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The Abundance and Distribution of Fish in the Sisters Creek/ Deep Creek Salt Marsh System, Duval County, FL

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Abstract

Salt marshes in Northeastern Florida were sampled from June 2 to September 10, 2000. A 1m^2 throw trap was used to sample different areas of the marsh and fish assemblages were quantified based on tidal stage and the presence of emergent vegetation. One hundred – eight samples were taken during the different tidal stages of which 64 samples contained emergent vegetation. An average of 14.8 nekton, of which 5.5 were fish species, were obtained per sample effort. Certain species exhibited preferences to habitats based on the inclusion of vegetation while others were more frequently encountered in the absence of vegetation. There was also a relationship between tidal stage and species occurrence. Some of the more abundant fish were found at specific tidal stages while others showed no relationship between abundance and tide. This study indicates that different species of fish use the salt marsh system in different ways. Vegetation is more of a necessity for certain species of fish then it is to others. The changing of the tide moves fish into and out of the system and allows them access to other areas of the marsh. During periods of low tide, the marsh surface is exposed, but as the tide comes in, the vegetation becomes submersed and in some cases completely covered by water. This in creates two entirely different habitats for usage by the fish. The changing tide allows the fish to disperse throughout the marsh according to their specific habitat needs.

Introduction

Many commercially important fish use the salt marsh as their breeding grounds. The diversity of the habitat provides different niches for the juvenile fish to feed and escape predation from larger fish. The vegetation along the fringe of the salt marsh is where many of the juvenile fish remain during the first parts of their life cycle. It isn't well known which species of nekton prefer the different types of habitat provided by the estuarine system, or how far up the inter-tidal creeks they migrate with the incoming and outgoing tides (Frey, 1985).

The marsh system to be surveyed provides a large number of small tidal streams that run off of the main waterway. These shallow waters are bounded by different emergent vegetations, mainly *Spartina alterniflora*, and incorporate oyster beds along the bottom. These areas are popular nursery grounds for juvenile nekton. The dense halophytic vegetation and abundant epifauna provide a high quality food for the fishes (Craft, 1999, Day, 1989). The changing tides flood different areas of the marsh and transport the juvenile fish deeper into the marsh system. Access to the vegetation is dependent on the tidal stage. During periods of high tide, the nekton are able to move onto the marsh surface. As the tide recedes, the nekton can then to move back into the intertidal streams. The fringing *Spartina alterniflora* is partially submersed during low tide. This allows for the nekton to seek refuge in the vegetation. The constant flooding of the marsh allows for greater species diversity and increased refuge areas from larger predatory fish (Komarow, 1999). Once the juvenile nekton enter the inter-tidal creeks they may find refuge from the larger predatory fish that inhabit the deeper waters. Some species rely on the tidal fluctuation for reproduction. *Fundulus heteroclitus* and *Menidia menidia* are known to use the exposed marsh surface as a substrate for their eggs (Taylor, 1999, Middaugh, 1981). Species of *Gobiosoma bosci* have also been observed using the exposed marsh surface (Targett, 1985). During periods of high spring tide the fish have access to the marsh surface to lay their eggs. They then leave the area when the tide goes out. On the ensuing spring tide, the eggs hatch in response to water flooding the marsh surface (Taylor, 1983).

The Sister's Creek / Deep Creek system is located in Duval county. This area is of high importance because of its proximity to the Intercoastal waterway. The migratory marine nekton use the salt marshes for spawning, usually remaining in the ecosystem for a short time before heading back out to sea (Turner, 1997). The nekton that live in the intertidal areas act as a food source for larger predators and when fully grown, are important to commercial industries. In fact, migratory nekton that use the salt marsh as breeding grounds and nursery habitat make up approximately 90% of the commercially important species on the south-east Atlantic coast (Mitsch, 1993). Fish from this system were sampled from June 2, 2000 through September 10, 2000 with emphasis on specific habitat assays. This allowed for species abundances to be monitored after the spawning season, giving a better understanding of which nekton species use the salt marsh system as a nursery.

Methods

The goal of this project was to sample juvenile fish in their preferred habitat. There are many ways to sample nekton in their natural environment. One of the more successful methods is throw trapping, a method widely used in salt marshes (Kushlan 1981, Turner and Trexler 1997, Chick et al. 1992). The throw trap was set by dropping or throwing the 1m^2 metal box into the desired area. This allowed for samples to be collected from an enclosed area of water with a depth of less then 1 meter. The trap was then cleared of nekton using a bar seine with 3 mm (1/8 inch) mesh. The area was determined to be clear after three consecutive sweeps in which no nekton was obtained. This method allowed for a quantitative study of juvenile fish within a desired area.

The different sampling areas were chosen based on distinctive criteria: Vegetated vs. un-vegetated, bottom firmness, presence or absence of oyster beds, and distance from the main waterway. Sample area locations (Fig. 1) were chosen by their availability during the different tidal stages (Fig. 2). Access to back areas of the tidal creeks was limited during periods of low and ebb tides. Four samples were taken from each location during each effort. The specimens were identified to lowest possible taxon and measured to standard length (mm). The amount of *Palamonetes pugio* was estimated due to its abundance in numerous samples. *Callinectes sapidus*, *Alpheus heterochelis*, and *Penaeus sp* abundance were recorded and carapace width was measured for *Callinectes sapidus*. Specimens that could not be identified in the field were preserved in 10% formalin and returned to the lab. Environmental parameters monitored included water depth, temperature, salinity, and dissolved oxygen. A YSI- model #85 handheld salinity, conductivity, dissolved oxygen, and temperature meter was used to monitor the above environmental parameters.

Results

From June 2 to September 10, a total of 108 samples were collected. There were 1607 nekton specimens collected, of which 589 were fish species (Table 1). Species were listed according to their abundance. The most abundant fish species was *Menidia menidia* (n=194). The dominant invertebrate species was *Palamonetes pugio* (n=~ 730). All of the species were collected in intertidal water areas. The average yield per square meter for all nekton encountered was 14.8 m^{-2} and 5.5 m^{-2}, for fish species (Table 2). The majority of the sampling was done during flood tides with *Spartina alterniflora* present. Tide was recorded based on hours away from high tide.

There were 6 fish species that had a Shannon index value greater then .090 (Table 1). *Harengula jaguana* was not included because the majority of specimens obtained came from one sampling effort (n= 26 from sample 87). *Eucinostomus sp.* was also omitted because of difficulty in identifying the juveniles to species level.

Discussion

It was found that some of the more abundant species did exhibit trends in abundance at different tidal stages (Fig. 3). Only one specimen of *Gobionellus boleosoma* was collected at high tide, but the species was abundant in the other three tidal stages. *Gobiosoma bosci* was also absent from high tide collections, with the majority of the specimens obtained at ebb tide. *Symphurus plagiusa* was found mainly during low tide periods and *Anchoa hepsetus* was collected only during flood tides. No specimens of *Menidia menidia* were found during ebb tides but the species was abundant during the other three tidal stages. Specimens of *Fundulus heteroclitus* were found to occur at all four tidal stages. Overall, the more abundant species were encountered during the ebb and flood tides. This may indicate the these fish use the tide as a means for dispersal through the marsh system. Sampling during low tides was focused mainly on unvegetated areas in the mouths of the creeks. High tide samples were taken in the fringing vegetation of the marsh. The accessibility of different sampling areas was limited by the tidal stage. During low tide, access to back areas of the creeks was limited.

The inclusion of vegetation within the sample area also influenced the fish assemblages (Fig. 4). Sample areas that contained vegetation exhibited a greater abundance of, *Menidia menidia*, and *Fundulus heteroclitus*. These fish were either seeking refuge or foraging at the time of sampling. The unvegetated habitats were comprised mainly *of Gobiosoma bosci*, *Symphurus plagiusa*, and *Anchoa hepsetus*. These species either don't rely on vegetation for refuge and foraging or were unable to get into the vegetation quickly enough during the sampling. *Gobionellus boleosoma* exhibited no preference to habitat choice in regards to vegetation in this study. The species was evenly distributed in samples that included vegetation and those that had no vegetation.

Not enough samples containing oyster beds were analyzed to quantitatively assess its role in the distribution of fish assemblages. However, many of the areas that were sampled were in close proximity to the oyster beds. Although they play an important role in nutrient circulation in the marsh system (Day, 1989), its role in fish distribution patterns are unclear from this study.

An earlier study conducted by the St. Johns Water Management District in neighboring waterways helps to support these results. All of the species obtained in this study were present in trawl and minnow trap samples collected from the area, with the exception of *Gobionellus boleosoma* (Weaver, 1998). This could be due to seasonal variance or the species preference of inhabiting the fringing marsh areas, which aren't sampled effectively using trawling. Also, the species is thought to live in the burrows of *Alpheus heterochelis*. The purpose of this study was to indicate how fish assemblages vary according to tidal stage and habitat preference. The overall diversity of the salt marsh system sampled showed how versatile an ecosystem it is. Certain fish utilize different areas of the marsh according to their needs. The changing of the tidal stage allows different species to move into different areas of the marsh as it becomes more accessible to them.

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Table 1. Species composition and abundance of nekton collected with the 1 m^2 throw trap. Species listed in order of rank, with dominant species at the top.

Species Fish:	Abundance Per m^2	Size Range (mm)	Shannon Index
Menidia menidia	1.79	16.7 - 52.9	0.366
Eucinostomus sp	0.907	7.7 - 52.0	Not applicable
Fundulus heteroclitus	0.583	11.1 - 64.0	0.239
Gobionellus boleosoma	0.481	9.2 -64.5	0.214
Gobiosoma bosci	0.315	9.5 - 67.0	0.165
Harengula jaguana	0.296	17.4 - 27.0	0.158
Symphurus plagiusa	0.194	18.1 - 47.0	0.119
Anchoa hepsetus	0.148	26.1 - 43.4	0.098
Leiostomus xanthurus	0.120	45.1 - 108.0	0.084
Citharichthyes spilopterous	0.111	25.7 - 51.9	0.079
Mugil curema	0.111	25.7 - 44.1	0.079
Fundulus majalis	0.074	24.0 - 34.0	0.058
Anchoa mitchilli	0.046	38.4 - 41.8	0.040
Mictophurus punctatus	0.037	92.0 - 130.0	0.034
Cynoscion nebulosus	0.028	25.1 - 270.0	0.027
Opsithonema oglinum	0.028	58.6 - 66.8	0.027
Achirus lineatus	0.019	16.9 - 18.3	0.019
Bathygobius soperator	0.019	53.5 - 73.0	0.019
Lagadon rhomboides	0.019	53.4 - 66.5	0.019
Mugil cephalus	0.019	54.3 - 64.4	0.019
Orhtopristus chrysoptera	0.019	53.5 - 63.5	0.019
Sygnathus louisianae	0.019	152.0 - 153.0	0.019
Bairdiella chrysoura	0.009	43.5	0.011
Chasmodes bosquianas	0.009	35.5	0.011
Lutjanus griseus	0.009	15.6	0.011
Menticirrhus americanus	0.009	19.6	0.011
Paralichthys lethostigma	0.009	178	0.011
Sphoeroides maculatus	0.009	26.7	0.011
Sygnathus fuscus	0.009	71.9	0.011
Total Number of Fish	589		
Total Number Of Fish Species	29		2.276 **= H'**
Decapod crustacea:			
Palemonetes pugio	729		
Alpheus heterochelis	193		
Callinectes sapidus	58		
Penaeus setiferus	31		
Penaeus aztecus	6		
Squilla empusa	1		
Total Number of Decapod Crustacea	1018		
Number of Species	6		

Table 2. Summary of environmental parameters for the sample areas (values combined over all dates). Veg. was primarily *Spartina alterniflora*.

Days Sampled	9	W/ Veg	w/o Veg	W/ Oyster	High tide	Ebb tide	Low tide	Flood tide
Number of Samples	108	64	44	15	24	18	21	45

Mean Values		**Range**
Salinity	31.9 ppt	24.6 – 38.0 ppt
Dissolved Oxygen	3.68 mg/L	3.03 – 4.11 mg/L
Temperature	27.7 ^{O}C	25.8 – 29.5 ^{O} C
Depth	363 mm	50 – 600 mm

Nekton per m^2	14.8
Fish per m^2	5.5

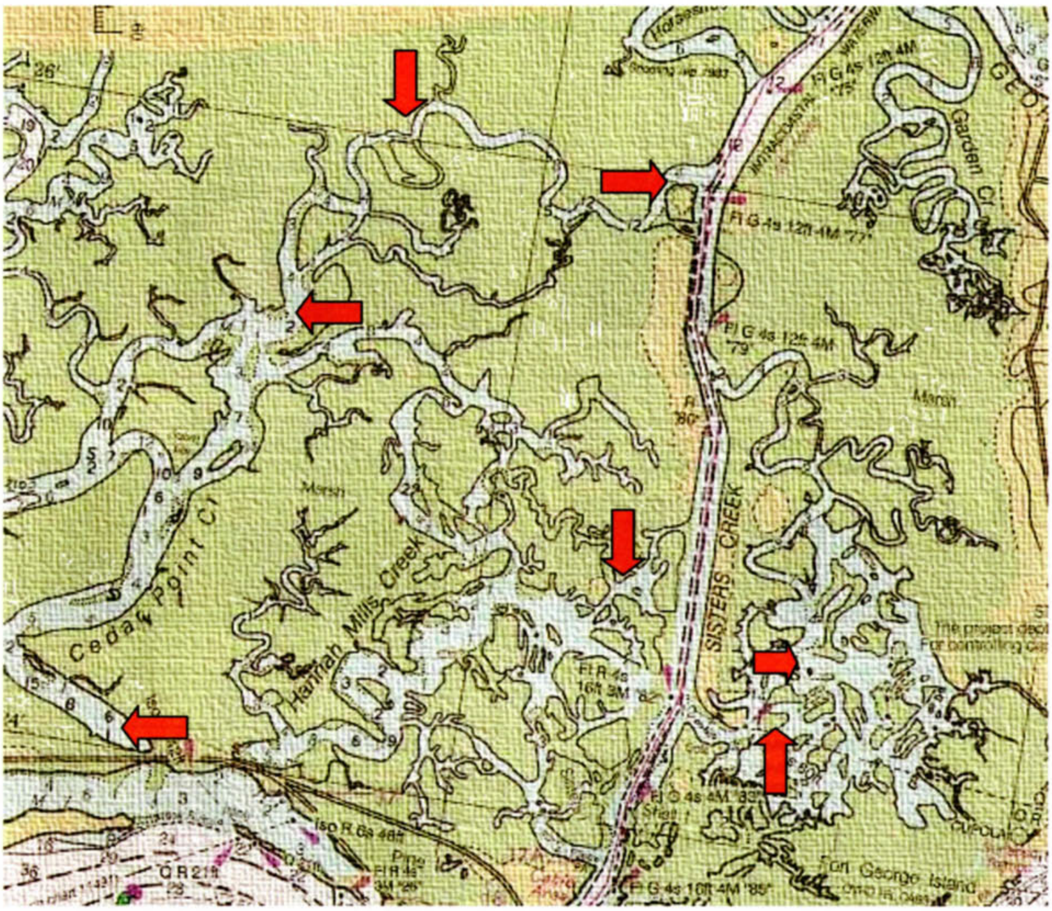

Figure 1. Deep Creek, Sisters Creek, and Cedar Point Creek sampling areas, within Duval County, Florida

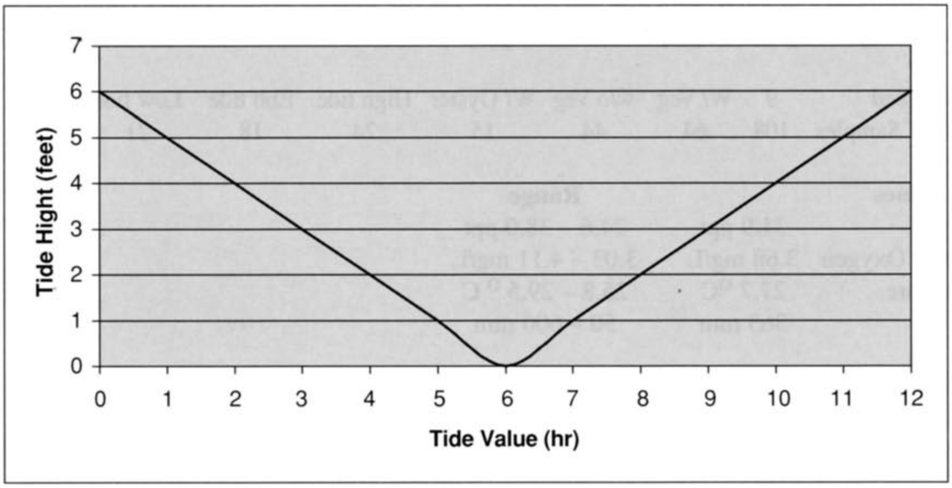

Figure 2. Definition of each tidal stage based on time from high tide. High tide = 0.0 to 1.0 feet, and 11.0 to 12.0 feet. Ebb tide = 1.1 to 5.0 feet. Low tide = 5.1 to 7.0 feet. Flood tide = 7.1 to 10.0 feet.

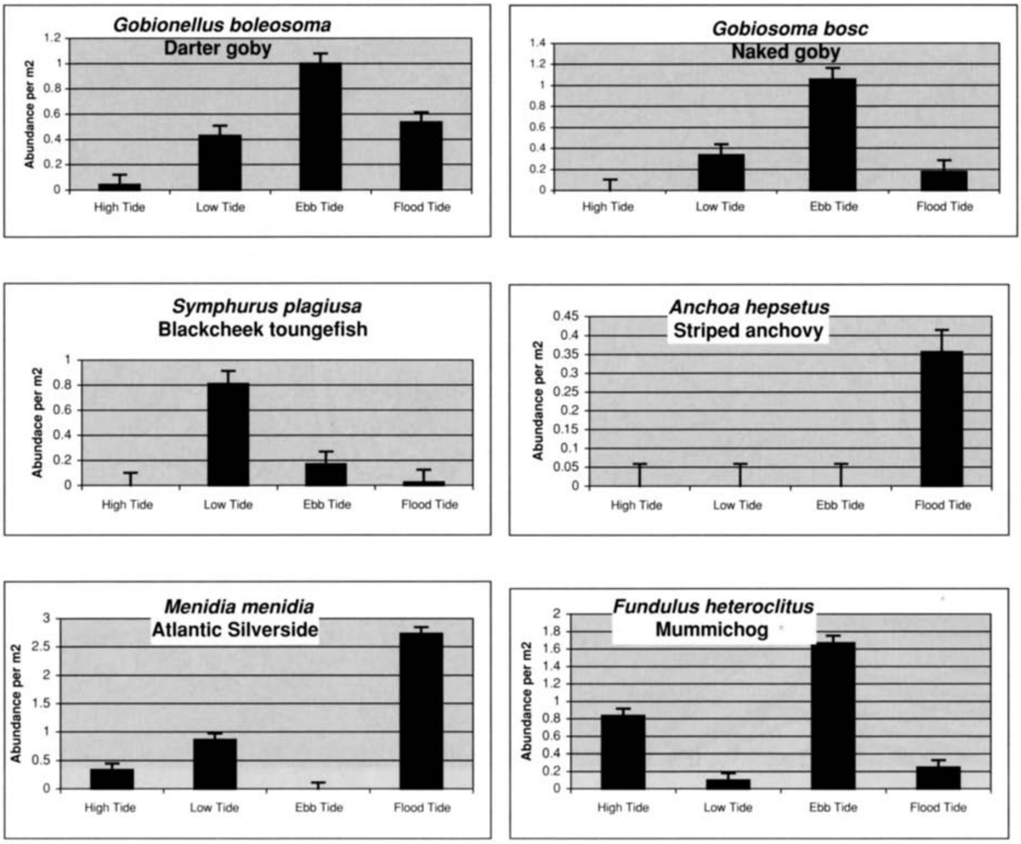

Figure 3. Total abundance per m^2 of fish species based on tidal stage, using the 1 m^2 throw trap collector.

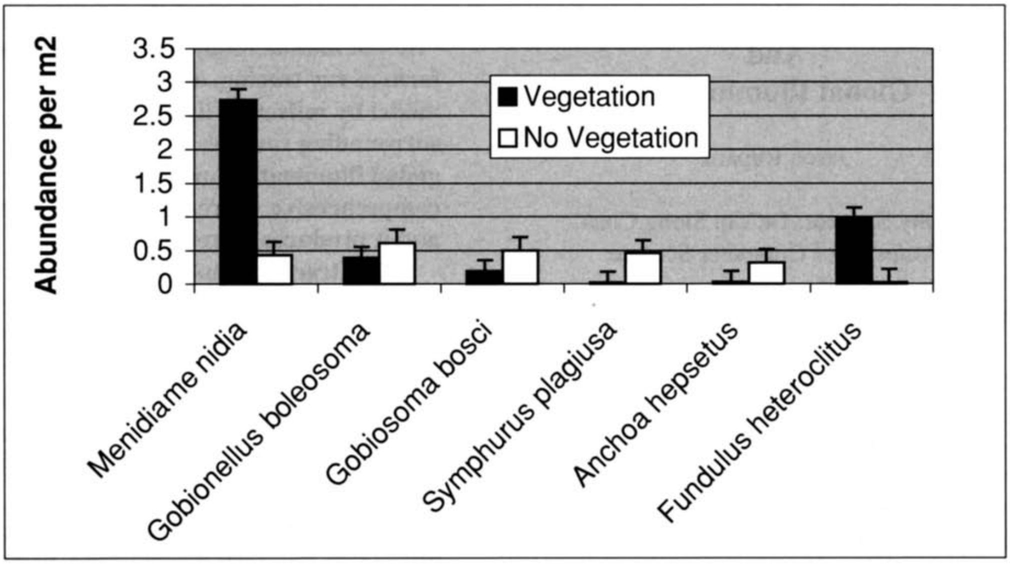

Figure 4. Total abundance per m^2 of fish based on presence or absence of *Spartina alterniflora*, using the 1 m^2 throw trap collector.