000	6992	1	1413	0
Willow	3000 – 5000	2970	0	4717	1
Floating leaf	2500 or less	4504	0	238	1
Torpedograss	2000 or less	3493	0	3658	0
Other Invasive Exotics	25 or less	47	0	126	0
Woody Vegetation, Not Willow	500 - 1500	1188	1	3636	0
Points			2		2
		2003		**2007**	
Sentinel Vegetation Target	**Target Area(Hectares)**	ha	Score	ha	Score
Bulrush	30 or greater	13	0	0	0
Beakrush/Spikerush	375 or greater	48	0	116	0
Cattail	150 – 300	206	1	31	0
Willow	110 – 190	30	0	35	0
Floating leaf	90 or less	278	0	1	1
Torpedograss	75 or less	324	0	134	0
Other Invasive Exotics	0	0	1	0	1
Woody Vegetation, Not Willow	15 - 60	19	1	100	0
Points			3		2

2.0 Justification

Landscapes that consist of a moderately diverse mosaic of emergent and submerged plants in Lake Okeechobee's littoral and nearshore zones provide important habitat for wading birds, sport fish, and other wildlife.

The Pesnell and Brown 1973 vegetation map was chosen as the basis for establishing restoration targets for the Lake Okeechobee littoral zone because it is probably the earliest scientifically documentable vegetation map for the marsh and because it was prepared during a period of moderate lake levels, after the Herbert Hoover Dike was completed (circa 1969), but probably before the full effects of the rapid and acyclic fluctuations in lake levels and elevating nutrient concentrations that the combination of the dike, water control operations, and development of the watershed have imposed over the intervening 40 plus years occurred.

In the early 1970s, there were more than 12,575 ha of spikerush and beakrush in Lake Okeechobee's littoral zone. These native plants provide important wildlife habitat that is selectively used by wading birds and sport fish. During the past 40 years, about 80% of this native habitat has been lost due primarily to expansion of torpedograss and cattail. Bulrush also provides important habitat, reduces turbidity by stabilizing bottom sediments, and reduces potentially damaging wave energy that otherwise may uproot submerged aquatic vegetation and other rooted plants along the lakeward edge of the littoral zone. A thick band of bulrush was present in the north and west shoreline regions of the Lake up until the early 1990s. However, by 1999, more than 50% of the bulrush community was lost in conjunction with a prolonged period of high lake stages. At the other extreme, if lake stages remain low for extended periods of time, vital marsh vegetation is replaced by woody vegetation and other more terrestrial species reducing quality habitat for wading birds, sport fish, and other wetland wildlife.

3.0 Scientific Basis

3.1 Relationship to Conceptual Ecological Models

The indicator for this performance measure is an ecological attribute (Vegetation) in the Lake Okeechobee conceptual ecological model. The relationships between the spatial and temporal parameters of the preferred stage envelope, the impacts of prolonged excessive high and low lake stages, nutrient eutrophication, and exotic–invasive vegetation are all presented as linkages in the model although specific areal coverage targets are not provided.

Regional Models

This performance measure is not compatible with any regional model since it is a tool for assessing monitoring results only and cannot evaluate regional model output.

Ecological Model for Hypothesis Clusters

Ecological Communities and Effects of Water Stages Conceptual Ecological Model

3.2 Relationship to Adaptive Assessment Hypothesis Clusters

Ecological Premise: A combination of excessive high, excessive low, and lake levels otherwise outside the temporal and spatial bounds of the preferred stage envelope coupled with nutrient enrichment of lake waters and the importation of various species of non-native invasive vegetation into the Lake Okeechobee watershed resulted in the reduction and degradation of the pre-drainage littoral vegetative community in Lake Okeechobee.

CERP Hypotheses:

1) Providing a reduction in the frequency of extreme high water levels (stage >17 feet and stage >15 feet for more than 12 consecutive months) and low water levels (stage <11 feet and stage <12 feet for more than 12 consecutive months) and an increase in the frequency of spring recessions (yearly stage decline from near 15.5 feet in January to near 12.5 feet in June, with no reversal >0.5 feet) will result in an increase in spatial extent of bulrush along the western outside edge of the littoral zone and increased spatial extent of spikerush, beakrush, and other native plants in the littoral zone.
2) Reductions in Nitrogen and Phosphorus concentrations will further contribute to control of cattail.
3) Irrespective of operational or restoration improvements, an ongoing invasive nuisance and exotic vegetation control program will continue to be a component of maintaining a desirable emergent vegetation mosaic in the Lake Okeechobee littoral marsh due to the inexhaustible exotic/nuisance vegetation propagule bank that exists in the surrounding watershed.

4.0 Evaluation Application

4.1 Evaluation Protocol

There is no evaluation protocol for this PM because lake stage data generated as regional model output do not provide the specific input data required by the performance measure to generate scores which are used for evaluation. To date the specific relationships between lake stage and changes in the complex emergent vegetation mosaic are poorly understood adding a further reason why this performance measure cannot be linked to hydrologic model output and used in an evaluative fashion.

4.2 Normalized Performance Output

4.3 Model Output

5.0 Monitoring and Assessment Approach

5.1 MAP Module and Section

See CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research – Lake Okeechobee Module section 3.4.3.2 (RECOVER 2004a). Monitoring will be accomplished by producing a spatially, and technically accurate vegetation map of Lake Okeechobee's littoral zone (emergent marsh) using color infrared (CIR) aerial georectified stereoscopic photographs. Since a comprehensive yearly map of the entire littoral zone is both time and cost intensive, vegetation maps will be created for three geographically separate areas of the lake, 1) Kreamer, Torry, and Rita Islands in the south; 2) western marsh north of Fisheating Bay (Indian Prairie Marsh); 3) the western marsh south of Fisheating Bay (Moore Haven Marsh). Each region will be mapped at least once in every

three year period so as to be able to compile a full map of the entire vegetated Lake Okeechobee Marsh once every three years. This map will be used to determine if performance measures are achieved as well as to guide vegetation restoration and control activities Directly comparable maps indicating the distribution and areal coverage of vegetation in the western marsh were produced in 1973, 1996, 2003, 2007, and a composite map combining 2012 and 2015. However only data from the 2003 and 2007 maps reflected the areas surveyed by Pesnell and Brown closely enough to be scored by the performance measure. In the future whole marsh and sentinel site field mapping will be done in such a way as to ensure that the results can be scored using the performance measure.

For yearly monitoring between 3 year intervals, 23 sentinel grids representing a subset of the marsh will be used to detect change. This will allow for yearly detection of any major community shifts that may need attention between 3 year mapping efforts.

5.2 Assessment Approach

Every three to five years, or as funding allows for the collection of the required aerial imagery, the complete areal distribution (ha) of focal species will be compared to performance measure targets. On a yearly basis, sentinel grids will be used to detect annual changes that occur in response to environmental conditions and/or management actions.

Scoring will be conducted as described in section 1.2 above.

6.0 Future Tool Development Needed to Support Performance Measure

6.1 Evaluation Tools Needed –

6.2 Assessment Tools Needed – Yearly sentinel site monitoring and the entire littoral zone mapped every three years.

7.0 Notes

8.0 Working Group Members

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9.0 References

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