Greater Everglades Performance Measure

Coastal Salinity Gradients

Last Date Revised: March 2, 2007

Acceptance Status: Accepted

1.0 Desired Restoration Condition

Maintain broad coastal gradients of salinity in the southern Everglades, due to the restoration of predrainage freshwater inflow volume, timing and distribution, given predicted rates of sea level rise during the next century.

1.1 Predictive Metric and Target

Predictive metric and target are not available at this time.

1.2 Assessment Parameter and Target

2.0 Justification

Restored freshwater inflows from the Everglades, in combination with sea level rise, will alter the distribution of salinity in the mangrove ecotones of Florida Bay and the Gulf of Mexico. These changes will strongly influence landscape patterns and wetland trophic relationships within the estuaries.

Understanding landscape changes in coastal environments of the Everglades requires tracking salinity gradients along historic flow paths that will be both restored by the CERP and influenced by sea level rise. Salinity gradients also will be used to identify the oligohaline zone between marine and freshwater conditions that is considered to be an important prey production and foraging area for wading birds.

3.0 Scientific Basis

3.1 Relationship to Conceptual Ecological Models

The indicator for this performance measure is an ecological effect (Coastal salinity gradient) in the following conceptual ecological models:

<u>Regional Models (RECOVER 2004b)</u>

Everglades Mangrove Estuaries

<u>Ecological Model for Hypothesis Clusters (RECOVER 2005)</u>

Coastal Salinity Gradients Conceptual Ecological Model

3.2 Relationship to Adaptive Assessment Hypothesis Clusters

Ecological Premise: Pre-drainage hydrological conditions in the southern Everglades produced prolonged pooling of fresh water just upstream of the mangrove ecotones and prolonged patterns of freshwater inflow into the mangrove ecotones. The freshwater pooling and inflow supported a wide salinity gradient, including a broad oligohaline zone, in the mangrove estuary. The freshwater inflows also provided nitrogen that supported a highly productive transition zone without stimulating algal blooms in the estuaries (RECOVER 2004).

Currently, the Everglades mangrove ecotones are characterized by salinity gradients and mosaics that vary spatially with topography and vary seasonally and inter-annually with rainfall, tide, and freshwater inflow from the Everglades. Because of their location at the lower end of the Everglades drainage basin, Everglades mangrove ecotones have been affected by upstream water management practices that have altered the freshwater inflows and affect salinity gradients. Additionally, interannual variation in precipitation patterns, particularly those caused by El Niño events, control freshwater inputs and salinity dynamics in these estuaries (Childers et al. 2005). Two major societal drivers on this system are water management activities and global climate change. These drivers lead to two major ecosystem stressors: reduced freshwater inflow volume and duration, and sea level rise. Major ecological attributes include estuarine geomorphology, mangrove forests and associated plant communities, resident mangrove fish communities, wood stork (*Mycteria Americana* Linnaeus) and roseate spoonbill (*Platelea ajaja* Linnaeus) nesting colonies, and estuarine crocodilian populations. Estuarine geomorphology is affected by accretion or erosion of coastal storm embankments and mangrove soils, and by loss of tidal creek patterns, both in relationship to sea level and freshwater inflow. Mangrove forests and associated plant communities are affected by nutrient mixing and mangrove forest productivity in relation to freshwater inflow and sea level. The resident mangrove fish community reflects the production and seasonal concentration of the small fishes that thrive under oligohaline conditions, and that are affected by hydrologic patterns, salinity gradients and estuarine nutrient concentration. Wood stork and roseate spoonbill nesting colonies are affected by density, distribution and concentration of resident mangrove fishes in relation to hydrology, salinity and nutrient concentration. Salinity affects American alligator (*Alligator mississippiensis* Daudin) distribution and nesting in tidal creeks and American crocodile (*Crocodylus acutus* Cuvier) juvenile growth and mortality. The functional estuary and its ecological attributes, as influenced by sea level and freshwater inflow, must be viewed as spatially dynamic, with a possible near-term balancing of transgression, but ultimately a long-term continuation of inland movement. Regardless of the spatio-temporal timing of this transition, a salinity gradient supportive of ecologically functional mangrove ecotones will be required to maintain the integrity of the South Florida ecosystem.

Coastal Transgression, Tidal Channel Characteristics, Salinity Gradients, and Mangrove Forest Productivity (RECOVER 2006)

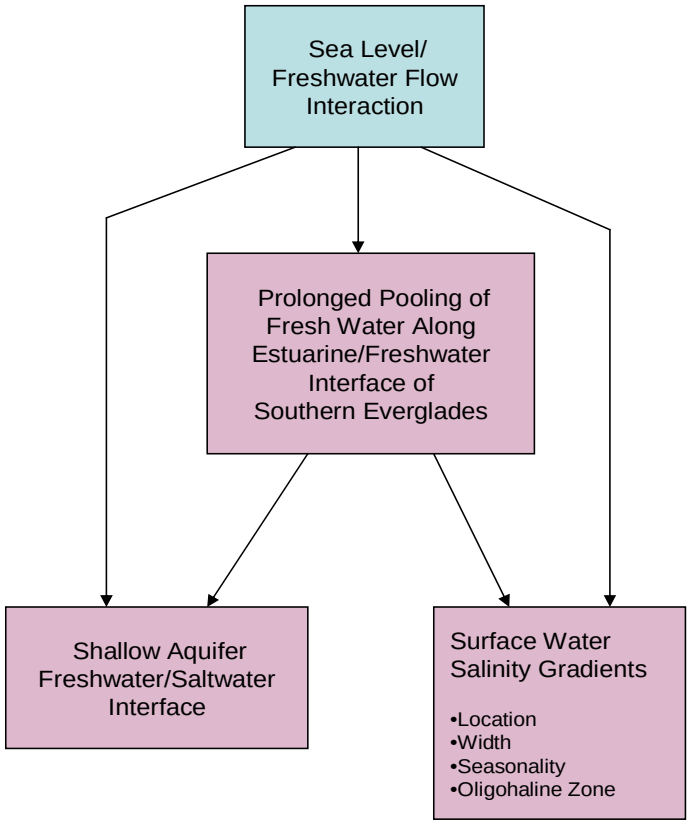
Hypothesis 3: Sea Level and Freshwater Flow as Determinants of Coastal Salinity Gradients (See diagram to the below.)

Sheet flow in the southern Everglades prior to drainage produced prolonged pooling of fresh water upstream of the mangrove estuaries and prolonged patterns of freshwater flow into the mangrove estuaries. The freshwater pooling and inflow supported a wide salinity gradient, including a broad oligohaline zone, in the mangrove estuary. A combination of historical reduced freshwater flow and

increased relative sea level rise has resulted in higher salinities in the formally estuarine mangrove zone and significant saline intrusion into former freshwater marshes of the lower Everglades.

Rationale: Increasing seasonal freshwater sheet flow to the lower Everglades is expected to provide a broader zone of salinity gradients in the lower Everglades and coastal wetlands and should, in the short term, re-establish an oligohaline zone in the coastal wetlands. Although surface water salinities fluctuate laterally through the wet and dry seasons, saline groundwater intrusion has moved and remains far inland of the position at the turn of the last century. The freshwater/saltwater interface in the shallow aquifer is slower to respond. The response or movement of the interface depends on the intensity and duration of freshwater flow stoppage to the lower Everglades during the dry season.

Coastal Salinity Gradients Conceptual Ecological Model



Over a long-term period, rising sea level is expected to result in high tides overtopping coastal marl ridges and saline waters penetrating more deeply through tidal channels and mangrove forests, shifting inland the areas of fresh and lower salinity waters.

4.0 Evaluation Application

4.1 Evaluation Protocol

Predictive models to evaluate this performance measure are still under development and refinement. At this time, this performance measure should not be used to conduct evaluations.

4.2 Normalized Performance Output

4.3 Model Output

4.4 Uncertainty

Recognition of model uncertainty is needed when interpreting the ecological significance of model output. The Model Uncertainty Workshop Report provides guidance on the potential implications of uncertainty on model output interpretation (RECOVER 2002).

5.0 Monitoring and Assessment Approach

5.1 MAP Module and Section

See CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research - Greater Everglades Wetlands Module section 3.1.3.3 (RECOVER 2004)

See 2006 Assessment Strategy for the Monitoring and Assessment Plan. Final Draft. (RECOVER 2006).

5.2 Assessment Approach

6.0 Future Tool Development Needed to Support Performance Measure

6.1 Evaluation Tools Needed

Predictive models to evaluate this performance measure are still under development and refinement.

6.2 Assessment Tools Needed

Accessibility to the various data sources through an integrated database is needed for the complete evaluation of these hypotheses and for parameter refinement.

7.0 Notes

This performance measure supersedes and addresses GE-12 Greater Everglades Wetlands Coastal Salinity Gradients (Last Date Revised: November 22, 2005).

8.0 Working Group Members

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9.0 References

Davis, S.M., D.L. Childers, J.J. Lorenz, and T.E. Hopkins. 2005b. A conceptual model of ecological interactions in the mangrove estuaries of the Florida Everglades. Wetlands 25(4):832-842.

RECOVER 2002. Model Uncertainty Workshop Report: Quantifying and Communicating Model Uncertainty for Decision Making in the Everglades, Restoration Coordination and Verification Program (RECOVER), United States Army Corps of Engineers, Jacksonville District, Jacksonville, Florida, and South Florida Water Management District, West Palm Beach, Florida.

RECOVER. 2004. CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research. Restoration Coordination and Verification Program, c/o United States Army Corps of Engineers, Jacksonville District, Jacksonville, Florida, and South Florida Water Management District, West Palm Beach, Florida.

RECOVER. 2006. 2006 Assessment Strategy for the Monitoring and Assessment Plan. Final Draft. c/o United States Army Corps of Engineers, Jacksonville District, Jacksonville, Florida, and South Florida Water Management District, West Palm Beach, Florida.