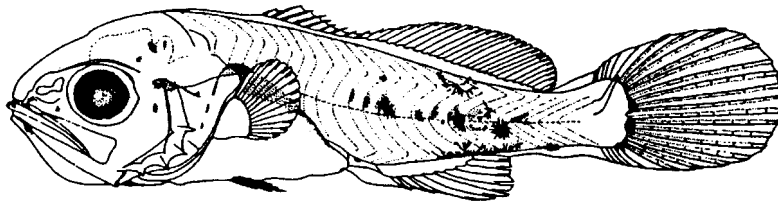




**NOAA TECHNICAL MEMORANDUM NMFS-SEFSC-485**

**An Evaluation of Northern Florida Bay as a Nursery Area for Red Drum, *Sciaenops ocellatus*, and Other Juvenile and Small Resident Fishes.**

**Allyn B. Powell, Michael W. Lacroix and Robin T. Cheshire**



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**June 2002**



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June 2002

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## Abstract

Red drum is one of the most popular species sought by anglers in Florida Bay, yet juveniles are rarely encountered. We evaluated Florida Bay as a nursery area for red drum by sampling for recently-settled late larvae in basin areas within the bay with an epi-benthic sled at six stations in November 2000, and at seven stations during December 2000 through February 2001. In November 2000 we surveyed potential sampling sites in quiet backwaters adjacent to mangroves for juvenile red drum. A total of 202 sites were sampled mainly in northern Florida Bay and adjacent waters with a cast net. We collected only one recently-settled red drum larvae and no juveniles. Obviously the sites that we sampled in Florida Bay and adjacent waters are not nursery habitat for this valuable species. Sled collections were dominated by bay anchovy, *Anchoa mitchilli*, but densities were biased by one collection. Five small resident species were among the dominant species: rainwater killifish, *Lucania parva*; dusky pipefish, *Syngnathus floridae*; dwarf seahorse, *Hippocampus zosterae*; and clown goby, *Microgobius gulosus*. Three species that spawn outside Florida Bay in the Gulf of Mexico were common: pinfish, *Lagodon rhomboides*; pigfish, *Orthopristis chrysoptera*; and silver perch, *Bairdiella chrysoura*. Twenty-seven species were collected with the cast net. Hardhead silversides (*Atherinomorus stipes*), bay anchovy, tidewater mojarra (*Eucinostomus harengulus*), silver jenny (*Eucinostomus gula*), and goldspotted killifish (*Floridichthys carpio*) were the most common in cast net collections. Although only one red drum was collected, we were able to: (1) identify mesohaline waters from our cast net sites to test our preliminary assessment that mesohaline habitat might be limited in Florida Bay, (2) document the distribution and abundance of fishes collected by cast net that should enhance our understanding of ichthyofauna in the Northern Subdivision of Florida Bay and adjacent waters, and (3) from epibenthic sled collections, describe the habitats, abundance and distribution of recently settled larvae/small juveniles/small resident fishes during late fall and winter. This information should be useful to managers and future research.

## Introduction

The red drum is one of the most popular species sought by anglers in Florida Bay (Schmidt et al. 1999), yet nursery areas for red drum in Florida Bay are unknown. Red drum spawn from mid-September through mid-February with a peak in October (Jannke 1971) in coastal Gulf of Mexico waters in close proximity to Florida Bay and adjacent estuarine waters (Collins and Finucane 1984). Jannke (1971) collected relatively large numbers of larval red drum at the mouth of the Little Shark River in Everglades National Park. The Shark River system could be a nursery area for juvenile red drum, but this potential juvenile nursery area has not been documented by subsequent investigations.

Juvenile red drum are rarely encountered in Florida Bay, but studies in other areas of the Gulf Coast give clues to potential juvenile habitats. Postsettlement stage red drum (4 and 30 mm) SL utilize *Halodule wrightii* seagrass beds in Texas (Holt et al. 1983; Rooker and Holt 1997; Rooker et al. 1998). Nursery habitats for drum > approximately 40 mm SL were undetermined in those studies. Studies in Tampa Bay identified the nursery habitats for red drum < approximately 50 mm SL (Peters and McMichael 1987). Red drum spawn near the mouth of Tampa Bay, Florida, and settle out along the shore of the bay, move to backwaters, then eventually disperse throughout the bay. Backwaters that supported the majority of juvenile red drum were characterized as 1) located in a river at the head of the bay, 2) in low energy environments, 3) salinities averaging 7 ppt (range = 0-25 ppt), and 4) possessing mud and sand/mud bottoms and turbid waters. Ninety-eight percent of all the juveniles (8-300 mm SL;  $n = 7,536$ ) were collected in these backwater areas.

The most notable collection of juvenile red drum in Florida Bay waters ( $n = 10$ ; 25-49 mm SL; salinity = 6ppt) was made at East Creek in Little Madeira Bay (Colvocoresses<sup>1</sup>) (Fig. 1). During November 1999, we collected recently-settled red drum (5.2-10.8 mm SL) in Florida Bay at Johnson Key Basin ( $n = 18$ ), Bradley Key ( $n = 6$ ) and Whipray Basin ( $n = 1$ ) using an epibenthic sled (1.0 x 0.5 m with 0.947 mesh). To the best of our knowledge this is the first time recently-settled red drum have been collected in Florida Bay. One of the objectives of this study was to determine whether our 1999 collection of recently-settled red drum was a sporadic or systematic event. The other objective was to sample backwaters of Florida Bay to determine if these low energy habitats are nursery areas for juvenile red drum.

## Methods

Sampling for recently settled red drum was conducted monthly at six stations (Middle Ground, Johnson Key basin, Snake Bight, Crocodile Point, Roscoe Key and East Creek; Fig.1) from November 2000 through February 2001 using a 1.0 m x 0.5 m epibenthic sled with 0.947 mm mesh. An additional station (Bradley Key) was added in December. Because of tidal conditions we were unable to sample McCormick Creek from December through February. This station was moved to Crocodile Point. A flowmeter was inserted in the frame of the sled to estimate the volume of water sampled. Replicate tows were taken at each station along with

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<sup>1</sup>Colvocoresses, James A. Personal communications. 2000. Florida Marine Research Institute 2796 Overseas Highway, Marathon, FL 33050.

measures of water clarity (secchi disk), water depth, salinity, temperature, and sediment depth. Three 0.008m<sup>2</sup> cores were taken along a transect adjacent to the towed area for seagrass composition, short-shoot densities, blade length, and standing crop. Fish were preserved in formalin then transferred to alcohol in the laboratory.

Originally, we intended to augment our sled samples with beach seine collections. However, soft sediments and mangrove roots made seining at most sites impossible. Instead we used cast nets (6.4 mm square mesh; 1.5 or 1.8 m radius) to collect fishes at 202 sites (Fig. 2). Fewer sites were sampled in Florida Bay waters away from the mainland, but adjacent to mangroves, for comparative purposes. In general, a 1.8 m radius net was used, but at some sites where space was limited we used a 1.5 m radius net. At each site three cast net samples were taken and fish were combined into one sample. Species and numbers were recorded and specimens released.

A few sites (Davis Cove, Deer Key and East Creek; Fig.3) were sampled in December and February with a beach seine (12.2m x 1.2m x 1.6 mm mesh or 30.5m x 2.4m x 6.4mm square mesh). The smaller seine was used only at East Creek. The latter site was the same site red drum juveniles had previously been collected (see Introduction). Species were recorded and fishes released alive. We did not analyze the limited beach seine collections as fish composition mirrored that of the cast nets. We used non-parametric Kruskal-Wallis tests with  $\alpha = 0.10$  (Sokal and Rohlf 1981) and relied on Wilcoxon mean scores to infer patterns and trends in densities by gears and among stations/sites and time periods.

Based on recommendations by the South Florida Ecosystem Restoration Prediction and Modeling (SFERPM), Program Management Committee (PMC), Florida Bay was divided into six zones (Fig. 1).

## **Results and Discussion**

### Red Drum

We collected only one recently settled red drum with the epibenthic sled (Johnson Key Basin; 7.2mm SL) and no juvenile red drum with the other gear. This strongly suggested that recently settled red drum occur sporadically. The habitats that we were able to sample in Florida Bay and adjacent waters, that is, shallow seagrass beds, mangrove edges, and beach habitats are not nursery areas for juvenile red drum. Given the reported spawning area of red drum along the south Florida Gulf coast (Jannke 1971; Collins and Finucane 1984) and prevailing currents (Lee et al.<sup>2</sup>), it is puzzling that late stage larvae or early stage juveniles are not collected regularly in western Florida Bay. Spawning surely occurs in coastal waters based on collections of red drum larvae in Florida coastal waters by Collins and Finucane (1984), and Jannke's collection of numerous red drum larvae at the entrance of Little Shark River indicates that some larvae do enter the Shark River system. Lee et al.'s (1999) observations of surface drifters deployed near the Shark River indicate that currents move southerly, and move through western Florida Bay

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<sup>2</sup> Lee, T. N, E. Williams, E. Johns and D. Wilson. 1999. First year results from enhanced observations of circulation and exchange processes in western Florida Bay and connecting waters, including effects of El Nino and Hurricane Georges. Abstract, p. 145. Florida Bay and Adjacent Marine Systems Science Conference, November 1-5, 1999, Key Largo Florida, 263 p..

toward the Florida Keys reef tract through Long Key Channel. Hence, the transport mechanism appears to be available for recruitment into the western portion of the bay.

We made a considerable number of cast net collections in mesohaline waters (Fig. 4) where red drum are commonly collected in other estuaries (Peters and McMichael 1987). However, the vast majority of our collections in mesohaline waters were in the Eastern Subdivision, a considerable distance from red drum spawning areas on the Gulf coast. Hence, recruitment limitations might be a major factor in the absence of red drum from these mesohaline waters.

#### Epi-benthic Sled Collections for Other Fishes

Epi-benthic sled collections were made at stations that represented diverse habitat types (Tables 1 and 2). Johnson Key Basin had lush, mixed seagrass beds, and all seagrass species had long blade lengths. As a result, this station had the largest seagrass standing crop (Table 2). Crocodile Point, which had the second largest standing crop of seagrass, had the greatest densities of *Thalassia* short shoots (approximately seven times greater than Johnson Key Basin), but blade lengths were the shortest observed, resulting in a standing crop of *Thalassia* that was only similar to Johnson Key Basin. Similarly, East Creek had the highest densities of *Halodule* short shoots (approximately three times greater than observed at Johnson Key Basin), but blade length was the shortest observed for that species, resulting in a standing crop of *Halodule* that was one-half that observed at Johnson Key Basin. Low standing crops of seagrasses were observed at three stations (Bradley Key, McCormick Creek, and Roscoe Key) located in separate subdivisions (Table 2, Figs. 1 and 3).

We anticipated an increase in standing crop and short shoot densities from the east to west on the basis of Hall et al. (1999) who reported increases in Florida Bay from the northeast to the southwest. Seagrass standing crop was highest in the west, but a gradient from the east to west was not apparent (Table 2; Fig. 1). This disparity could have been a result of our lack of sampling in the southwest, but this disparity was also noted by Thayer and Chester (1989) who sampled extensively in Florida Bay.

Temperature and salinity patterns were similar among stations (Table 1). Salinities were relatively low in January and February, while temperatures were relatively low in December and January. There were no significant differences in densities of the more commonly collected fish taxa (Fig. 5) among months despite differences in temperature and salinity (Table 1).

The bay anchovy, *Anchoa mitchilli*, dominated epibenthic sled collections (Table 3), but densities were biased by one collection (508 bay anchovy 100 m<sup>-3</sup>) from McCormick Creek (Fig. 1) in November. Differences in densities of bay anchovy among stations were significant (Table 4). Highest density and Wilcoxon mean score was observed at Roscoe Key. Densities at McCormick Creek/Crocodile Point were biased by one collection (see above) and this is reflected in the relatively low Wilcoxon mean score (Table 4). Bay anchovy were absent at Johnson Key Basin (Fig. 5). Populations of juvenile bay anchovy have fluctuated widely in Florida Bay (Thayer et al. 1999; unpublished data). In 1984-1985, they were not a dominant component of the ichthyofauna, but were dominant in 1994-1995 (Thayer et al. 1999). Our six station epi-benthic sled samples mirror otter trawl samples taken at numerous stations throughout Florida Bay in 2000-2001 (unpublished data). Juvenile bay anchovy, sampled by otter trawl, were absent in the Western zone, and abundant in vicinity of Roscoe Key in the Central Zone,



and the Northern Transition Zone.

Five other small resident species were among the dominant species and their densities were significantly different among stations. Rainwater killifish, *Lucania parva*, was collected at high densities at Johnson Key Basin, but rare to absent at all other stations. The rainwater killifish, a canopy-dweller, was the dominant taxa in both bank and basin habitats in Florida Bay in 1984-1985, but declined markedly in densities and in geographic range in 1994-1995 following the seagrass die-off that began in the late 1980's (Matheson et al. 1999; Thayer et al. 1999). Dusky pipefish, *Syngnathus floridae*, overall, was not collected in great densities, but was common at Johnson Key Basin and Bradley Key. This canopy-dweller is more frequently collected in the western portion of Florida Bay (Sogard et al. 1987; Thayer et al. 1999). Dwarf seahorse, *Hippocampus zosterae*, were collected mainly at Bradley Key, and absent to rare in collections at Middle Ground, McCormick Creek/Crocodile Point, and East Creek. Other studies report this canopy-dweller as ubiquitous, but more common in the western and central areas of the bay (Sogard et al. 1987; Thayer et al. 1999). The clown goby, *Microgobius gulosus*, had the most restricted distribution. It was absent at four stations, rarely collected at two others, but was common at East Creek (Table 4, Fig. 5). The clown goby, a benthic species, is more common in the north central and northeastern area of Florida Bay (Sogard et al. 1987; this study; unpublished data).

Three species that spawn outside Florida Bay in the Gulf of Mexico (Jannke 1971; Collins and Finucane 1984) were among the most commonly collected taxa. Pinfish, *Lagodon rhomboides*, pigfish, *Orthopristis chrysoptera*, and silver perch, *Bairdiella chrysoura*, exhibited similar patterns of distribution, in that they were collected at stations in close proximity to their spawning area (Fig. 5). The distribution of juveniles collected by otter trawl at numerous stations (unpublished data) indicate that the pigfish and silver perch have the most restricted distribution. Pigfish are absent from the Northern Transition and Eastern Zones and rare in the Atlantic Transition Zone (Fig. 1). Silver perch are absent from the Northern Transition and Atlantic Transition Zones and rare in the Eastern Zone. Pinfish are absent from the Northern Transition Zone and rare in the Eastern Zone.

#### Cast Net Collections of Other Fishes

Twenty-seven species were collected with cast nets near mangroves (Table 5), although 47 of 202 (23%) sites had no catches. The hardhead silversides, *Atherinomorus stipes*, was the dominant species collected, but occurred at only 12% of the sites sampled that had positive catches. Bay anchovy, tidewater mojarra (*Eucinostomus harengulus*), silver jenny (*E. gula*), and goldspotted killifish (*Floridichthys carpio*) were the most common species and occurred at relatively high frequencies (Table 5). All of these species except the silver jenny have an affinity to mangrove prop root habitats (Thayer et al. 1987)

The greatest number of species occurred in mesohaline waters, the least in oligohaline waters (Table 6). Densities of five commonly collected species (Table 5;  $\geq 100$  total number collected) were significantly different among salinity regimes (Table 6). The hardhead silverside was most abundant in mesohaline waters (Table 6), but it had a low frequency of occurrence (Table 5) and Wilcoxon mean score (Table 7), which indicated that this species had a restricted and contagious distribution. The bay anchovy was most abundant in polyhaline and euhaline

waters; tidewater silversides, *Menidia peninsulae*, in polyhaline waters; and goldspotted killifish in mesohaline to euhaline waters. The two species of *Eucinostomus* appeared sympatric in their distribution with the tidewater mojarra occurring in more brackish waters than its congener, the silver jenny (Table 6 and 7).

Densities of two of the most common species (silver jenny; and white mullet, *Mugil curema*) were significantly different between the Central, Eastern and Gulf Transition Subdivisions (Tables 8 and 9, Fig. 6). The silver jenny was uncommon in the Gulf Transition Subdivision, and although densities were relatively high in the Eastern Subdivision, Wilcoxon mean scores were similar to those observed for the Gulf Transition Subdivision. The white mullet was only collected in the Gulf Transition Zone. We observed very high densities of hardhead silversides in the Eastern Subdivision, but the majority of these fish ( $n = 438$ ) were collected at one site (Deer Key). Although densities of tidewater mojarra, dwarf seahorse, tidewater silverside (*Menidia peninsulae*), sailfin molly (*Poecilia latipinna*) and redbfin needlefish (*Strongylura notata*) were not significantly different among the three subdivisions, they were rare in one subdivision. The striped mojarra, *Diapterus plumieri*, and gulf pipefish, *Syngnathus scovelli*, were not collected in any of these three subdivisions.

In the Northern Transition Subdivision, densities of five of the most common species were significantly different among sites (Tables 10 and 11, Fig. 6). The hardhead silversides was collected at only three sites and was abundant at Trout Cove and Madeira Bay. The tidewater mojarra was most abundant at Joe Bay, while the silver jenny was most common at Little Madeira Bay, Trout Cove and Mud Creek. The goldspotted killifish was common at Rankin Bight, and the sailfin molly which was most abundant at Long Sound (Table 10, Fig. 6), had the highest Wilcoxon mean score at Snake Bight Canal (Table 11).

In conclusion, the sites in Florida Bay and adjacent waters that we sampled are not nursery areas for juvenile red drum. We suspect that recruitment could be a major factor in inhibiting red drum juveniles from using mesohaline waters in the northeastern portion of Florida Bay. Future investigations to examine nursery areas for this valuable species should concentrate on mesohaline waters of the Shark River system where large numbers of larvae have historically been collected (Jannke 1971).

Although we were unable to collect juvenile red drum, other information was attained that provides a framework for future investigations. First we identified mesohaline waters from our cast net sites to test our preliminary assessment that mesohaline habitat might be limited in Florida Bay. Second, we documented the distribution and abundance of fishes collected by cast nets that should enhance our understanding of ichthyofauna in the Northern Subdivision and adjacent waters. Third, from epibenthic sled collections we described the habitats (temperature; salinity; water depth; sediment depth; seagrass composition, density and standing crop), abundance, and distribution of recently settled larvae/small juveniles/small resident fishes during late fall and winter.

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Table 1. Summary of epibenthic sled station data.

Station	Month	Salinity ‰	Temperature °C	Sediment depth (m)	Water depth (m)
Middle Ground	Nov	36	25	1.4	1.5
	Dec	35	20	2.3	0.8
	Jan	26	16	2.0	1.7
	Feb	28	26	2.2	0.9
Johnson Key Basin	Nov	37	25	2.1	1.1
	Dec	36	20	1.9	0.7
	Jan	26	17	1.3	1.4
	Feb	29	26	1.4	1.1
Snake Bight	Nov	37	25	1.5	1.0
	Dec	36	20	1.8	0.6
	Jan	27	16	1.6	0.8
	Feb	31	25	0.8	1.4
Roscoe Key	Nov	38	26	0.9	1.3
	Dec	37	22	0.9	1.1
	Jan	30	15	1.0	1.0
	Feb	30	25	1.0	0.9
McCormick Creek	Nov	27	26	1.3	1.3
Crocodile Point	Dec	36	21	1.0	1.0
	Jan	28	14	0.5	0.5
	Feb	27	22	0.3	0.3
East Creek	Nov	18	26	0.5	0.5
	Dec	14	21	1.0	1.0
	Jan	5	17	0.5	0.5
	Feb	8	25	0.7	0.7
Bradley Key	Dec	36	23	1.9	0.7
	Jan	28	16	1.5	1.2
	Feb	30	26	1.9	1.0

Table 2. Summary of seagrass data at epibenthic sled stations. HW=*Halodule wrightii*; RM=*Ruppia maritima*; SF=*Syringodium filiforme*; TT=*Thalassia testudinum*. Values are averaged across months. McCormick Creek was only sampled in November

Station	Species	Short shoots (no. m <sup>-2</sup> )	Blade length (mm)	Standing crop (g dry weight m <sup>-2</sup> )
Middle Ground	HW	157	102	2
	SF	24	158	1
	TT	105	181	18
Johnson Key Basin	HW	251	190	6
	SF	253	260	19
	TT	58	367	26
Snake Bight	HW	604	113	7
	TT	16	300	5
Roscoe Key	HW	139	108	2
	TT	58	143	7
McCormick Creek	HW	500	80	4
	RM	125	39	<1
Crocodile Point	TT	403	111	26
East Creek	HW	760	50	3
	RM	188	47	<1
	TT	170	119	11
Bradley Key	SF	238	172	8

Table 3. List of species collected at seven epibenthic sled sites in Florida Bay. Density (numbers 100 m<sup>-3</sup>) is the mean density averaged over all stations and cruises. Species are listed in descending order of mean density.

Species	Mean density
<i>Anchoa mitchilli</i>	23.15
<i>Lucania parva</i>	7.77
<i>Orthopristis chrysoptera</i>	5.87
<i>Hippocampus zosterae</i>	5.85
<i>Syngnathus scovelli</i>	4.55
<i>Microgobius gulosus</i>	3.67
<i>Lagodon rhomboides</i>	3.39
<i>Syngnathus floridae</i>	2.31
<i>Bairdiella chrysoura</i>	2.16
<i>Syngnathus</i> sp.	0.98
<i>Eucinostomus</i> sp.	0.95
<i>Eucinostomus gula</i>	0.60
<i>Syngnathus louisianae</i>	0.30
<i>Monacanthus hispidus</i>	0.28
<i>Chilomycterus schoepfi</i>	0.10
<i>Cynoscion nebulosus</i>	0.09
<i>Sphoeroides nephelus</i>	0.09
<i>Hippocampus erectus</i>	0.08
<i>Gobiosoma robustum</i>	0.07
<i>Symphurus plagiusa</i>	0.05
<i>Bairdiella batabana</i>	0.05
<i>Lutjanus synagris</i>	0.05
<i>Sphyaena barracuda</i>	0.05
<i>Synodus foetens</i>	0.04
<i>Anarchopterus criniger</i>	0.04
<i>Monacanthus ciliatus</i>	0.03
<i>Chasmodes saburrae</i>	0.02

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Table 3. (Cont.)

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Species	Mean density
<i>Gobiesox strumosus</i>	0.02
<i>Sciaenops ocellatus</i>	0.02
<i>Strongylura notata</i>	0.02
<i>Floridichthys carpio</i>	0.02
<i>Hypsoblennius ionthus</i>	0.01
<i>Lactophrys trigonis</i>	0.01
<i>Haemulon plumeri</i>	0.01
<i>Archosargus probatocephelus</i>	0.01
<i>Haemulon</i> sp.	0.01

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Table 4. Results of Kruskal-Wallis test used to examine differences among selected taxa densities (density > 10.0 for, at least, one collection) and epi-benthic sled stations. Listed are the P-values and the Wilcoxon mean scores by station. MG = Middle Ground; JKB=Johnson Key Basin; SB=Snake Bight; RK=Roscoe Key; MC/CP=McCormick Creek/Crocodile Point; EC=East Creek; BK=Bradley Key.

Species	P-value	Station						
		MG	JKB	SB	RK	MC/CP	EC	BK
<i>Anchoa mitchilli</i>	0.0979	16.0	7.0	10.5	22.2	12.0	13.2	18.0
<i>Bairdiella chrysoura</i>	0.0110	13.8	18.5	24.0	9.0	9.0	9.0	15.0
<i>Hippocampus zosterae</i>	0.0012	7.5	17.2	20.5	18.5	7.5	4.5	25.0
<i>Lagodon rhomboides</i>	0.0257	12.5	17.5	16.2	10.0	10.0	10.0	24.3
<i>Lucania parva</i>	0.0035	6.0	25.5	15.8	9.2	16.5	17.0	6.0
<i>Microgobius gulosus</i>	0.0032	10.5	10.5	13.4	10.5	16.2	25.5	10.5
<i>Orthopristis chrysoptera</i>	0.0075	17.1	15.5	16.9	8.5	8.5	8.5	26.0
<i>Syngnathus floridae</i>	0.0026	14.9	24.0	15.1	8.4	6.5	8.1	23.3
<i>Syngnathus scovelli</i>	0.0056	7.0	22.0	22.8	9.2	6.5	13.0	18.7

Table 5. List of species collected at 202 cast net sites in Florida Bay and adjacent waters. Frequency of occurrence is the number of sites the species occurred; density is the mean number averaged over all sites and cruises. Species are listed in descending order.

Species	Frequency of occurrence	Total number collected	Density
<i>Atherinomorus stipes</i>	18	966	4.78
<i>Anchoa mitchilli</i>	33	308	1.52
<i>Menidia peninsulae</i>	5	237	1.17
<i>Poecilia latipinna</i>	14	175	0.87
<i>Eucinostomus harengulus</i>	39	173	0.86
<i>Eucinostomus</i> spp.	26	139	0.69
<i>Sardinella aurita</i>	11	120	0.59
<i>Eucinostomus gula</i>	41	117	0.58
<i>Floridichthys carpio</i>	37	100	0.50
<i>Mugil curema</i>	16	34	0.17
<i>Diapterus plumeri</i>	15	31	0.15
<i>Syngnathus scovelli</i>	10	18	0.09
<i>Hippocampus zosterae</i>	9	15	0.07
<i>Strongylura notata</i>	4	11	0.05
<i>Fundulis grandis</i>	5	9	0.04
<i>Lucania parva</i>	7	8	0.04
<i>Cichlasoma urophthalmus</i>	3	3	0.03
<i>Elops saurus</i>	6	6	0.03
<i>Anchoa hepsetus</i>	2	4	0.02
<i>Centropomis undecimalis</i>	3	3	0.01
<i>Lutjanus griseus</i>	3	3	0.01
<i>Lepisosteus platyrhincus</i>	1	2	0.01
<i>Mugil cephalus</i>	1	2	0.01
<i>Micrgobius gulosus</i>	2	2	0.01
<i>Pristis pectinata</i>	2	2	0.01
<i>Sphyraena barracuda</i>	2	2	0.01

Table 5 (cont).

Species	Frequency of occurrence	Total number collected	Density
<i>Arius felis</i>	1	1	<0.01
<i>Caranx hippos</i>	1	1	<0.01
<i>Diplogrammus pauciradiatus</i>	1	1	<0.01
<i>Megalops atlanticus</i>	1	1	<0.01
<i>Sphoeroides nephalus</i>	1	1	<0.01
<i>Trinectes maculatus</i>	1	1	<0.01

Table 6. Total number, and mean number per cast (in parenthesis) by salinity regime of selected taxa (total number collected >10) collected by cast net in Florida Bay and adjacent waters. Species are listed by alphabetical order.

Species	Salinity regime			
	Oligohaline	Mesohaline	Polyhaline	Euhaline
<i>Anchoa mitchilli</i>	2 (0.07)	56 (0.49)	115 (3.03)	135 (6.14)
<i>Atherinomorus stipes</i>	4 (0.15)	886 (7.70)	42 (1.11)	34 (1.55)
<i>Diapterus plumeri</i>	12 (0.44)	18 (0.16)	1 (0.03)	0
<i>Eucinostomus harengulus</i>	34 (1.26)	139 (1.21)	0	0
<i>Eucinostomus gula</i>	1 (0.04)	85 (0.74)	24 (0.63)	7 (0.32)
<i>Eucinostomus spp.</i>	0	56 (0.49)	18 (0.47)	65 (2.95)
<i>Floridichthys carpio</i>	0	67 (0.58)	21 (0.55)	12 (0.55)
<i>Hippocampus zosterae</i>	0	2 (0.02)	3 (0.08)	10 (0.45)
<i>Menidia peninsulae</i>	0	8 (0.07)	229 (6.03)	0
<i>Mugil curema</i>	0	22 (0.19)	6 (0.16)	6 (0.27)
<i>Poecilia latipinna</i>	8 (0.30)	156 (1.36)	8 (0.21)	3 (0.14)
<i>Sardinella aurita</i>	0	58 (0.50)	6 (0.16)	56 (2.55)
<i>Strongylura notata</i>	0	10 (0.09)	0	1 (0.05)
<i>Syngnathus scovelli</i>	0	6 (0.05)	9 (0.24)	3 (0.14)

Table 7. Results of Kruskal-Wallis Test used to examine differences between selected taxa (total number collected >10) densities collected with a cast net and salinity regime. Listed are the P-values and the Wilcoxon mean scores by salinity regimes. Species are listed by alphabetical order.

Species	P-value	Salinity regime			
		Oligohaline	Mesohaline	Polyhaline	Euhaline
<i>Anchoa mitchilli</i>	0.0108	91.7	97.0	111.8	119.2
<i>Atherinomorus stipes</i>	0.6631	96.1	101.5	102.9	106.0
<i>Diapterus plumeri</i>	0.1225	109.6	102.7	96.5	94.0
<i>Eucinostomus harengulus</i>	0.0001	122.6	106.7	82.0	82.0
<i>Eucinostomus gula</i>	0.0564	84.3	102.5	112.3	98.8
<i>Eucinostomus spp.</i>	0.0001	88.5	98.3	101.7	134.0
<i>Floridichthys carpio</i>	0.0699	83.0	104.3	106.1	101.7
<i>Hippocampus zosterae</i>	0.0001	97.0	98.0	102.3	124.5
<i>Menidia peninsulae</i>	0.0056	99.0	99.9	109.6	99.0
<i>Mugil curema</i>	0.0700	93.5	99.8	106.4	111.7
<i>Poecilia latipinna</i>	0.2243	109.2	99.0	104.9	99.2
<i>Sardinella aurita</i>	0.1672	96.0	100.4	103.8	109.8
<i>Strongylura notata</i>	0.5180	99.5	102.1	99.5	104.1
<i>Syngnathus scovelli</i>	0.3866	96.5	100.9	104.5	105.8

Table 8. Total number, and mean number per cast (in parenthesis) by subdivision (Eastern, Central and Gulf Transition) of selected taxa (total number collected >10) collected by cast net in Florida Bay. Species are listed by alphabetical order. Data for the Northern Transition Subdivision are depicted in Table 10.

Species	Subdivision		
	Central	Eastern	Gulf Transition
<i>Anchoa mitchilli</i>	2 (0.15)	103 (6.87)	101 (7.77)
<i>Atherinomorus stipes</i>	47 (3.62)	439 (29.27)	0
<i>Diapterus plumeri</i>	0	0	0
<i>Eucinostomus harengulus</i>	0	3 (0.20)	0
<i>Eucinostomus gula</i>	19 (1.46)	27 (1.80)	8 (0.62)
<i>Eucinostomus spp.</i>	1 (0.08)	20 (1.33)	3 (0.23)
<i>Floridichthys carpio</i>	4 (0.31)	8 (0.53)	0
<i>Hippocampus zosterae</i>	1 (0.08)	0	0
<i>Menidia peninsulae</i>	0	1 (0.07)	0
<i>Mugil curema</i>	0	0	9 (0.69)
<i>Poecilia latipinna</i>	5 (0.38)	0	0
<i>Sardinella aurita</i>	1 (0.08)	0	55 (4.23)
<i>Strongylura notata</i>	0	0	1 (0.08)
<i>Syngnathus scovelli</i>	0	0	0

Table 9. Results of Kruskal-Wallis Test used to examine differences among selected taxa (total number collected >10) densities and subdivisions collected by cast net. Listed are the P-values and the Wilcoxon mean scores by subdivision. Species are listed by alphabetical order. Data for the Northern Transition Subdivision are depicted in Table 11.

Species	P-value	Subdivision		
		Central	Eastern	Gulf Transition
<i>Anchoa mitchilli</i>	0.1789	17.9	20.9	24.2
<i>Atherinomorus stipes</i>	0.1702	23.2	22.6	17.0
<i>Diapterus plumeri</i>	1.0000	21.0	21.0	21.0
<i>Eucinostomus harengulus</i>	0.1692	20.0	22.7	20.0
<i>Eucinostomus gula</i>	0.0220	27.7	18.3	17.4
<i>Eucinostomus spp.</i>	0.4780	20.0	22.7	20.1
<i>Floridichthys carpio</i>	0.1289	23.5	21.9	17.5
<i>Hippocampus zosterae</i>	0.3406	22.1	20.5	20.5
<i>Menidia peninsulae</i>	0.4204	20.5	21.9	20.5
<i>Mugil curema</i>	0.0006	18.0	18.0	27.5
<i>Poecilia latipinna</i>	0.3406	22.1	20.5	20.5
<i>Sardinella aurita</i>	0.2888	21.0	19.5	22.7
<i>Strongylura notata</i>	0.3406	20.5	20.5	22.1
<i>Syngnathus scovelli</i>	1.0000	21.0	21.0	21.0

Table 10. Total number, and mean number per cast (in parenthesis) by subareas in the Northern Transition Subdivision of selected taxa (total number collected >10) collected by cast net in Florida Bay and adjacent waters. Species are listed by alphabetical order. CP=Crocodile Point; GB= Garfield Bight; JB=Joe Bay; LMB=Little Madeira Bay; LS=Long Sound; MB=Madeira Bay; MC=Mud Creek; RB=Rankin Bight; SBC=Snake Bight Canal; TC=Trout Cove; and WL=West Lake

Species	CP	GB	JB	LMB	LS	MB	MC	RB	SBC	TC	WL
<i>Anchoa mitchilli</i>	8 (4.00)	5 (0.45)	24 (1.20)	11 (0.32)	1 (0.03)	29 (7.25)	8 (0.62)	1 (0.50)	0	10 (0.91)	5 (0.18)
<i>Atherinomorus stipes</i>	0	0	0	64 (1.88)	0	22 (5.50)	0	0	0	394 (35.82)	0
<i>Diapterus plumeri</i>	0	0	6 (0.30)	14 (0.42)	5 (0.15)	0	0	0	0	0	6 (0.21)
<i>Eucinostomus harengulus</i>	0	0	59 (2.95)	19 (0.56)	53 (1.61)	0	7 (0.54)	0	0	1 (0.09)	31 (1.11)
<i>Eucinostomus gula</i>	0	3 (0.27)	0	33 (0.97)	8 (0.24)	0	5 (0.38)	0	0	14 (1.27)	0
<i>Eucinostomus spp.</i>	5 (2.50)	5 (0.45)	0	38 (1.12)	10 (0.30)	54 (13.50)	0	1 (0.50)	0	0	2 (0.07)
<i>Floridichthys carpio</i>	2 (1.00)	14 (1.27)	1 (0.05)	9 (0.26)	40 (1.21)	0	8 (0.62)	9 (4.50)	0	5 (0.45)	0
<i>Hippocampus zosterae</i>	2 (1.0)	3 (0.27)	0	2 (0.06)	0	3 (0.75)	0	4 (2.00)	0	0	0
<i>Menidia peninsulae</i>	0	0	0	8 (0.23)	201 (6.09)	0	0	0	0	27 (2.45)	0
<i>Mugil curema</i>	0	1 (0.09)	6 (0.30)	2 (0.06)	14 (0.42)	0	2 (0.15)	0	0	0	0
<i>Poecilia latipinna</i>	0	3 (0.27)	0	0	154 (4.67)	0	0	0	3 (1.0)	2 (0.18)	8 (0.29)
<i>Sardinella aurita</i>	0	0	9 (0.45)	0	23 (0.70)	1 (0.25)	0	0	0	31 (2.82)	0
<i>Strongylura notata</i>	0	0	0	0	1 (0.03)	0	9 (0.69)	0	0	0	0
<i>Syngnathus scovelli</i>	1 (0.05)	10 (0.90)	0	2 (0.06)	2 (0.06)	0	0	2 (1.0)	0	1 (0.09)	0



Table 11. Results of Kruskal-Wallis Test used to examine differences among selected taxa (total number collected >10) densities and cast net sites. Listed are the P-values and the Wilcoxon mean scores Northern Transition Subdivision sites. Species are listed by alphabetical order. CP=Crocodile Point; GB= Garfield Bight; JB=Joe Bay; LMB=Little Madeira Bay; LS=Long Sound; MB=Madeira Bay; MC=Mud Creek; RB=Rankin Bight; SBC=Snake Bight Canal; TC=Trout Cove; and WL=West Lake

Species	P-value	Station										
		CP	GB	JB	LMB	LS	MB	MC	RB	SBC	TC	WL
<i>Anchoa mitchilli</i>	0.1132	113.2	90.6	81.4	80.8	71.2	114.0	87.1	106.0	69.0	77.2	79.9
<i>Atherinomorus stipes</i>	0.0001	76.0	76.0	76.0	85.5	76.0	115.6	76.0	76.0	76.0	105.5	76.0
<i>Diapterus plumeri</i>	0.6319	73.5	73.5	81.7	88.0	82.9	73.5	73.5	73.5	73.5	73.5	82.2
<i>Eucinostomus harengulus</i>	0.0633	62.5	62.5	100.9	75.8	80.8	62.5	90.6	62.5	62.5	68.8	88.2
<i>Eucinostomus gula</i>	0.0042	69.0	83.1	69.0	93.8	76.5	69.0	97.3	69.0	69.0	98.1	69.0
<i>Eucinostomus spp.</i>	0.0001	149.2	91.3	70.5	85.2	80.0	155.0	70.5	107.5	70.5	70.5	73.3
<i>Floridichthys carpio</i>	0.0001	108.5	88.0	69.7	75.5	100.1	66.0	73.1	149.2	66.0	93.9	66.0
<i>Hippocampus zosterae</i>	0.0001	117.8	91.5	77.0	79.4	77.0	116.8	77.0	158.5	77.0	77.0	77.0
<i>Menidia peninsulae</i>	0.8268	79.0	79.0	79.0	81.4	83.9	79.0	79.0	79.0	79.0	86.4	79.0
<i>Mugil curema</i>	0.5652	76.0	83.1	88.0	78.4	85.8	76.0	82.3	76.0	76.0	76.0	76.0
<i>Poecilia latipinna</i>	0.0899	74.5	95.6	74.5	74.5	84.6	74.5	74.5	74.5	102.0	81.9	85.8
<i>Sardinella aurita</i>	0.1130	77.0	77.0	81.1	77.0	86.8	96.4	77.0	77.0	77.0	91.7	77.0
<i>Strongylura notata</i>	0.1177	79.5	79.5	79.5	79.5	81.9	79.5	91.9	79.5	79.5	79.5	79.5
<i>Syngnathus scovelli</i>	0.0001	115.5	105.3	76.0	80.6	78.5	76.0	76.0	117.8	76.0	83.2	76.0

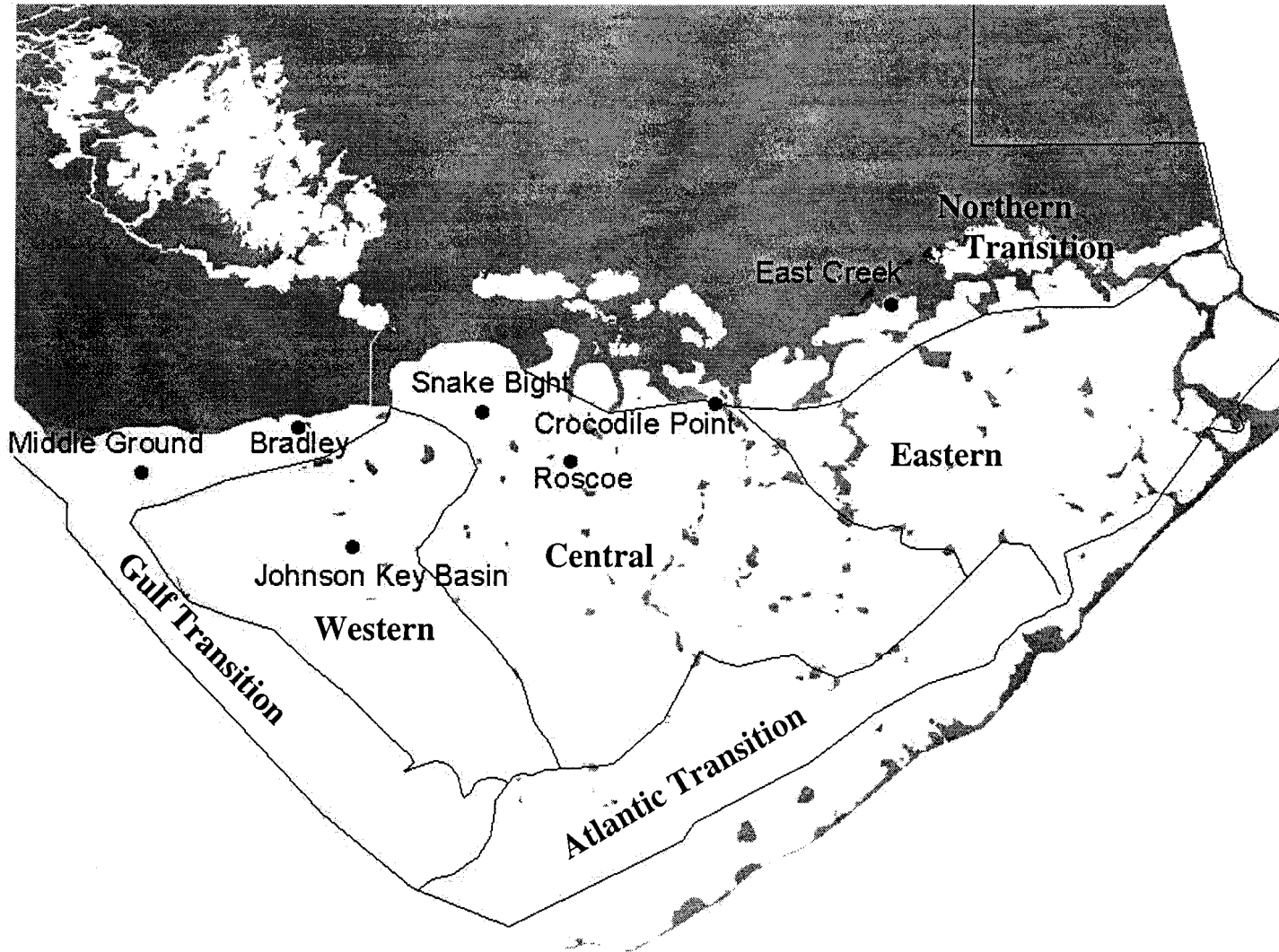


Figure 1. Epibenthic sled stations and Florida Bay Subdivisions.



Figure 2. Cast net stations. See Figure 1 for subdivision labels.

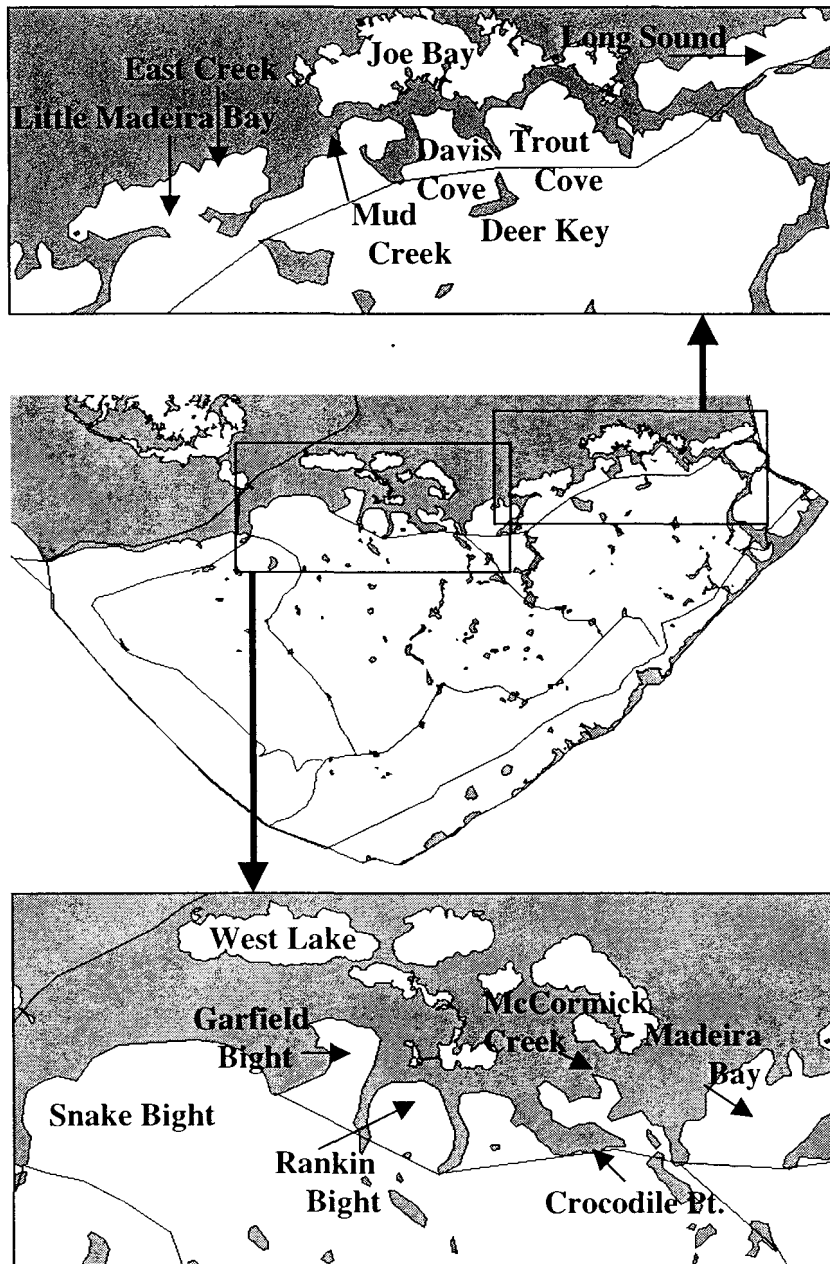


Figure 3. Geographic locations referred to in the text. See Figure 1 for subdivision labels.

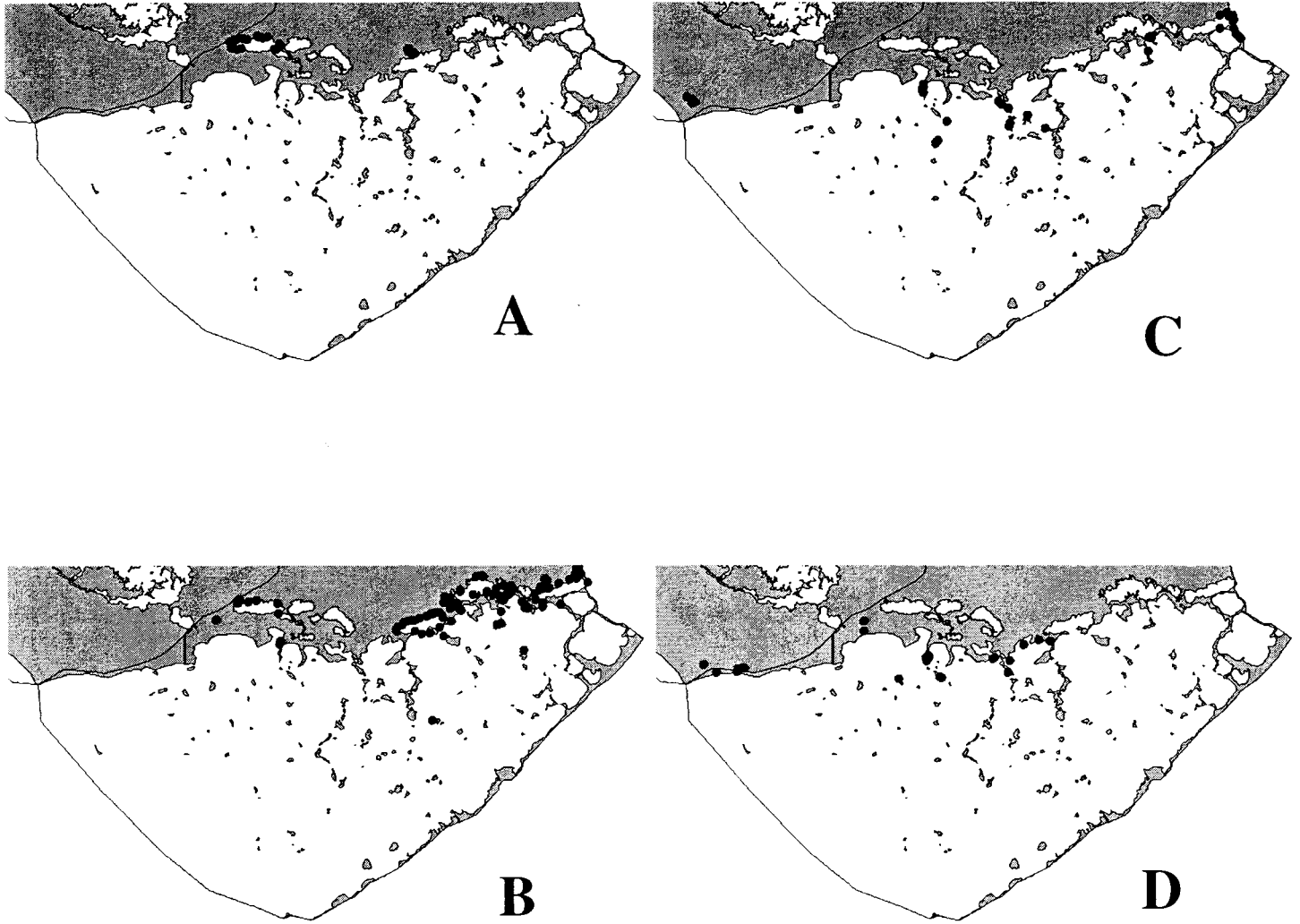


Figure 4. Cast net stations by salinity regime. A, Oligohaline; B, Mesohaline; C, Polyhaline; and D, Euhaline.

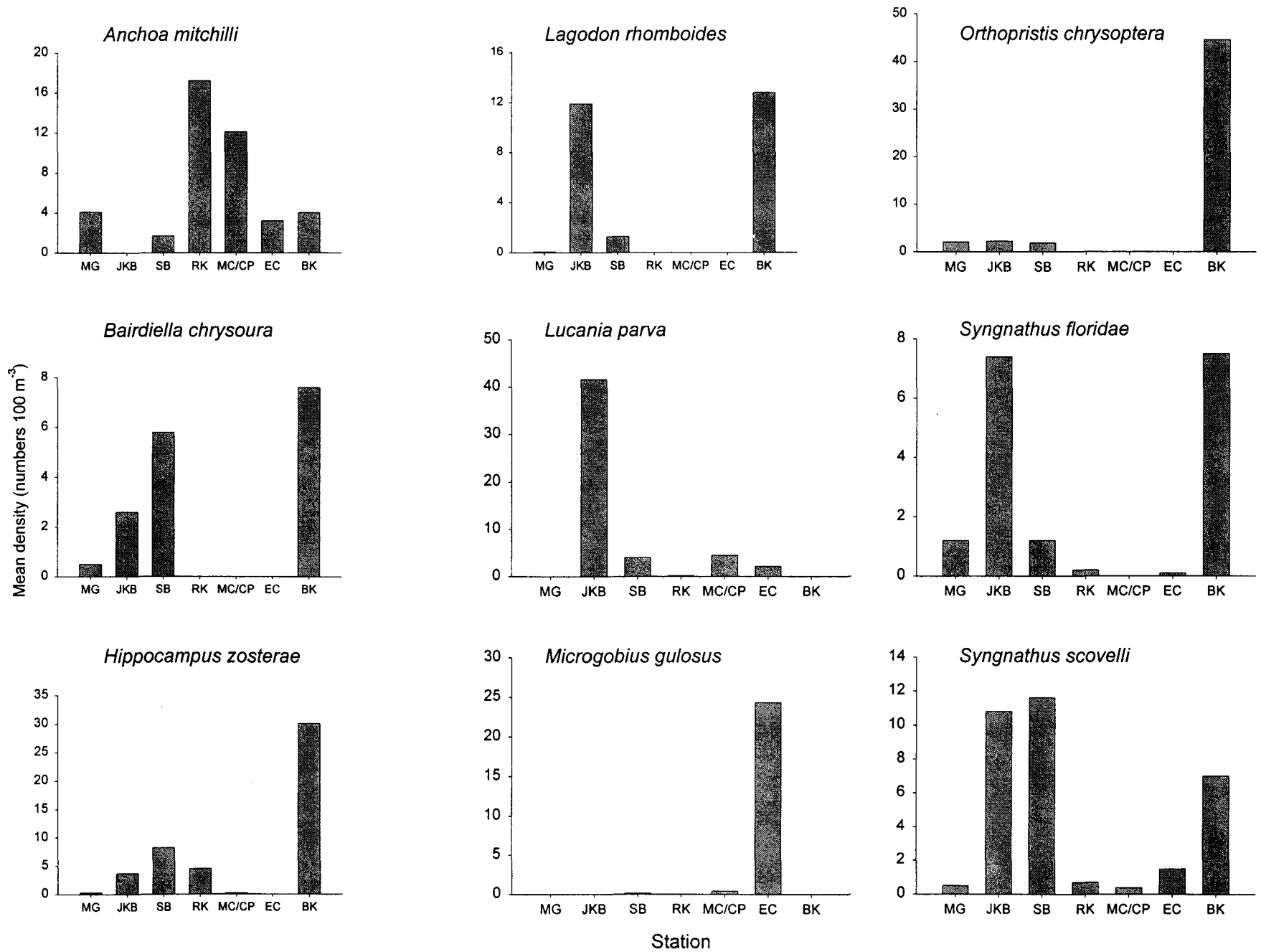


Figure 5. Abundance (number 100 m<sup>-3</sup>) of selected taxa collected with an epi-benthic sled at six stations.

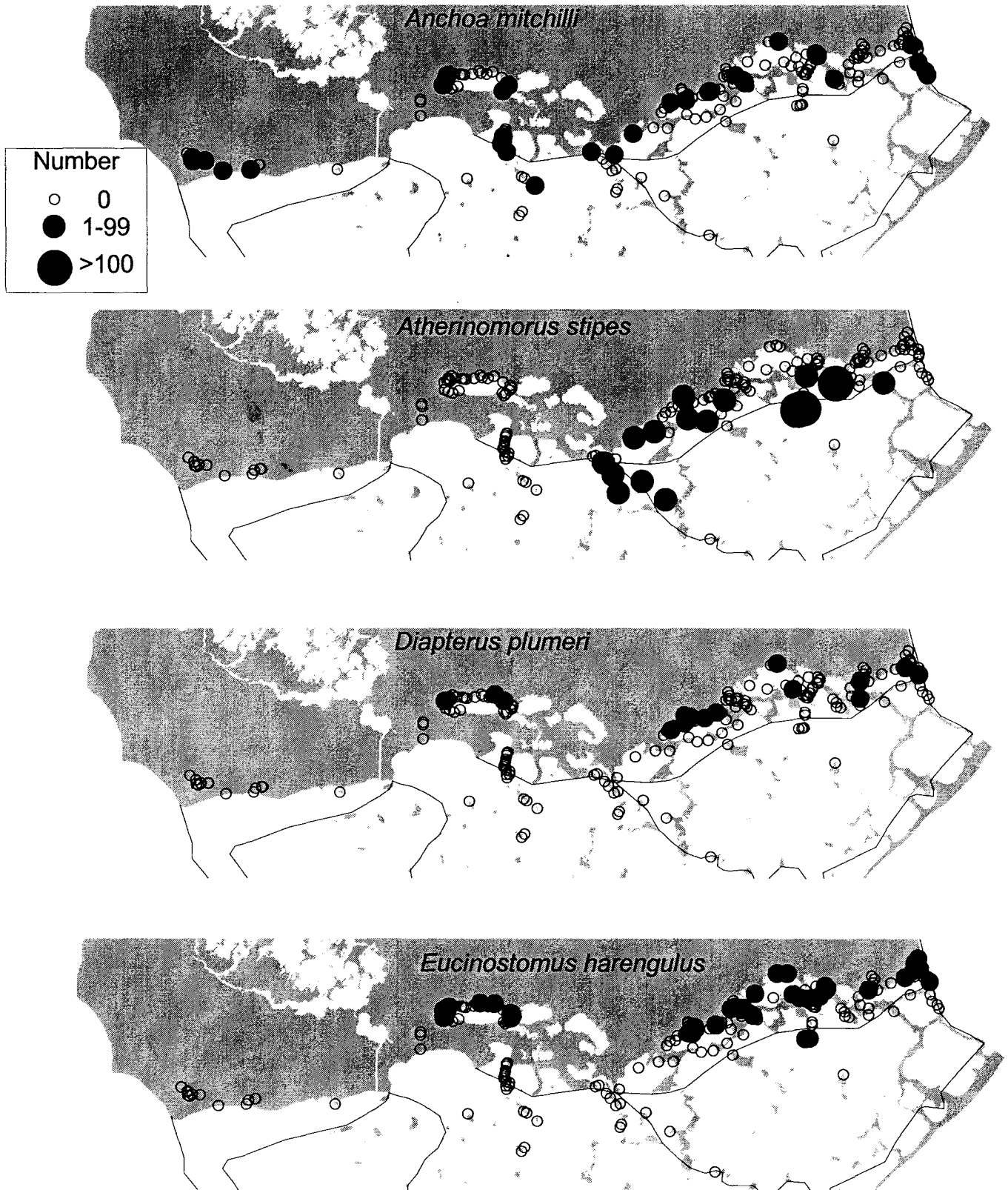


Figure 6. Numbers per cast net site of selected taxa. See Figure 1 for geographic locations.

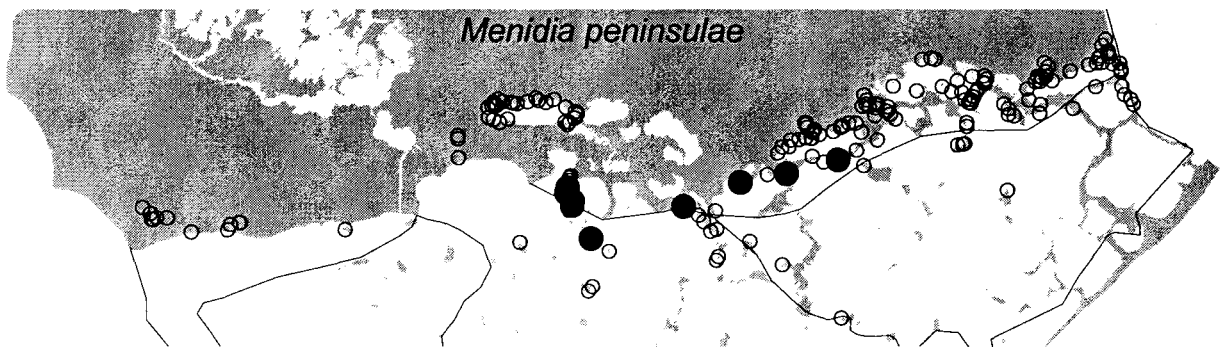
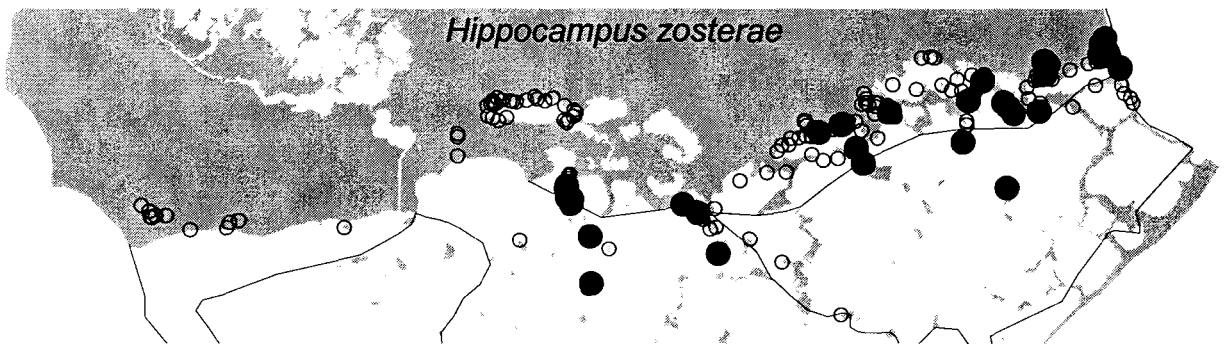
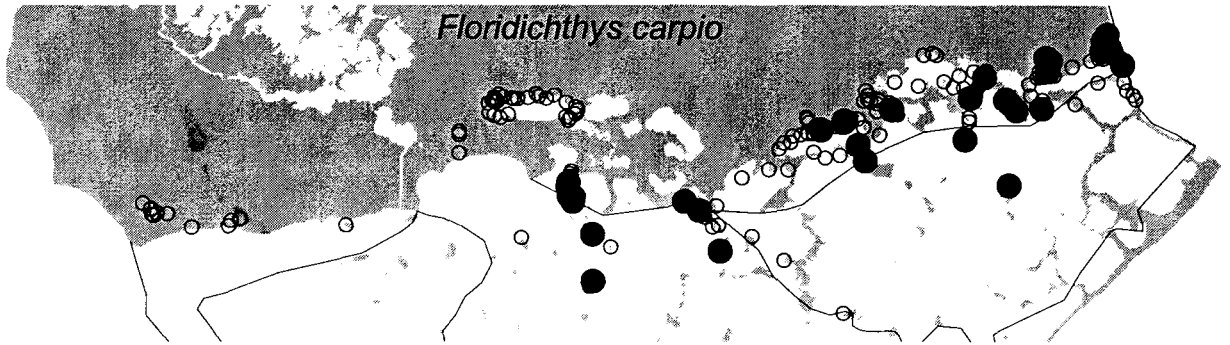
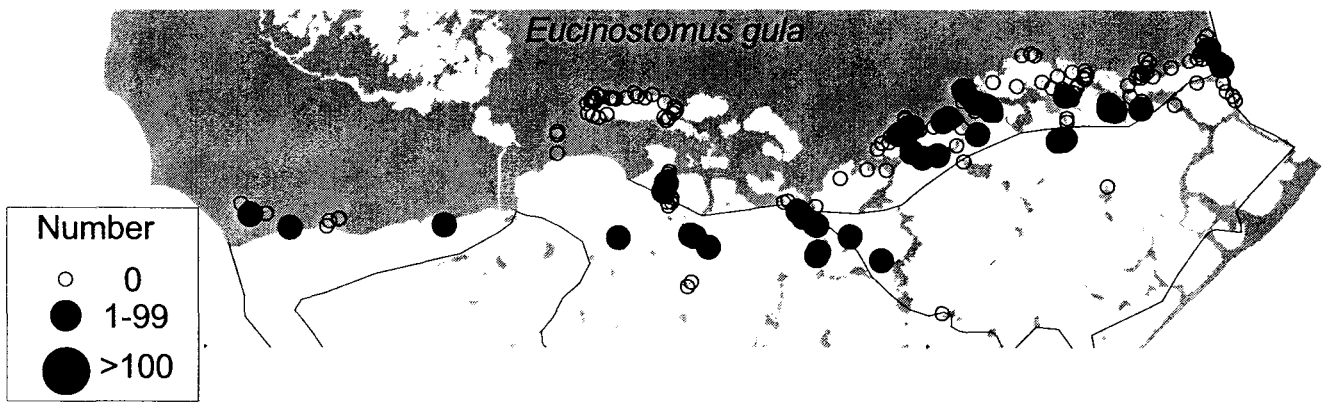


Figure 6 (continued).



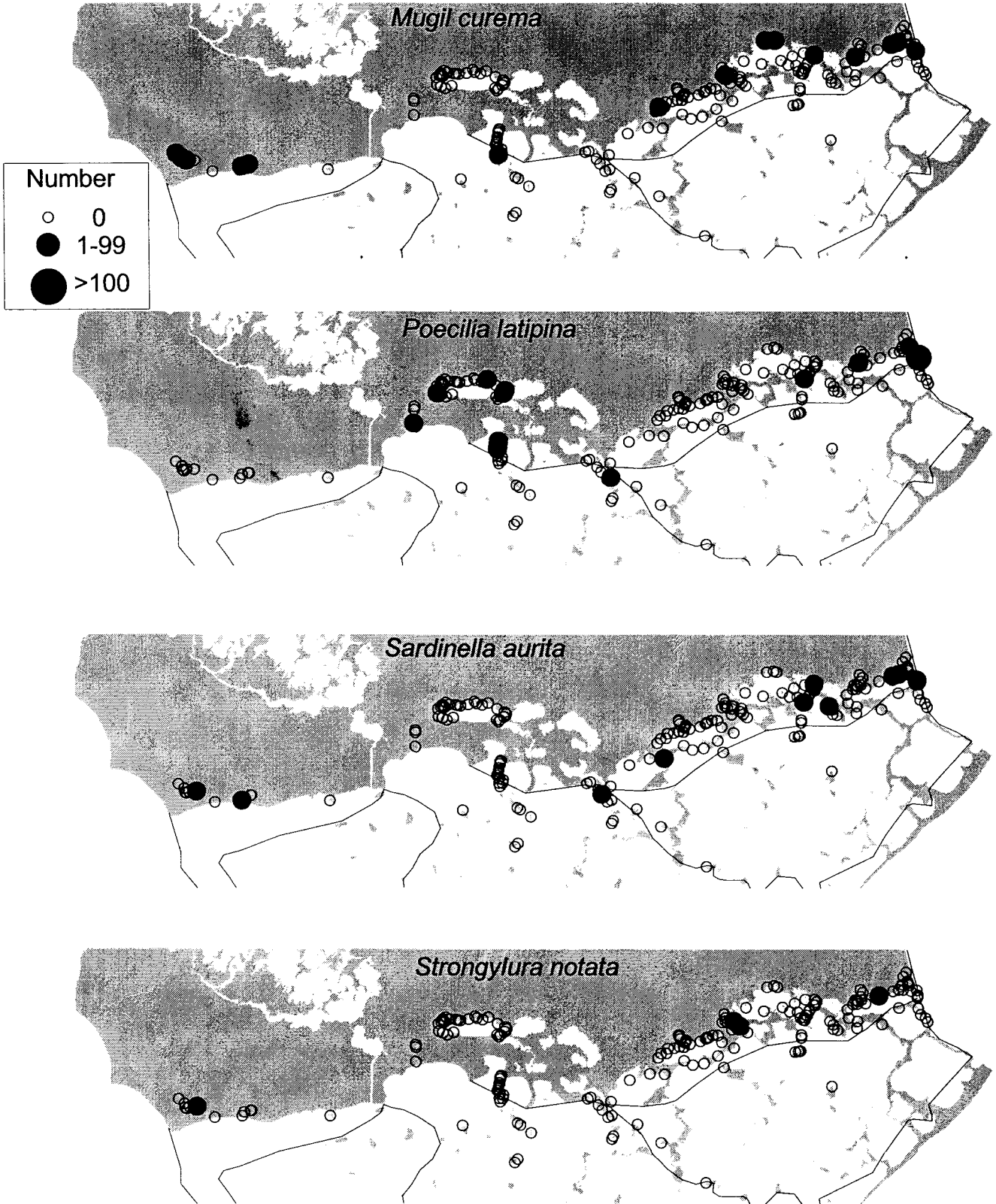


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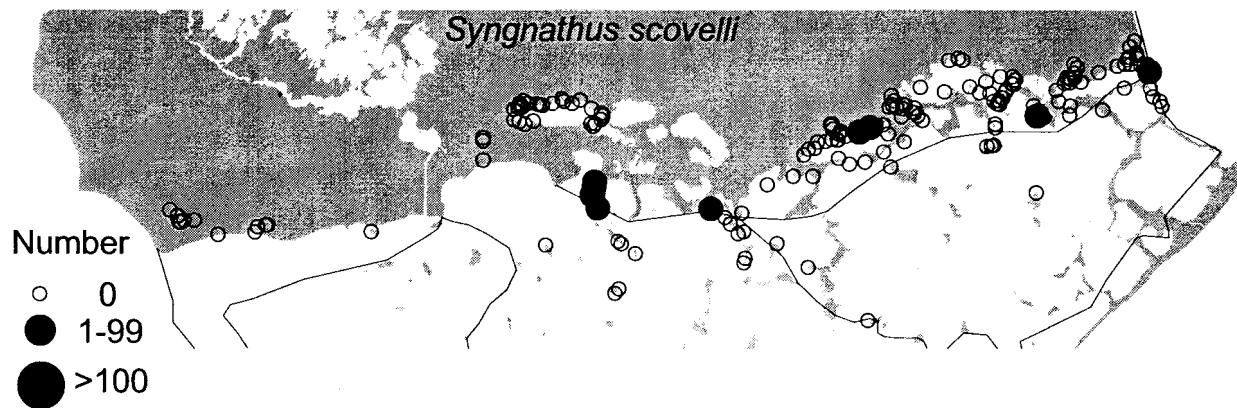


Figure 6 (continued).