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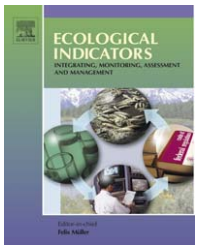

Pink shrimp as an indicator for restoration of everglades ecosystems

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ARTICLE INFO

Article history:
Received 18 March 2008
Received in revised form
13 October 2008
Accepted 13 October 2008

Keywords:
Penaeid
Farfantepenaeus duorarum
Stoplight
Florida Bay
Biscayne Bay
Whitewater Bay
Freshwater inflow
Estuaries

ABSTRACT

The pink shrimp, *Farfantepenaeus duorarum*, familiar to most Floridians as either food or bait shrimp, is ubiquitous in South Florida coastal and offshore waters and is proposed as an indicator for assessing restoration of South Florida's southern estuaries: Florida Bay, Biscayne Bay, and the mangrove estuaries of the lower southwest coast. Relationships between pink shrimp and salinity have been determined in both field and laboratory studies. Salinity is directly relevant to restoration because the salinity regimes of South Florida estuaries, critical nursery habitat for the pink shrimp, will be altered by changes in the quantity, timing, and distribution of freshwater inflow planned as part of the Comprehensive Everglades Restoration Project (CERP). Here we suggest performance measures based on pink shrimp density (number per square meter) in the estuaries and propose a restoration assessment and scoring scheme using these performance measures that can readily be communicated to managers, policy makers, and the interested public. The pink shrimp is an appropriate restoration indicator because of its ecological as well as its economic importance and also because scientific interest in pink shrimp in South Florida has produced a wealth of information about the species and relatively long time series of data on both juveniles in estuarine nursery habitats and adults on the fishing grounds. We suggest research needs for improving the pink shrimp performance measure.

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1. Introduction and background

The pink shrimp, *Farfantepenaeus duorarum*, is proposed as a biological indicator of estuarine responses to the Comprehensive Everglades Restoration Project (CERP), which is undertaking alterations in the structure and operation of South Florida's water management system. With implementation of CERP, substantial changes are expected in the timing, quantity, quality, and distribution of freshwater to South Florida estuaries. Performance measures based on pink shrimp will help assess the effect of CERP on Florida's southernmost estuaries.

Shallow marine waters in South Florida are nursery habitat for the ecologically and economically important pink shrimp, a well studied and prominent member of the epibenthic community of small fish and invertebrates found most abundantly in vegetated habitats. Pink shrimp spawn on the southwest Florida shelf, migrate shoreward as larvae/postlarvae, and spend their juvenile stage in Biscayne Bay, Florida Bay, and the shallow open waters of southwest coast mangrove estuaries (Costello and Allen, 1966). They return to deeper offshore waters to spawn and support a major fishery operating near the Dry Tortugas, the Tortugas Grounds, and a smaller fishery north of Cape Romano, the Sanibel Grounds (Costello and Allen, 1966). Small commercial bait and food shrimp fisheries for pink shrimp also operate in Biscayne Bay, while commercial harvest is banned in Florida Bay and other coastal waters of Everglades National Park (Tilmant, 1989). Both offshore and in estuaries,

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1470-160X/$ – see front matter. Published by Elsevier Ltd.
doi:10.1016/j.ecolind.2008.10.007

the pink shrimp forms a critical intermediate link in the food webs of top consumers such as wading birds, crocodiles, and game fish (Palmer, 1962; Tabb et al., 1962; Odum and Heald, 1972; Rutherford et al., 1983; Schmidt, 1993; Mason and Zengel, 1996; Fry et al., 1999).

In South Florida the density of juvenile pink shrimp varies regionally, among monitoring locations within regions (Fig. 1), and seasonally, being most abundant in the fall (Robblee et al., 1991; Browder et al., 2005a). Variation in benthic vegetation, salinity regime, and accessibility to settlement-stage larvae may account for density differences among inshore areas, although this needs confirmation. Higher pink shrimp densities are found in western Florida Bay than in other regions of South Florida (Robblee and Browder, 2008), possibly because of a combination of suitable bottom habitat, suitable salinity range, and reliable seasonal influx of pink shrimp postlarvae from the offshore spawning grounds.

Statistical relationships between salinity and upstream groundwater stages (used as a proxy for freshwater inflow) have been defined in Florida Bay and the mangrove estuaries in a series of reports by Marshall (2003, 2005), Marshall and Smith (2007), and Marshall et al. (2003, 2004, undated). In addition, the hydrodynamic model of Wang et al. (2003) has related salinity to freshwater inflow in southern Biscayne Bay. Both the statistical models and the hydrodynamic models, applied to selected scenarios of water management, indicate that water management affects salinity patterns in these estuaries. Thus performance measures based on biological indicators that respond to changes in salinity can be successful metrics for assessing responses to CERP in South Florida's most southern estuaries.

Reported relationships of pink shrimp with salinity suggest that water management affects pink shrimp abundance on inshore nursery grounds. Laboratory trials with growth and survival of small juvenile pink shrimp from western Florida Bay were significantly related to salinity and demonstrated a temperature effect (Browder et al., 2002). Indices of pink shrimp abundance based on Tortugas fisheries data were significantly related to indices of freshwater flow from the Everglades (Browder, 1985; Sheridan, 1996). A meta-analysis of forage fish and macro-invertebrates in Florida Bay found that pink shrimp were more closely related to salinity and seagrass than as many as 19 other species examined (Johnson et al., 2002, 2005). Most recently, we have found that mean fall density (September and October) of juvenile pink shrimp in Johnson Key Basin, western Florida Bay, is significantly negatively correlated with salinity over the range 28.3–45.3 psu ($r^2 = 0.19$, $p = 0.0483$ and $n = 20$). The parabolic relationship of pink shrimp with salinity suggested in mean spring density was not significant (Fig. 2).

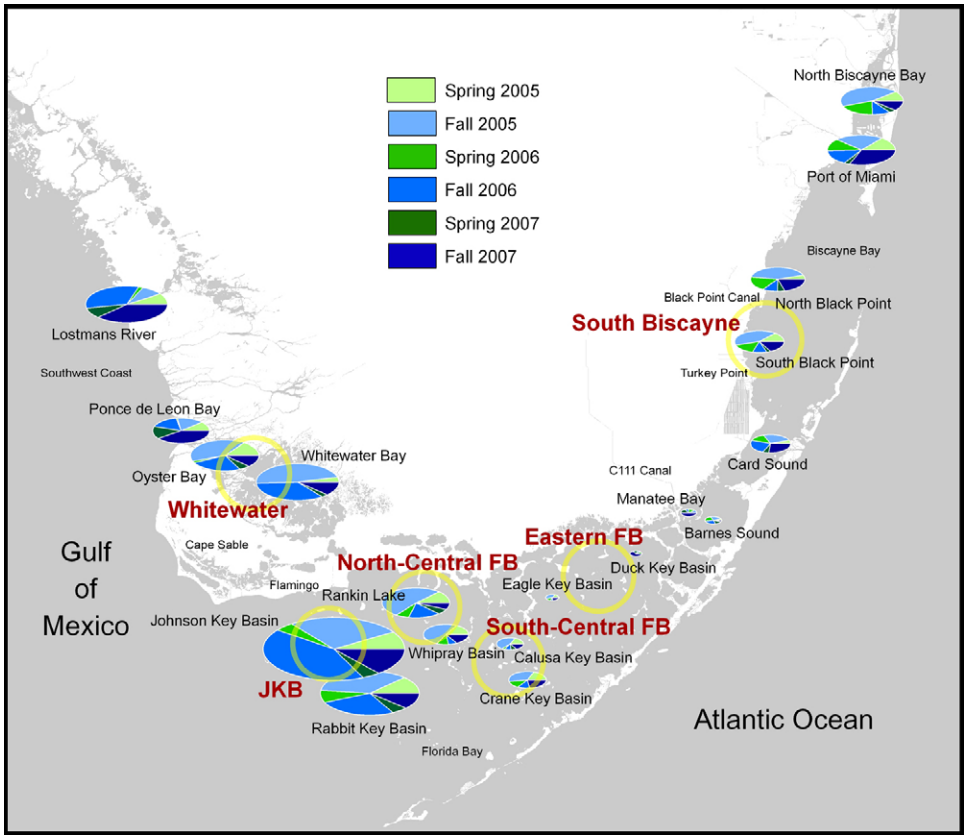

Fig. 1 – Map of South Florida estuaries showing locations of the 19 FIAN monitoring locations and the regional distribution of pink shrimp density (shrimp/m^2), from FIAN spring and fall collections, 2005–2007 (FB = Florida Bay). Yellow circles indicate the six pink shrimp assessment areas. Pie size at each monitoring location represents mean pink shrimp density summed for the six collections and scaled to the maximum, Σ = 50 shrimp/m^2 at Johnson Key Basin. Colored slices within each circle represent proportions of the sum of mean pink shrimp density at that location contributed by each collection. Read the pie counterclockwise starting with light green to go from first (spring 2005) to last (fall 2007) collection.