

## 1.0 Performance Measure Title

### **Wetland Trophic Relationships - Regional Populations of Fishes, Crayfish, Grass Shrimp and Amphibians**

**Last Date Revised: December 2006**

## 2.0 Justification

Understanding the CERP's effects on the prey bases for wading birds and other higher consumers requires monitoring the regional populations of fishes and associated aquatic fauna that are produced during each wet season and the distribution of those populations across the Greater Everglades Wetlands (Gawlik 2000). Many lines of evidence suggest that success in restoring wading-bird nesting depends on the correct combination of production, concentration and distribution of prey organisms. However, the hydrologic patterns necessary to achieve the required populations of prey organisms are unknown.

The prey organisms anticipated to channel most of the energy from primary production to higher vertebrates under restored conditions include wetland fishes, crayfishes, grass shrimp, and aquatic amphibians. Crayfish are key aquatic species in their native ecosystems (Momot et al., 1978, Kushlan et al., 1979, J.B. Hogger in Holdich et al., 1988, Hobbs et al., 1989), and use varied survival strategies to overcome environmental stress. Crayfish provide an energetic link between primary production, detritus, and higher order predators (Momot et al., 1976), and are an important food source for many Florida animals (Kushlan 1979, Gunderson and Loftus 1993). Their omnivorous feeding habits have a significant effect on the structure and species richness of macrophytes and detritus (Weber et al., 1990, Nystrom et al., 1996).

The most abundant wading bird species in the Everglades is the White Ibis, which feeds largely on crayfish. The preponderance of White Ibis in large wading bird nesting colonies, and the tendency of these colonies to form after drought periods, strongly suggest that crayfish population dynamics in relation to hydrology are a key element in the re-establishment of wading-bird nesting in the Everglades.

Fishes are also important components of the Everglades ecosystem as they provide food for other species, including alligators and birds. Disturbances such as drydown events negatively impact small-sized (generally less than 8-cm maximum adult length) fish populations as fishes are forced into refuges limited in area, depth, and number, and are exposed to greater predation risk than under continual inundation regimes (Loftus and Eklund 1994, Trexler et al. 2005). There is a high positive correlation between fish density and long-term average hydroperiod in Everglades National Park and WCA 3 (Trexler et al. 2005). Everglades restoration efforts are aimed, in part, to minimize the artificially imposed drydown conditions from water-management practices, as multiple years are required for fish populations to return to pre-disturbance levels. Restoration of natural hydropatterns will also reduce the amount of time that aquatic animals are confined to dry-season refuges where mortality from aquatic predators can be high (Nelson and Loftus 1996; Rehage and Loftus 2005). Understanding the CERP's effects on wetland fishes includes not only their population sizes but also whether they are made available as prey for wading birds. This requires monitoring the concentrations of fishes in high-density patches where the birds can feed effectively as water levels recede during the dry season. A close relationship has been demonstrated between high prey-availability patches and wading bird foraging patterns under experimental conditions, and it is hypothesized that a similar linkage exists between high prey-availability patches and foraging and nesting patterns in the ecosystem (Gawlik 2002). The restoration of natural hydroperiods in Greater Everglades Wetlands is expected to provide high prey-availability patches where wading birds can feed effectively as water levels recede during the dry season.

An increase in the seasonal production of marsh fishes and associated fauna, as indicated by late-wet-season population densities is expected in areas of the Greater Everglades Wetlands where natural hydropatterns are restored. Changes in high population sizes of fishes and associated aquatic fauna from the northern to southern Everglades is expected as a result. Population increases in the salinity-transition zone will be further augmented by the restoration of natural freshwater flow regimes, associated reductions in estuarine salinity, and increases in estuarine productivity.

### 3.0 Relationship to CEMs and Adaptive Assessment Hypotheses

Everglades Ridge and Slough, Southern Marl Prairies, and Big Cypress Regional Ecosystem Conceptual Ecological Models attribute (RECOVER 2004b)

*Ecological Premise:* Reproduction of higher vertebrates that are dependent on aquatic food webs is food-limited due to altered hydrologic and water-quality conditions in the Greater Everglades Wetlands. As a result, the foraging distributions and nesting patterns of wading birds have been altered due to the depletion and redistribution of high concentrations of prey organisms.

9.2.6. Greater Everglades Wetlands Module Predator-Prey Interactions of Wading Birds and Aquatic Fauna Forage Base hypotheses:

Hypothesis 1:

The wet-season density, size structure, and relative abundance of marsh fishes and other aquatic wading bird prey are directly related to the time since the last dry-down and the length of time the marsh was dry. Aquatic prey populations are further affected by salinity in coastal ecotones and by site nutrient status. Responses are non-linear and species specific.

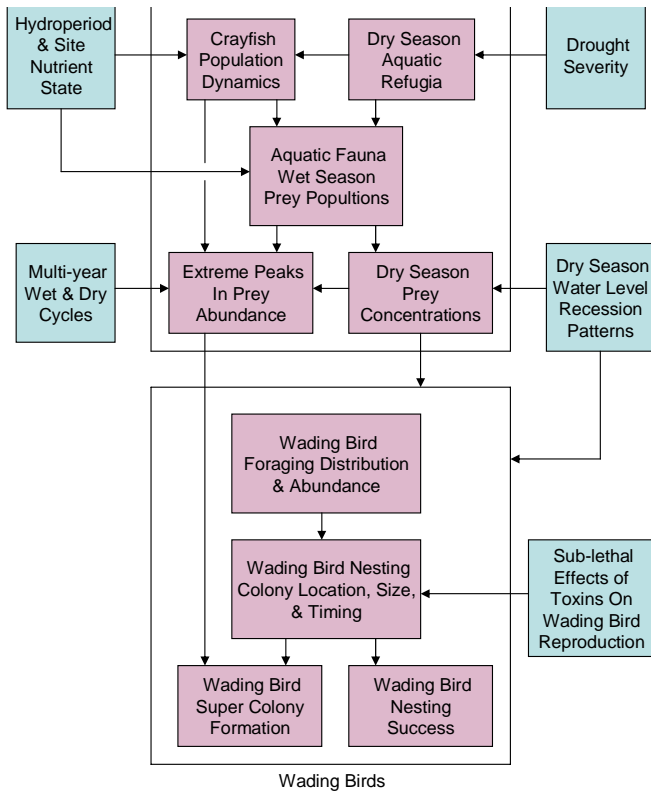
**Rationale.** Persistent pools of fresh water, with multi-year hydroperiods and gradual water recession rates, occurred in ridge and slough landscapes and adjacent coastal ecotones of the southern Everglades under pre-drainage conditions. Expansive, naturally occurring pools in the southern Everglades have been replaced by artificial impoundments in the lower ends of Water Conservation Areas. Resumption of natural volume, timing, and distribution of freshwater flow will restore historical hydroperiods and salinity distributions to the southern Everglades, which should result in an increase wet-season density and size structure of wading bird prey in the southern Everglades.

Hypothesis 2:

The concentration of marsh fishes and other wading bird prey into high-density patches where wading birds can feed effectively is controlled by the rate of dry-season water-level recession and local topography/habitat heterogeneity.

**Rationale:** Erratic water-level fluctuation in the remaining managed system, particularly in the Water Conservation Areas, commonly cause drying pattern interruptions, ultimately leading to ill-timed, fewer or less dense concentrations of aquatic fauna that serve as wading bird prey.

**Predator-prey interactions of wading birds and aquatic fauna forage base conceptual ecological model**



**4.0 Restoration Expectation**

Resumption of natural volume, timing, and distribution of freshwater flow will restore historical hydroperiods, and salinity distributions, and historical patterns of water level recession to the southern Everglades. In the wet season these changes are expected to increase the density and size structure of wading bird prey in the southern Everglades, while in the dry-season wading bird prey will be concentrated into a succession of high-density patches in the ridge and slough, marl prairie, and coastal landscapes as predicted by predrainage hydropatterns and salinities.

**4.1 Predictive Metric and Target**

Habitat Suitability Indices within 10% of NSM values was initially proposed, but RECOVER currently does not advocate use of this metric. Efforts to refine and update a predictive model are in development with an expected completion date beyond 2008.

**4.2 Assessment Parameter and Target**

The assessment parameters are regional populations of aquatic prey. The specific targets will be set once a Natural System Model [NSM] is updated and supporting research is conducted. This parameter is assessed along with the complete hypothesis cluster 9.2.6 (RECOVER 2006)

**5.0 Evaluation Application**

**5.1 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.

<b>5.2 Normalized Performance Output</b>
<b>5.3 Model Output (example attached)</b>
<b>5.4 Uncertainty</b>
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).
<b>6.0 Monitoring and Assessment Approach</b>
See <i>CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research</i> - Greater Everglades Wetlands Module sections 3.1.3.10 – 3.3.3.11 (RECOVER 2004a)
See RECOVER Team’s Recommendations for Interim Goals and Interim Targets for the Comprehensive Everglades Restoration Plan – Interim Goal 3.9 Aquatic Fauna Regional Populations in Everglades Wetlands (RECOVER 2005)
See RECOVER Team’s 2006 Assessment Strategy for the Monitoring and Assessment Plan. Final Draft (RECOVER 2006)
<b>7.0 Future Tool Development Needed to Support Performance Measure</b>
<b>7.1 Evaluation Tools Needed</b>
Predictive models to evaluate this performance measure are still under development and refinement.
<b>7.2 Assessment Tools Needed</b>
Accessibility to the various data sources through an integrated database is needed for the complete evaluation of these hypotheses and for parameter refinement.
<b>8.0 Notes</b>
This Performance Measure supersedes and addresses GE-19 Wetland Trophic Relationships - Regional Populations of Fishes, Crayfish, Grass Shrimp and Amphibians (Last Date Revised: November 22, 2005).
<b>9.0 Working Group Members</b>
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<b>10.0 Acceptance Status</b>	
GE Working Group	November 22, 2005
ET	
AT	
Public Review	
Final Acceptance Date	
<b>11.0 References</b>	
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