

1.0 Performance Measure Title

Southern Estuaries Juvenile Pink Shrimp and Associated Epifauna

Last Date Revised: December 30, 2004

2.0 Justification

The seagrass beds of Florida Bay, Biscayne Bay and the Gulf of Mexico coastal shelf provide essential nursery grounds for juvenile stages of the commercially valuable pink shrimp, as well as habitats for a diversity of other epifaunal fish and macroinvertebrates that are important components of estuarine ecosystems. The drainage of the Everglades and other human activities have caused seagrass die-offs, sustained algal blooms, and declines in lobster, fish and shrimp species within Florida Bay. It is expected that Florida Bay restoration will involve changes in freshwater flow that will not only increase the quantity of this flow, but also alter the timing and distribution of flow. A direct effect of freshwater flow restoration will be a change in the bay's salinity. The change in salinity will then affect seagrasses and shrimp. Another potential effect of the bay's restoration will be improved water quality. Decreasing the amount of nutrients coming into the bay should decrease the occurrence of algal blooms. Such blooms often occur with nutrient pollution and can negatively impact seagrass habitat and other ecosystem components.

Pink shrimp (*Farfantepenaeus duorarum*) are an important ecological indicator species in the adaptive environmental management process of the South Florida restoration program. The species is economically important to south Florida, and the shrimp population is also closely tied to the bay's food web, with shrimp being a primary food source for many game fish species and wading birds (PMC 2003).

Modeling suggests that temperature and salinity may be key elements, along with seagrass habitat, influencing juvenile densities in Florida Bay. Laboratory experiments on pink shrimp growth and survival in relation to temperature and salinity indicate maximum growth at 30 ‰ (Browder et al. 1999, Browder et al. 2002) and increasing growth up to 35°C. Physiological survival is high over a wide salinity range, especially at optimal temperatures (20-25°C), but decreases abruptly at salinity extremes. Long-term data on shrimp abundance and salinity in western Florida Bay support these experimental results particularly at relatively high salinities (Robblee pers. comm.). The scatter of data evident in this relationship ($r^2=.28$, $p=.16$) implies that additional factors influence shrimp density in the bay. Principal among these are assumed to be habitat; seagrass species composition, density, and cover are known to affect pink shrimp density (Sheridan 1992, Johnson et al. 2002). Furthermore, year-to-year variation in the supply of postlarvae (largely from the Gulf of Mexico, especially the Dry Tortugas region) will affect the density of juveniles in the Bay.

3.0 Relationship to CEMs and Adaptive Assessment Hypotheses

Florida Bay, Biscayne Bay, and Everglades Mangrove Estuaries Conceptual Ecological Models attribute (RECOVER 2004b)

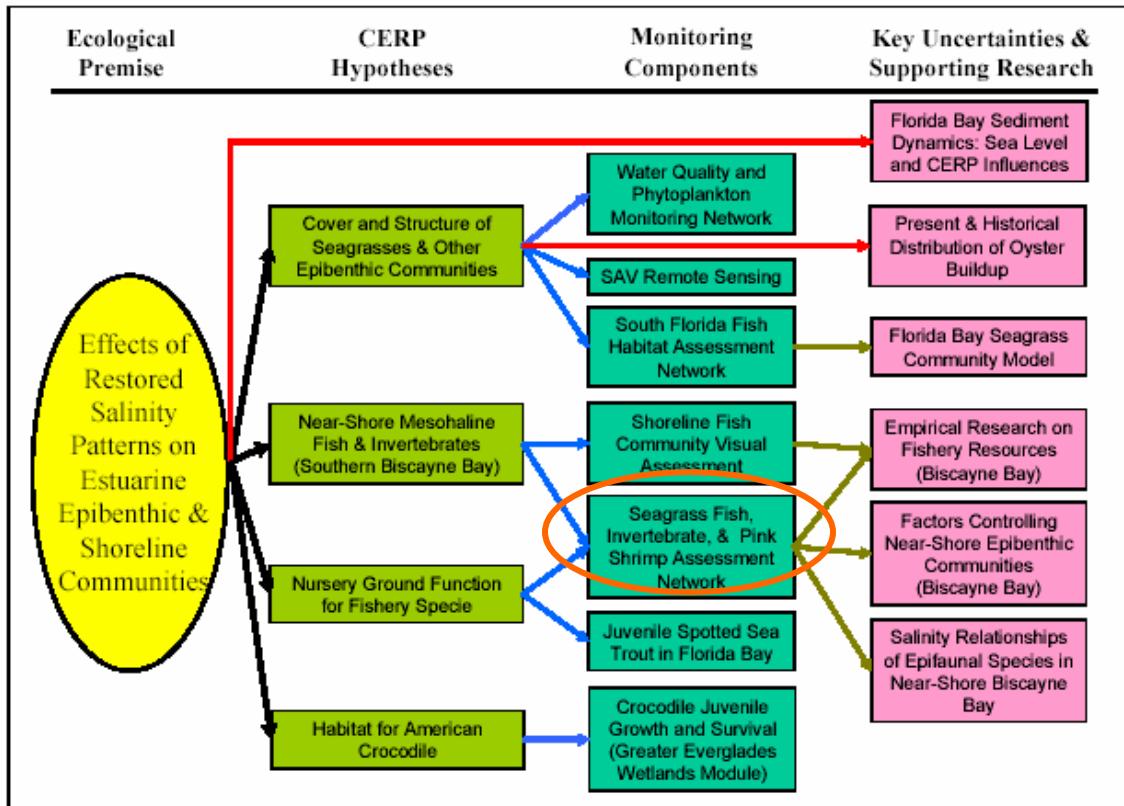
Ecological Premise: Prior to upstream water management, mesohaline salinity conditions with fewer extremes in the coastal environments of Biscayne Bay, Florida Bay, and the southwest Florida coast supported broader coverage and higher diversity of seagrass and other epibenthic communities. These communities, in combination with prop-root habitats of mangrove shorelines, provided habitat for higher densities of valued estuarine fauna, including juvenile and adult stages of several economically important

CERP Hypotheses: The restoration of favorable flow and salinity regimes will result in the following:

- Extend the range of *Halodule* seaward into the near-shore environment of Biscayne Bay
- Increase seagrass cover and diversity in Florida Bay, reduce the region of *Thalassia* overdominance, and increase both *Halodule* and *Ruppia* cover
- Enhance the productivity of near-shore mesohaline fish and invertebrates in south Biscayne Bay, resulting in higher abundances of mesohaline forms and lower abundances of purely marine forms such as some reef

fishes

- Extend the spatial extent of high concentrations of pink shrimp further south in Biscayne Bay
- Enhance the function of Florida Bay, the mangrove estuaries of the southwest coast, and Biscayne Bay as nursery grounds for fishery species, increasing the distribution and density of juvenile pink shrimp, spotted seatrout, and other species and resulting in higher yields in the pink shrimp
- Restore habitat for the endangered American crocodile



4.0 Desired Restoration Condition

Threshold salinity levels for Florida Bay are 20 parts per thousand (ppt) for eastern Florida Bay and 30 ppt for western Florida Bay. Algal bloom threshold targets for Florida Bay are 2 parts per billion (ppb) of chlorophyll *a* in eastern Florida Bay and 3 ppb of chlorophyll *a* in central and western Florida Bay. The abundance of juvenile fish should increase. The abundance and diversity of fish and macroinvertebrates associated with seagrass beds should increase in Biscayne Bay and Florida Bay and along the Gulf of Mexico coastal shelf westward to Lostman's River. More refined targets for Florida Bay restoration are being developed as part of the Florida Bay and Florida Keys Feasibility Study.

4.1 Predictive Metric and Target

4.2 Assessment Parameter and Target

The target for all areas is an increase in pink shrimp density, but such an increase is not expected to be a result of restoration actions for zones outside of Florida Bay proper or in northeastern Florida Bay. In central and western Florida Bay zones, specific density thresholds that are based on historic trapping statistics (Robblee et al.,

unpublished) are as follows.

Semi-annual density targets for Florida Bay Pink Shrimp:

Zone 3: $\geq 5/m^2$

Zone 4: $\geq 17/m^2$

Zone 5: $\geq 5/m^2$

Zone 6: $\geq 7/m^2$

Zone 16: $\geq 17/m^2$

5.0 Evaluation Application

5.1 Evaluation Protocol

For each FBFKFS zone, pink shrimp density will be calculated on a daily time-step in order to take into account short-term stresses, such as temperature extremes. Shrimp density will be averaged spatially ($\#/m^2$ for each zone) and a monthly mean density calculated (from daily values). Because there may be one or two cohorts of juvenile shrimp within the bay, comparisons will be on a semi-annual (July-December and January-June) basis. For each semi-annual time period, the maximum monthly density will be tabulated per zone, and the frequency (over the FBFKFS evaluation period) of values that meet or exceed density targets (given below) will be reported. The target for all areas is an increase in pink shrimp density, but such an increase is not expected to be a result of restoration actions for zones outside of Florida Bay proper or in northeastern Florida Bay.

In order to account for potential spatial shifts in density among these zones and among other zones, a mean monthly density will be also calculated for the entire FBFKFS region (with all zones) and semi-annual peak densities tabulated. Alternatives will be evaluated with a target of maximizing this overall shrimp density.

Pink shrimp growth and survival will be simulated for the evaluation period using a model of growth and survival as a function of salinity and temperature (Browder et al. 2002) in combination with empirical knowledge of seagrass habitat relationships (with rules based on statistical functions to be incorporated in this model). Input data to the pink shrimp model will be from the FBFKFS hydrodynamic and seagrass models. This model will not evaluate the effect of changing predation by the fish community and thus will represent a potential pink shrimp population response and not a prediction of realized abundance.

5.2 Normalized Performance Output

5.3 Model Output (example attached)

5.4 Uncertainty

6.0 Monitoring and Assessment Approach

See *CERP Monitoring and Assessment Plan: Part 1 Monitoring and Supporting Research* - Southern Estuaries Module section 3.2.3.5 (RECOVER 2004a)

See *The RECOVER Team's Recommendations for Interim Goals and Interim Targets for the Comprehensive Everglades Restoration Plan* – Indicator 4.3 Juvenile Shrimp Densities in Florida and Biscayne Bays (RECOVER 2005)

7.0 Future Tool Development to Support Performance Measure	
7.1 Evaluation Tools Needed	
7.2 Assessment Tools Needed	
8.0 Notes	
This Performance Measure supersedes and addresses SE-11 Southern Estuaries Juvenile Pink Shrimp and Associated Epifauna (Florida Bay and Biscayne Bay), (Last Date Revised: December 30, 2004).	
9.0 Working Group Members	
Joan Browder, NOAA	Susan Markley, MDDERM
Peter Ortner, NOAA	Dewitt Smith, ENP
Cheryl Buckingham, Corps	Dave Rudnick, SFWMD
Steve Blair, MDDERM	Don Deis, EPJV
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SE Working Group	December 30, 2004
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11.0 References	
Browder, J. A., V. R. Restrepo, J. K. Rice, M. B. Robblee, and Z. Zein-Eldin. 1999. Environmental influences on potential recruitment of pink shrimp, <i>Farfantepenaeus duorarum</i> , from Florida Bay nursery grounds. <i>Estuaries</i> 22: 484-499.	
Browder, J. A., Z. Zien-Eldin, M. M. Criaes, M. B. Robblee, S. Wong, T. L. Jackson, and D. Johnson. 2002. Dynamics of pink shrimp (<i>Farfantepenaeus duorarum</i>) recruitment potential in relation to salinity and temperature in Florida Bay. <i>Estuaries</i> 26(6B): 1355-1371.	
Johnson, D., J. Browder, D. Harper, and S. Wong. 2002. A meta-analysis and synthesis of existing information on higher trophic levels in Florida Bay (model validation and prediction). Final Report on project IA5280-9-9030. Everglades National Park, Homestead, FL. National Marine Fisheries Service, Miami, FL.	
PMC. 2003. Higher Trophic Level Species (Browder et al.). In: A synthesis of research on Florida Bay. www.aoml.noaa.gov/flbay	
RECOVER. 2004a. 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. 2004b. Draft Conceptual Ecological Models. In: RECOVER. 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, Appendix A.

RECOVER. 2005. The RECOVER Team's Recommendations for Interim Goals and Interim Targets for the Comprehensive Everglades Restoration Plan, c/o United States Army Corps of Engineers, Jacksonville District, Jacksonville, Florida, and South Florida Water Management District, West Palm Beach, Florida.

Sheridan, P.F. 1996. Forecasting the fishery for pink shrimp, *Penaeus duorarum*, on the Tortugas grounds, Florida. Fishery Bulletin. 94:743-755.