Comparison of Juvenile Pink Shrimp Abundance in South Florida Mangrove and Seagrass Dominated Estuaries

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Introduction

The pink shrimp, familiar to most Floridians as either food or bait shrimp, is ubiquitous in both seagrass- and mangrove-dominated south Florida coastal waters. The pink shrimp, *Farfantepenaeus duorarum*, is a biological indicator in the Southern Estuaries Module of MAP, the Monitoring and Assessment Program of CERP. The South Florida Fish and Invertebrate Assessment Network (FIAN) is being developed to support the pink shrimp indicator by quantifying change and trend in density. Our purposes here are to:

1. Describe the South Florida Fish and Invertebrate Assessment Network (FIAN) and sampling protocols;
2. Quantify associations between pink shrimp abundance and measures of habitat while accounting for unobserved sources of variation in abundance and capture rate; and
3. Provide a regional characterization of the pink shrimp in south Florida coastal waters.

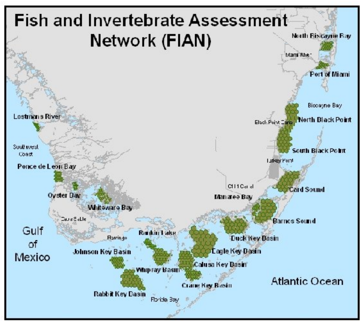

Figure 1. Sampling locations in the South Florida Fish and Invertebrate Assessment Network (FIAN). Hexagonal 30-cell tessellated sampling grids are shown for each of the 19 monitoring locations.

Monitoring Locations

Monitoring locations in FIAN are distributed among 3 regions: the seagrass-dominated regions of **Biscayne Bay**; North Biscayne Bay, Port of Miami, North Black Point, South Black Point, Card Sound, Barnes Sound and Manatee Bay and **Florida Bay;** Duck Key, Eagle Key, Calusa Key, Crane Key, Rankin Lake, Whipray Basin, Johnson Key Basin, Rabbit Key Basin and the mangrove-dominated **Southwest Coast** region**;** Lostmans River, Ponce de Leon Bay, Oyster Bay, Whitewater Bay. At present 19 monitoring locations (**Figure 1**) are sampled twice annually, at the end of the dry season (April-May) and at the end of the wet season (September-October).

FIAN overlaps with the MAP seagrass monitoring program at 18 of 19 monitoring locations, shares the same sampling grids at these locations, coordinates sampling stations by using the same random sampling points and uses the habitat estimation method, Braun-Blanquet Cover-Abundance (Braun-Blanquet 1932). This close coordination between projects links fauna with critical habitat.

Figure 2. One-m^2 throw-trap and sweep net being used to sample in Biscayne Bay. The cover net is in place with a sweep net in the throw-trap ready for use.

Throw-Trap Sampling Methods

The 1-m^2 throw-trap was first used in the freshwater Everglades (Kushlan 1981) and subsequently adopted for use in shallow marine waters (Sogard et al 1987; Robblee et al 1991). As used in FIAN, the throw-trap is an open-ended 1-m^2 aluminum box, 45-cm deep. The trap is covered in water greater than 45 cm in depth and SCUBA is used at depths greater than about 1 m (**Figure 2**).

One randomly located throw-trap sample was collected in each cell of the 30-cell sampling grid for a sample size of 30 at each monitoring location and 570 samples for each annual dry and wet season collection. The animals in each throw-trap were sampled with 5 successive passes of the sweep net through the trap. Each sweep's contents were processed and maintained separately so that animals collected in each sweep net could be identified and enumerated. The intent of this sampling protocol was to capture at leastut 95% of the animals in the trap and to provide the information needed to estimate a trap's capture efficiency for each species collected in the trap.

Each throw-trap sample is coupled with measurements of habitat and environment (**Table 1**).

Table 1. Environmental, Physical and Habitat Measures

Salinity	CT meter
Water Temperature	CT meter
Water Depth	Depth pole, max 3 m
Sediment Depth	Sediment rod, max 3 m
Turbidity	ntu
Seagrass Standing Crop	Harvested, g dry wt by species
Seagrass Blade Length	Length, by species
Seagrass Blade Density	Count, by species
Seagrass Short Shoot Density	Count, by species
Algal Biomass	Harvested, g dry wt by species
Braun-Blanquet Cover-Abundance	% Cover categories by species
Canopy Height	canopy max height, cm

Statistical Analysis

The sequence of sweeps taken from each throw-trap corresponds to a removal sample from the "population" of animals contained within the throw-trap. In principle, both the number of animals in the throw-trap and their probability of capture (per sweep) can be estimated using only the removal counts of a single throw-trap. However, the throw-trap is small and the trap "abundance" of many species will be low; consequently, the removal counts of these species are also likely to be low or even zero. Often when considering only pink shrimp a significant portion of the 30 samples collected at a monitoring location will be zero. In this situation pooling counts among throw-traps can be used to increase the removal counts per sweep, however, this approach results in a loss of information because habitat varies considerably among cells and sample locations.

To avoid these difficulties, we adopted an alternative approach wherein the spatially referenced throw-trap counts of pink shrimp are modeled hierarchically (Dorazio et al., 2005; Royle and Dorazio, 2006). This multilevel model formally accounts for the FIAN sampling design, which includes removal counts from each throw-trap (n=5), the clustering of observations within each location (n=30), and stratification of locations (n=19) between mangrove- and seagrass-dominated regions. Our goals are to estimate "true" shrimp abundance and to quantify associations between shrimp and salinity and benthic habitat while accounting for unobserved sources of variation in shrimp abundance and capture rate.

Regional Perspective

FIAN provides the first regional view of the distribution of the pink shrimp in south Florida (**Figure 3**). The density of juvenile pink shrimp varies both regionally and locally, as well as seasonally. Variation in benthic vegetation, salinity regime, and accessibility to settlement-stage larvae are thought to account for density differences among locations.

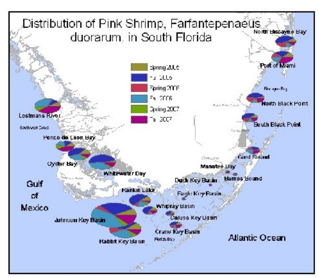

Figure 3. Distribution of pink shrimp abundance among 19 FIAN monitoring locations, 2005 – 2007.

Mangrove Seagrass Comparison

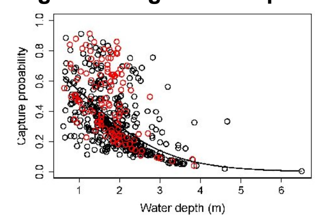

Figure 4. The probability of capture decreases with water depth in both mangrove- and seagrass-dominated regions, red and black circles, respectively. This was not unexpected, however, that capture probability did not differ with increasing benthic vegetation was unexpected.

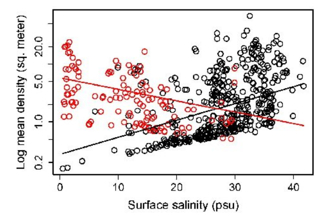

Figure 5. Inverse relationships of pink shrimp abundance with salinity were observed between mangrove- and seagrass-dominated regions. This result is counter-intuitive and further research is needed to explain these findings.

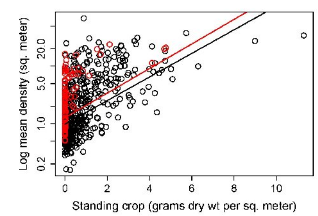

Figure 6. Pink shrimp abundance increases with standing crop of benthic vegetation in both mangrove- and seagrass-dominated regions.

Summary

Removal count samples and hierarchical modeling allowed cell-specific estimates of pink shrimp abundance adjusted for capture rate.

• Capture probability decreased with depth (**Figure 4**) but was unaffected by benthic vegetation and unexpected result.

• Pink shrimp abundance increased with standing crop of benthic vegetation in both mangrove- and seagrass-dominated regions (**Figure 6**).

• Inverse relationships of pink shrimp abundance with salinity were observed between mangrove- and seagrass-dominated regions (**Figure 5**). This result is wholly unexpected and difficult to explain given the current understanding from field correlations and laboratory experiments indicating that pink shrimp abundance declines below about 25 psu and above about 40 psu. Further research is needed.

• FIAN provides the first regional view of the distribution of the pink shrimp in south Florida (**Figure 3**).

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