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CHARACTERIZATION OF ICHTHYOPLANKTON IN THE NORTHEASTERN GULF OF MEXICO FROM SEAMAP PLANKTON SURVEYS, 1982—1999

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Abstract: Data for 61 selected ichthyoplankton taxa from 1,166 bongo and neuston net samples at 72 sites comprising the USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area were analyzed. These data were taken during annual spring and fall Southeast Area Monitoring and Assessment Program (SEAMAP) Gulfwide plankton surveys over the period 1982—1999. The UNIS study area contributed disproportionately more fish eggs, total larvae and net—caught zooplankton biomass to survey totals than would be expected from the number of samples taken in the study area. This pattern was more evident during spring than fall surveys and is probably related to the close proximity of UNIS study area stations to the Mississippi River and the inshore penetration of nutrient rich deep slope water via the DeSoto Canyon. Statistical comparison of the percent frequency of occurrence of the 61 selected taxa revealed that the larvae of many were taken significantly more often in the UNIS study area than expected based on their occurrence Gulfwide. Thirteen of these taxa were taken more often in the study area during the season and collecting gear combination that accounted for the highest catches. These taxa represented fishes from mesopelagic, continental shelf, and reef assemblages reflecting the wide diversity of habitats available in the northeastern Gulf of Mexico. Distinct distribution patterns were observed among larvae in the UNIS study area that appear to be associated with the presence of the DeSoto Canyon. The consistent presence of fish eggs throughout the UNIS study area at mean abundances exceeding 100 eggs under 10 m² sea surface indicates that this region of the Gulf of Mexico is an important spawning area.

Key Words: reef fishes, fish eggs, fish larvae, plankton displacement volume, DeSoto Canyon

Introduction

Hard—bottom and deep reef ecosystems in areas of hydrocarbon exploration and development in the northeastern Gulf of Mexico (NEGOM) have been the primary focus of integrated studies of fish communities of the outer continental shelf (OCS) by the U.S. Geological Survey (USGS)[1] under the Outer Continental Shelf Ecosystem Studies Program (Weaver et al. 1999, 2002, Sulak et al. 2000, Weaver and Sulak 2000, Gardner et al. 2001, Thurman et al. 2003). An ichthyoplankton component was added to these investigations in an attempt to address a fundamental deficiency in the knowledge of OCS ecosystems with the objective of assessing the composition, abundance, and geographic distribution patterns of fish eggs and larvae in the region. Of particular interest was acquisition of a baseline of knowledge on the larvae of fishes known to reside in OCS hard—bottom and deep—reef biotopes in order to better understand both zoogeographic and habitat factors determining demersal fish community structure and differentiation. Such baseline information may also prove valuable in assessing future anthropogenic impacts on the early life stages of fishes in areas of hydrocarbon exploration and development.

Previous studies of ichthyoplankton within the NEGOM region have detailed assemblage structure and seasonality, but were limited in duration (1—3 yr) and were conducted in adjoining but dissimilar habitats: Mississippi Sound and adjacent coastal waters (Rakocinski et al. 1996), Loop Current boundary in open Gulf of Mexico (GOM) waters (Richards et al. 1993), and the west Florida shelf southeast of Cape San Blas (Houde et al. 1979). The generalized description of seasonal occurrence, abundance and distribution of the early life stages of select taxa of fishes presented here is based on 1,166 ichthyoplankton samples collected during annual Southeast Area Monitoring and Assessment Program (SEAMAP; Rester et al. 2000) plankton surveys conducted by the National Marine Fisheries Service over the period 1982—1999. The objective of our study was to analyze SEAMAP ichthyoplankton data from 18 years of plankton surveys and, although not designed to elucidate biological/physical coupling and recruitment dynamics, the results presented here depict 'average conditions' for selected taxa in continental shelf and offshore waters of the NEGOM between the Mississippi River and Cape San Blas, Florida.

Materials and Methods

SEAMAP Surveys and Collections

The SEAMAP sampling area encompasses the northern GOM from the 10 m isobath out to the U.S. Exclusive Economic Zone (EEZ). Although about 300 sampling sites were initially proposed Gulfwide, only about 200 stations have been consistently targeted for sampling during SEAMAP sur-

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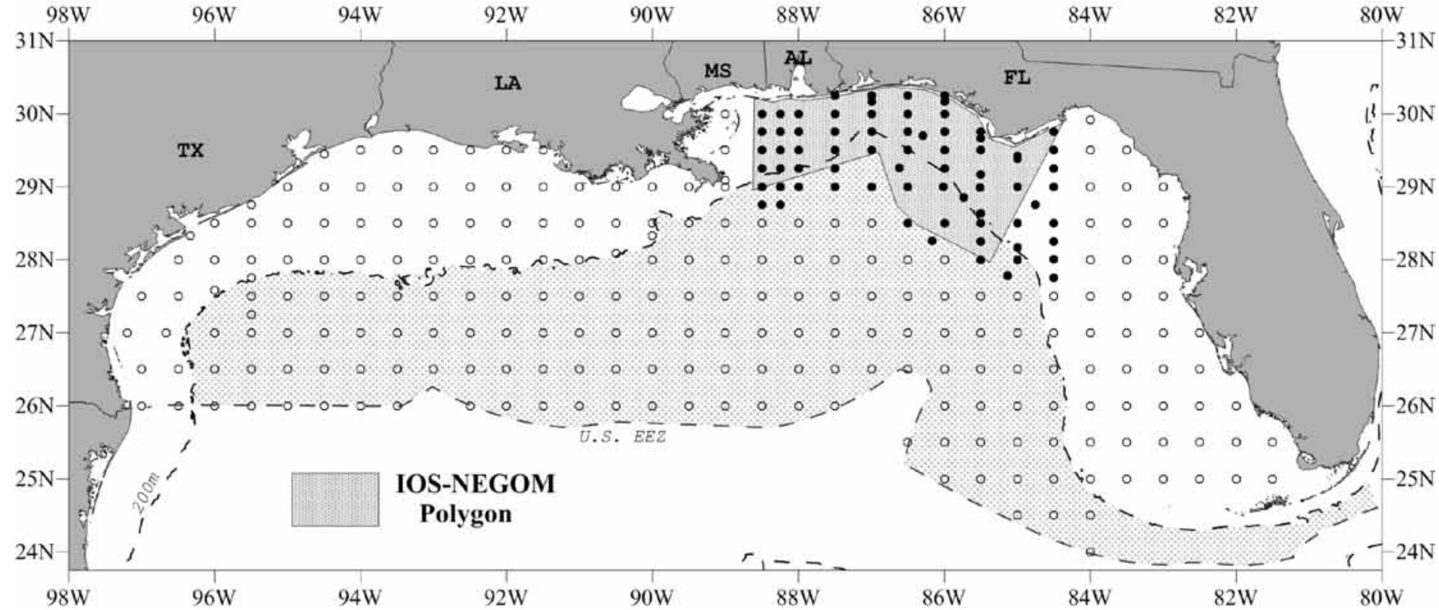

Figure 1. *Location of Southeast Area Monitoring and Assessment Program (SEAMAP) ichthyoplankton sampling sites in the Gulf of Mexico, 1982-1999 surveys (all circles). During fall, survey stations were generally located inside the 200 m isobath; during spring, survey stations were located outside the 200 m isobath (lighter shaded area). Survey stations located within the USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area (filled circles) extend outside of the Integrated Oceanographic Study - Northeastern Gulf of Mexico (IOS-NEGOM) polygon (darker shaded area). UNIS stations were sampled during fall and/or spring SEAMAP surveys. U.S. EEZ = United States Exclusive Economic Zone boundary.*

veys (Figure 1). A subset of 72 SEAMAP stations (fixed geographic locations) lying in and adjacent to the USGS study area or IOS—NEGOM (Integrated Oceanographic Study — northeastern Gulf of Mexico) research polygon was selected for analysis. This subset of sites identified by SEAMAP station number, and referred to hereafter as the UNIS (USGS NEGOM Ichthyoplankton Synopsis) study area is bounded to the east by longitude 84.5°W, and to the west by longitude 88.5°W. It extends from the 10 m isobath seaward to about the 1,000 m isobath (Figure 2).

Although SEAMAP plankton sampling in the GOM has been consistently conducted during 4 survey timeframes since 1982 (Lyczkowski—Shultz and Hanisko 2007), only surveys conducted in spring/early summer and late summer/early fall months covered the entire extent of the UNIS study area. Therefore, this characterization of ichthyoplankton in the UNIS study area is based on a subset of data from 32 SEAMAP plankton surveys conducted during the period 1982—1999 (Lyczkowski—Shultz et al. 2004). Two comparative areas and seasons were sampled: 1) the open GOM during April, May and June, 1982—1984 and 1986—1999, referred to hereafter as, the 'spring' survey, and 2) the continental shelf typically out to 200 m in August 1984 and September to early October, 1986—1999, referred to hereafter as the 'fall' survey.

The sampling gear and methodology used during SEAMAP surveys are similar to those recommended by Kramer et al. (1972), Smith and Richardson (1977) and Posgay and Marak (1980). A 61 cm bongo net fitted with 0.335 mm mesh netting was fished in an oblique tow path to a maximum depth of 200 m or to 2—5 m off the bottom at depths < 200 m. A mechanical flowmeter was mounted off—center in the mouth of each bongo net to record the volume of water filtered. Volumes filtered ranged from 22—555 m^3 but were typically 30—40 m^3 at the shallowest stations and 300—400 m^3 at the deepest stations in the UNIS study area. A single or double 2 x 1 m pipe frame neuston net fitted with 0.950 mm mesh netting was towed at the surface with the frame half—submerged for 10 min. The neuston net was not fitted with a flowmeter; therefore, filtered water volume was not measured for neuston samples. Samples were taken upon arrival on station regardless of time of day. The number of samples collected in daytime and nighttime hours was about equal during both seasons surveyed over the time period represented by this study. At each station, either a bongo and/or neuston tow was made depending on the specific survey.

Environmental data consistently gathered during SEAMAP surveys include salinity (psu), temperature (°C), dissolved oxygen (mg/L), and since ca. 1993 optical transmission (%) and fluorescence (µg/l) (see Rester et al. 2000 for complete description). Although not presented here, SEAMAP environmental data are available upon request from the SEAMAP Data Manager[2].

Most SEAMAP stations were located at 30 nautical

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mile or 0.5° (~56 km) intervals in a fixed, systematic grid of transects across the GOM. Occasionally during surveys, samples were moved to avoid navigational hazards or were taken at non–standard locations or stations. This was especially true during Oregon II cruise 146 in August 1984 when additional samples were taken at locations between standard SEAMAP stations. These stations are denoted with the prefix 'U' as opposed to the prefix 'B' or 'A' for standard SEAMAP stations in Figure 2. Data from these stations were also included in the analysis. At each station either a bongo

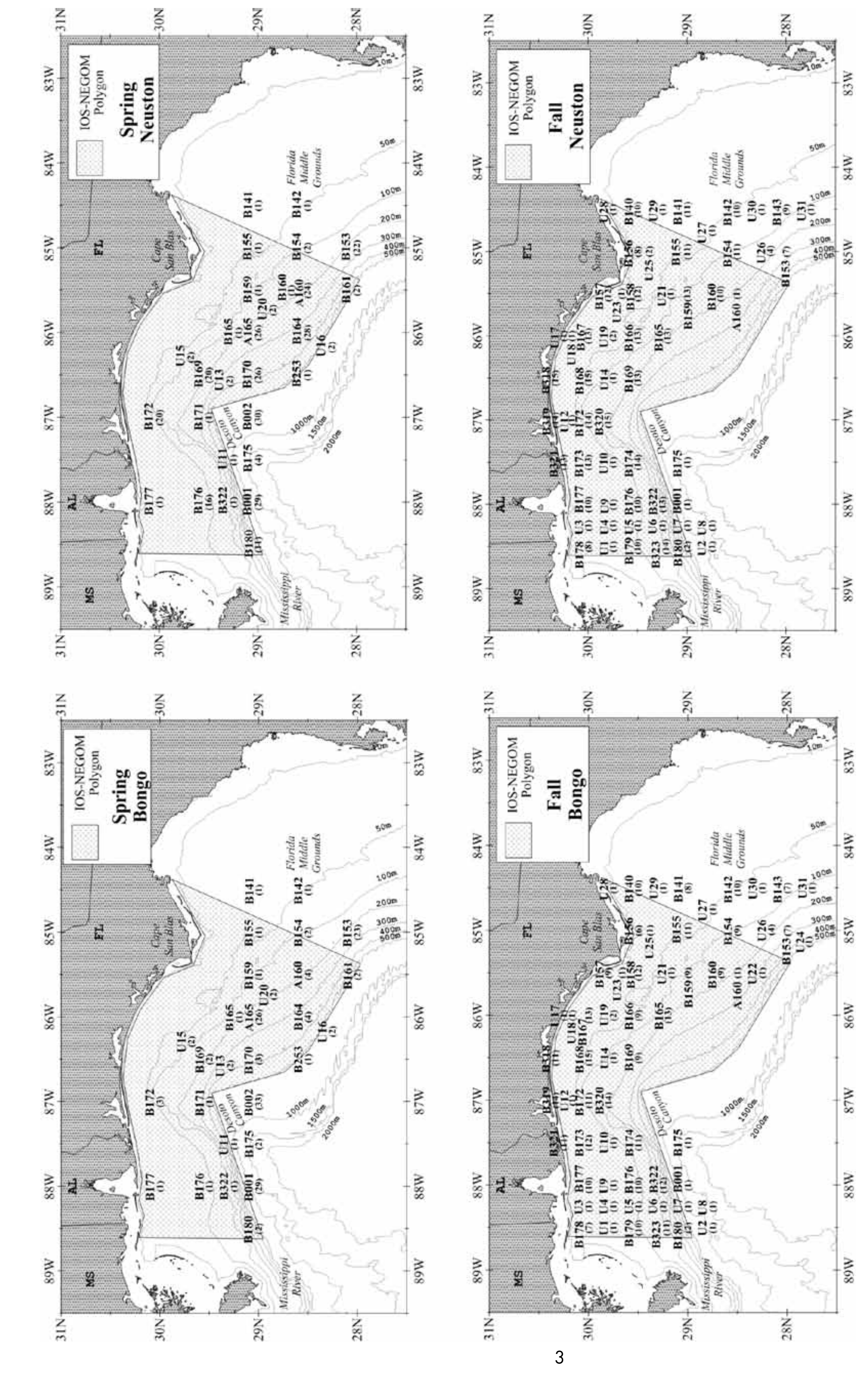

Figure 2. *Location of the 72 unique sampling sites comprising the UNIS Study area, including the smaller Integrated Oceanographic Study - Northeastern Gulf of Mexico (IOS-NEGOM) polygon (shaded), where ichthyoplankton samples were collected during SEAMAP plankton surveys over the period 1982-1999. Station identifier and the number of samples collected (in parenthesis) at that site are shown for each of the 2 seasons sampled (spring and fall) and each of the 2 plankton gear types (bongo and neuston) used during plankton surveys. UNIS and SEAMAP defined in Figure 1.*

and/or neuston tow was conducted depending on the specific survey. During spring surveys, bongo tows were made only at every other station and the targeted survey stations were sampled twice, i.e. 2 transits over the survey station grid were completed. However, only a single transit over the targeted survey area was completed during fall surveys. This accounts for the differences in total number of samples collected over the time series at stations in the study area during spring and fall surveys (Figure 2).

Of the 72 stations representing the UNIS study area, 12 were sampled only during spring surveys, 43 only during fall surveys, and 17 during both survey types. There was 35—40% overlap in spatial coverage during spring and fall surveys (Figure 2). Most spring survey sampling sites were located seaward of the 50 m isobath, whereas more than half of fall sites were located shoreward of the 50 m isobath. A detailed listing of the SEAMAP surveys, sampling dates, station positions and station depths that provided ichthyoplankton data presented here can be found in Lyczkowski—Shultz et al. (2004; http://fl.biology.usgs.gov/coastaleco).

Sample Processing and Ichthyoplankton Identifications

Initial processing of SEAMAP plankton samples was accomplished at the Sea Fisheries Institute, Plankton Sorting and Identification Center, in Szczecin, Poland, under a Joint Studies Agreement with NMFS. Wet plankton volumes of bongo net samples were measured by displacement to estimate net—caught zooplankton biomass (Smith and Richardson 1977). Fish eggs and larvae were removed from bongo net samples, and fish larvae only from neuston net samples. Fish egg counts were not quantitative for some samples during the early years of the SEAMAP time series. These samples were not used in calculations of mean egg abundance and this accounts for differences in the number of samples used to calculate mean egg and larval abundances that are presented here. Larvae were identified to the lowest possible taxon (to family in most cases). Body length (BL) in mm (either notochord or standard length) was measured for a varying number (2 to all specimens) depending on the taxonomic level of identification. Typically, all or up to 10 specimens were measured for larvae identified to species and in some instances genus. Only size range (i.e., size of the largest and smallest specimens) was recorded for larvae identified to family and higher levels. Mean length and/or length range are presented here as appropriate for the taxonomic level of identification. However, both mean length and range are summarized for 16 taxa of reef fishes regardless of taxonomic level of identification. For those 16 taxa, mean length was based only on samples where all captured specimens were measured. Vials of eggs and identified larvae, plankton displacement volume values, total egg counts, and counts and length measurements of identified larvae were sent to the SEAMAP Archive (SAC) at the Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute (formerly the Florida Marine Research Institute), St. Petersburg, FL. All data have been entered into the SEAMAP database that is maintained at the NMFS Mississippi Laboratories, Pascagoula Facility in Pascagoula, MS. Voucher specimens are curated at SAC, and are available on loan for scientific study and reference.

The majority of specimens collected in SEAMAP plankton samples and maintained at the Archive have been identified only to the family level. This is not unexpected since up until the recent publication of an identification guide to the early life stages of fishes in the western central Atlantic (Richards 2006), the larvae of only 27% of the ~ 1,800 species of marine fishes occurring in the western central Atlantic region (including the GOM) had been described (Kendall and Matarese 1994). Identification of larvae to the family level, however, is possible for over two—thirds of the families of marine fishes (Ahlstrom and Moser 1981; Richards 1990, 2006).

We summarized data for only a limited number of taxa due to the limitations of larval fish identifications in the taxonomically rich GOM. Moreover, the large number of specimens available from SEAMAP surveys (>100,000 at the time this analysis was undertaken) made it impractical to re—examine specimens using newly available descriptive information. Therefore, only larvae of 61 taxa, representing 34 families of fishes, were chosen for analysis because their larvae are distinctive and can be identified with confidence to family, subfamily, genus, or species (Table 1). Also, in the case of the tunas (from spring survey samples), mackerels and snappers (both spring and fall samples), most specimens have been re—examined and, as necessary, re—identified by NMFS ichthyoplankton experts prior to use of larval abundance data in stock assessments.

Taxa selected for treatment herein were chosen using these criteria: 1) larvae could be reliably identified throughout the time series; 2) larvae had been re—examined to validate identifications; and 3) larvae were identified as belonging to selected families considered as being consistently associated with reef environments (Sale 1991). Although identification of larvae in these latter families [Holocentridae, Serranidae (in part), Priacanthidae, Apogonidae, Haemulidae, Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae, Scaridae, and Acanthuridae] remains problematic, adults in these taxa often comprise key members of OCS hard—bottom and deep—reef communities in the NEGOM.

This subset of taxa chosen for analysis of ichthyoplankton in the UNIS study area represents the wide diversity of the NEGOM ichthyofauna and includes both key ecological and resource species. These taxa are representative of the tropical and warm temperate epipelagic, mesopelagic, coastal shelf and demersal (including reef), and pelagic species found in the northern GOM (Richards et al. 1993).

Data Summaries and Comparisons

Catches of total fish eggs, total fish larvae and larvae of selected taxa in bongo net samples were standardized to account for sampling effort and expressed as number under 10 m^2 sea surface by dividing the number of eggs or larvae by volume filtered and then multiplying the resultant by the product of 10 and maximum depth of tow. This standardization results in a less biased estimate of abundance than number per unit of volume filtered alone and permits direct comparison of abundance estimates across samples taken over a wide range of water column depths (Smith and Richardson 1977). Plankton displacement volumes from bongo nets were standardized using the same methodology as for fish eggs and larvae but are expressed as cc per 10 m^2 sea surface. Standardized catches or catch per unit effort (CPUE) of total fish larvae and larvae of selected taxa taken in neuston samples were expressed as number/10 min tow. Standardized catches of total fish larvae include all taxa taken in a sample and not just those selected for detailed analysis.

Mean values at UNIS stations for bongo and neuston nets

TABLE 1. *Catch data for 61 selected fish taxa analyzed from the USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area. Data include number of occurrences (Occ.) and the number of specimens collected in bongo and neuston samples during Southeast Area Monitoring and Assessment Program (SEAMAP) spring and fall plankton surveys over the period 1982–1999. Reef–associated species and higher taxa that include characteristically reef–associated species are denoted in bold. n = number of samples*

			Sampling Gear				**Survey**			
			Bongo n = 499		**Neuston n = 667**		**Spring n = 433**		**Fall n = 733**	
Taxon	**Total Occ.**	**Total Number Specimens**	**Occ.**	**Number Specimens**	**Occ.**	**Number Specimens**	**Occ.**	**Number Specimens**	**Occ.**	**Number Specimens**
Elopidae	7	16	3	5	4	11	0	0	7	16
Muraenidae	83	188	23	29	60	159	12	21	71	167
Engraulidae	573	40732	283	15345	290	25387	97	3100	476	37632
Clupeidae										
Etrumeus teres	56	1306	31	354	25	952	53	1303	3	3
Harengula jaguana	137	3909	30	140	107	3769	47	2440	90	1469
Opisthonema oglinum	89	1163	50	794	39	369	10	223	79	940
Sardinella aurita	148	4360	67	1616	81	2744	8	35	140	4325
Sternoptychidae	210	3533	204	3411	6	122	122	2310	88	1223
Synodontidae	501	7229	360	6497	141	732	140	1253	361	5976
Paralepididae	215	1053	196	1028	19	25	130	775	85	278
Carapidae	22	62	21	61	1	1	5	6	17	56
Carapus bermudensis	68	210	38	210	0	0	8	11	60	199
Bregmacerotidae	441	9918	371	9474	70	444	182	2933	259	6985
Mugilidae	154	1669	15	36	139	1633	144	1647	10	22
Melamphaidae	58	90	51	82	7	8	41	66	17	24
Holocentridae	23	34	5	5	18	29	10	17	13	17
Serranidae	320	1415	263	1272	57	143	88	317	232	1098
Serraninae	236	1672	150	1118	86	554	54	235	182	1437
Anthiinae	72	182	56	126	16	56	43	112	29	70
Epinephelinae	3	5	3	5	0	0	3	5	0	0
Grammistinae	117	215	78	143	39	72	17	41	100	174
Priacanthidae	109	239	55	102	54	137	18	57	91	182
Apogonidae	169	579	98	342	71	237	58	175	111	404
Rachycentridae										
Rachycentron canadum	5	21	0	0	5	21	3	17	2	4
Coryphaenidae	187	438	27	37	160	401	109	281	78	157
Carangidae										
Caranx spp.	183	1449	37	91	146	1358	90	812	93	637
Chloroscombrus chyrsurus	206	14916	98	1217	108	13699	1	8	205	2908
Decapturus spp.	479	7101	226	3832	253	3269	60	397	419	6704
Selar crumenophthalmus	99	710	54	122	45	588	4	4	95	706
Selene spp.	34	53	17	28	17	25	0	0	34	53
***Seriola* spp.**	123	461	8	12	115	449	80	385	43	76
Trachinotus spp.	46	85	0	0	46	85	32	60	14	25
Trachurus lathami	16	61	6	17	10	44	16	61	0	0
Lutjanidae	190	728	162	668	28	60	8	8	182	720
Lutjanus spp.	34	64	18	23	16	41	0	0	34	64

TABLE 1. *Continued*

Taxon	Total Occ.	Total Number Specimens	Sampling Gear: Bongo n = 499 Occ.	Bongo Number Specimens	Neuston n = 667 Occ.	Neuston Number Specimens	Survey: Spring n = 433 Occ.	Spring Number Specimens	Fall n = 733 Occ.	Fall Number Specimens
Lutjanus campechanus	33	71	10	14	23	57	1	2	32	69
Lutjanus griseus	9	9	6	6	3	3	1	1	8	8
Pristipomoides aquilonaris	74	208	51	124	23	84	5	6	69	202
Rhomboplites aurorubens	174	644	114	318	60	326	4	21	170	623
Lobotidae										
Lobotes surinamensis	23	39	0	0	23	39	2	2	21	37
Haemulidae	10	139	7	136	3	3	2	2	8	137
Sciaenidae										
Cynoscion spp.	64	515	42	412	22	103	4	19	60	496
Sciaenops ocellatus	48	351	32	243	16	108	0	0	48	351
Mullidae	268	19855	31	91	237	19764	241	19651	27	204
Chaetodontidae	11	12	4	5	7	7	2	2	9	10
Pomacanthidae	6	7	2	3	4	4	4	4	2	3
Pomacentridae	63	166	33	90	30	76	16	82	47	84
Labridae	358	3420	288	3180	70	240	50	165	308	3255
Scaridae	113	369	90	331	23	38	28	39	85	330
Acanthuridae	4	5	2	2	2	3	3	4	1	1
Trichiuridae										
Trichiurus lepturus	82	260	69	222	13	38	16	62	66	198
Scombridae										
Acanthocybium solandri	2	2	2	2	0	0	0	0	2	2
Katsuwonus pelamis	63	136	36	60	27	76	34	66	29	70
Scomberomorus cavalla	87	143	44	55	43	88	0	0	87	143
Scomberomorus maculatus	39	144	19	39	20	105	12	85	27	59
Thunnus spp.	165	712	76	186	89	526	45	209	120	503
Thunnus thynnus	26	136	7	13	19	123	26	136	0	0
Xiphiidae										
Xiphias gladius	3	4	0	0	3	4	3	4	0	0
Istiophoridae	38	78	4	7	34	71	13	27	25	51
Stromateidae										
Peprilus alepidotus	51	181	36	136	15	45	1	1	50	180
Peprilus burti	115	813	92	721	23	92	8	20	107	793

by survey (spring and fall plankton) were based on all samples collected at each sampling site during surveys over the period 1982—1999. Mean values of the aforementioned data categories (total eggs, total fish larvae, plankton sample displacement volume, and taxon—specific standardized catches) are represented on distribution maps (Figures 3—62). Mean abundance values for each selected taxon by area, season and gear combination are not directly reported here, but, these values can be calculated from the information found in Tables 2 and 4[3].

The percent frequency of occurrence for each taxon, gear and season combination was tested to determine if the UNIS study area value was significantly higher or lower than the expected value from Gulfwide sampling. Comparisons were carried out using a one sample binomial test for proportions ($p < 0.05$) utilizing the FREQ procedure in SAS (Version 9.3 of the SAS System for Windows). All comparisons were one sided based on whether the difference between the study area and Gulfwide values were less than or greater than zero. Comparisons were only carried out for combinations in which a taxon occurred in both the study area and Gulfwide samples. All p—values for percent frequency are presented in Table 3.

Direct comparison of ichthyoplankton abundance in the UNIS study area to the entire survey area Gulfwide is problematic due the zero—inflated nature of ichthyoplankton data, and the large difference between the 2 areas in number

[3]Mean abundance or CPUE is equal to the percent of total abundance (PTA) or percent of total CPUE (PTC) from Table 4 divided by 100 then multiplied by the total standardized abundance or CPUE in Table 2 and divided by the number of samples in Table 4 for the appropriate area, season and gear combination. Due to rounding of data presented in the tables, the calculated values will be approximate but very close to mean values calculated from the actual samples.

of samples collected (1,166 vs. 7,100, respectively). In order to overcome this difficulty, comparisons were made using metrics based on the percent of total standardized abundance or CPUE. Comparisons between the UNIS study area and Gulfwide sampling for fish eggs, total fish larvae (all taxa combined) and total standardized plankton displacement

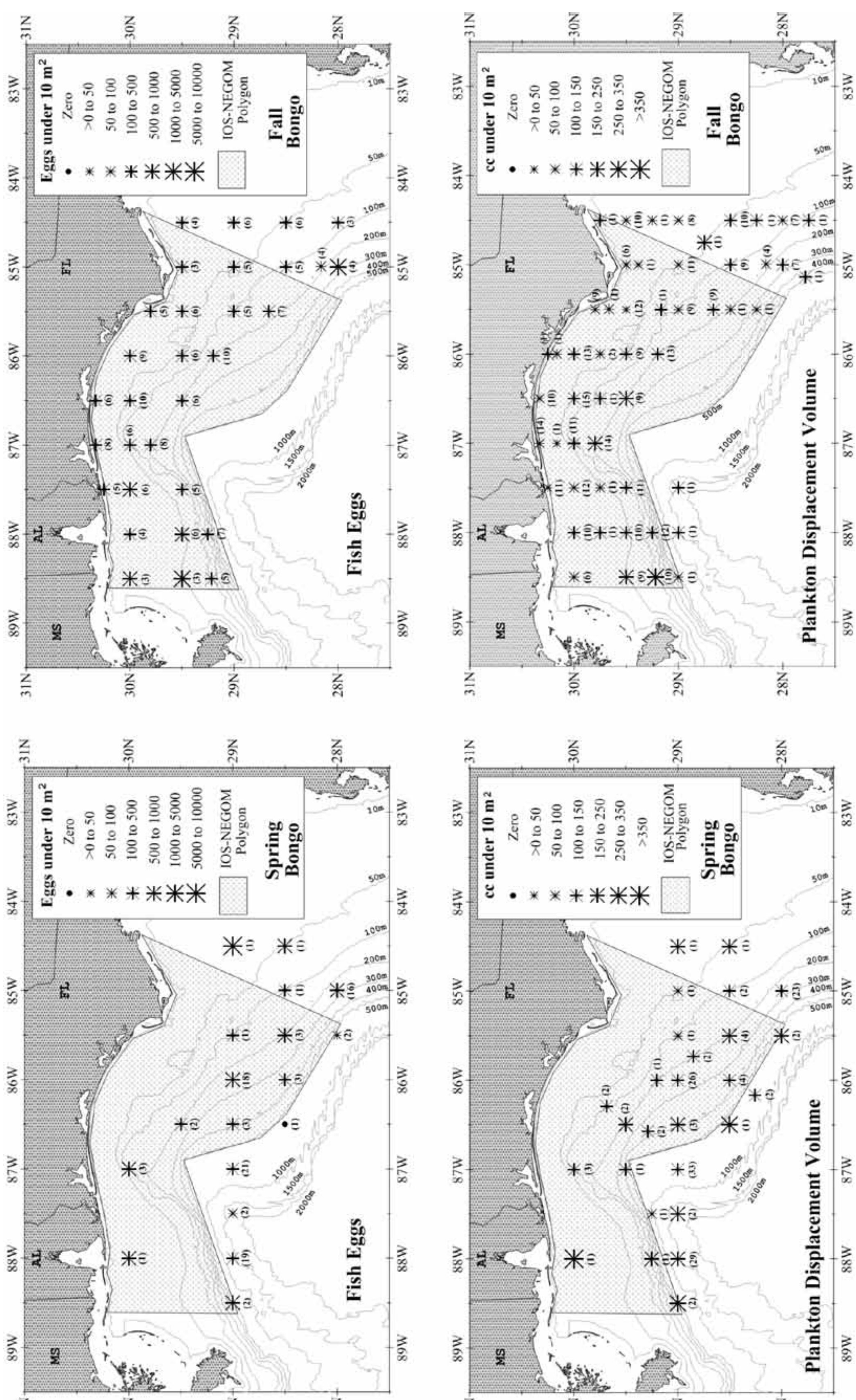

Figure 3. *Mean abundance of fish eggs and mean plankton displacement volumes at UNIS study area stations during SEAMAP spring and fall plankton surveys, 1982-1999. Number of bongo samples used to calculate mean values is in parenthesis. UNIS and SEAMAP defined in Figure 1.*

TABLE 2. *The number of USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area samples, total standardized abundance or CPUE of fish eggs and total fish larvae, and total standardized plankton displacement volumes expressed as a percent of the corresponding totals from Gulfwide sampling during SEAMAP spring and fall plankton surveys over the period, 1982-1999.*

	Number of Samples			Total Standardized Abundance or CPUE		
	UNIS	**Gulfwide**	**% UNIS/Gulfwide**	**UNIS**	**Gulfwide**	**% UNIS/Gulfwide**
Fish Eggs						
Spring Bongo	100	939	11	46,658.50	225,138.8	21
Fall Bongo	176	836	21	71,708.20	354,986.8	20
Total Larvae						
Spring Bongo	154	1,453	11	208,493.91	1,328,800.6	16
Spring Neuston	279	2,290	12	41,242.82	194,334.1	21
Fall Bongo	345	1,591	22	399,675.54	199,8674.1	20
Fall Neuston	388	1,766	22	56,908.48	356,974.1	16
Displacement Volume						
Spring Bongo	153	1,449	11	22,803.16	180,899.6	13
Fall Bongo	332	1,549	21	36,962.87	130,575.6	28

volumes were made based on the ratio of the UNIS study area total divided by the Gulfwide total and then multiplied by 100 (% UNIS/Gulfwide). Comparisons of the relative abundances of the selected taxa were made using the percent of total abundance (PTA) for bongo samples, and percent of total CPUE (PTC) for neuston samples. PTA and PTC were calculated by taking the total standardized abundance of an individual taxon and dividing it by the total standardized abundance of total fish larvae and multiplying by 100. The PTA/PTC metrics were calculated for each study area, season and gear combination.

Results and Discussion

Survey Summary Information

Over 7,000 plankton samples were taken during 17 spring (April, May and June) and 15 fall (August, September to early October) SEAMAP Gulfwide plankton surveys. A subset of 1,166 of these samples (499 bongo and 667 neuston samples) from these surveys were used to characterize ichthyoplankton in the UNIS study area (Figure 1, Table 2).

No attempt was made to identify fish eggs from SEAMAP samples as identification to even the family level is exceedingly difficult especially in bodies of water with high diversity such as the GOM. Fish eggs were present in bongo samples throughout the UNIS study area (Figure 3). Mean egg abundances at localities where the number of samples (n) sorted for eggs was > 1 generally ranged between 120—600 in the spring and 200—400 in the fall. Mean (± se) abundance from spring surveys was 467 ± 76 (n = 100), and from fall surveys 407 ± 35 (n = 176) eggs/10 m^2. The number of samples sorted for fish eggs in the UNIS study area represented 11% of the total number of samples with egg counts for all spring survey samples, yet the total standardized abundance of fish eggs in the UNIS study area accounted for 21% of the Gulfwide total (Table 2). Total standardized abundance of fish eggs in the UNIS study area during fall surveys reflected the proportion of total survey samples taken in the area, about 20%.

Mean plankton displacement volume for all stations in the UNIS study area combined was higher in spring, 149 ± 7 (n = 153) than in fall, 111 ± 4 (n = 332) cc/10 m^2 (Figure 3). Mean displacement volumes > 150 cc/10 m^2 in spring and > 100 cc/10 m^2 in fall were observed throughout the study area. During both spring and fall surveys, the contribution of UNIS study area samples to the sum of standardized plankton displacement volumes Gulfwide was proportionately higher than would be expected based on the allocation of samples in the area (Table 2). During spring surveys, the study area accounted for only 11% of the total number of survey samples but the total standardized plankton displacement volumes of these samples accounted for 13% of the entire spring survey total. During fall surveys, the study area contributed 21% of the total number of survey samples but total standardized plankton displacement volume of these samples accounted for 28% of the entire fall survey total.

Fish larvae were taken in each of the 499 bongo net collections and in all but 2 of the 667 neuston net collections in the UNIS study area. Overall mean abundance of total fish larvae (all taxa combined) from the two seasons were similar; 1354 ± 80 (n = 154) and 1158 ± 54 (n = 345) larvae under 10 m^2, and 148 ± 33 (n = 279) and 147 ± 19 (n = 388) larvae/10 min tow, in spring and fall surveys, respectively. Mean abundances of total fish larvae in bongo net samples at stations where the number of samples (n) was > 1 ranged from 529—2745 and 302—2239 larvae under 10 m^2 during spring and fall surveys, respectively. Mean abundances of total fish larvae in neuston collections at stations where n > 1 ranged from 43—571 and 27—1140 larvae/10 min tow in spring and fall surveys, respectively. Mean abundances of total fish larvae were relatively uniform throughout the area especially where estimates were based on more than 5 samples (Figure 4).

The relative contribution of UNIS study area samples to the overall standardized abundance of total fish larvae differed somewhat between the 2 seasonal surveys (Table 2). In spring, the total catch of all fish larvae captured by bongo nets in the UNIS study area was 5% higher than Gulfwide,

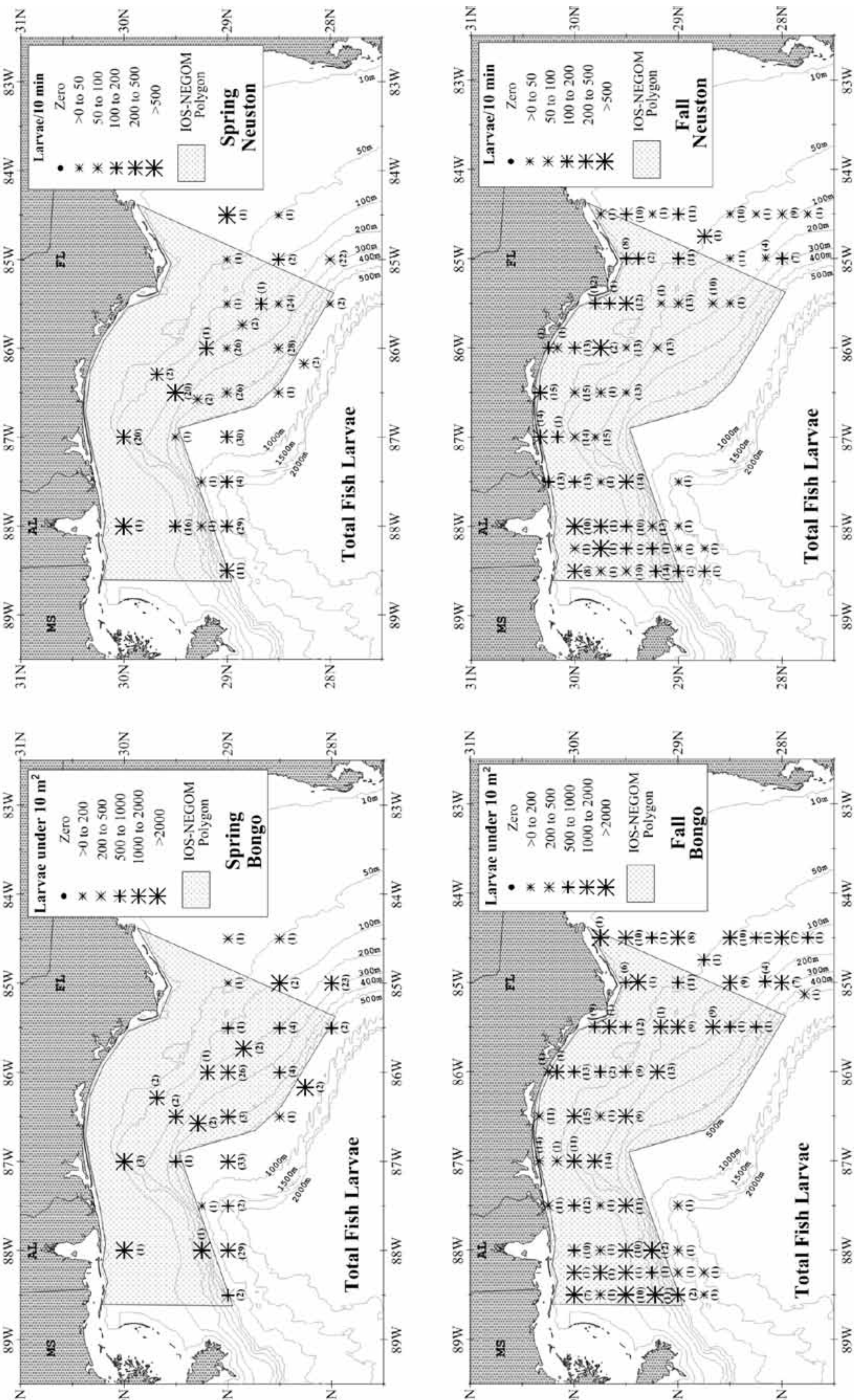

Figure 4. *Mean abundance and mean CPUE of total fish larvae (all taxa combined) collected in spring and fall, bongo and neuston samples at UNIS study area stations during SEAMAP plankton surveys, 1982-1999. Number of samples used to calculate mean values is indicated in parenthesis. UNIS and SEAMAP defined in Figure 1.*

TABLE 3. *Summary of a one sided, binomial test (α = 0.05) for proportions on the percent frequency of occurrence of 61 select ichthyoplankton taxa captured in USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area samples alone and in all Gulfwide (GOM) survey samples combined during SEAMAP spring and fall plankton surveys over the period 1982-1999. FO = frequency of occurrence. Diff. = UNIS %FO minus GOM %FO. n = number of samples. p–values in bold indicate a statistically significant difference. (p) = p–valve.*

	Spring Bongo			**Spring Neuston**			**Fall Bongo**			**Fall Neuston**		
Taxon	**UNIS %FO n = 154**	**GOM %FO n = 1453**	**Diff. (p)**	**UNIS %FO n = 279**	**GOM %FO n = 2290**	**Diff. (p)**	**UNIS %FO n = 345**	**GOM %FO n = 1591**	**Diff. (p)**	**UNIS %FO n = 388**	**GOM %FO n = 1766**	**Diff. (p)**
Elopidae							0.87	0.82	0.05 (0.457)	1.03	0.79	0.24 (0.298)
Muraenidae	1.30	2.48	-1.18 (0.173)	3.58	3.54	0.05 (0.483)	6.09	6.47	-0.39 (0.385)	12.89	9.12	3.77 **(0.005)**
Engraulidae	23.38	13.15	10.23 **(<0.001)**	21.86	10.61	11.25 **(<0.001)**	71.59	62.10	9.49 **(<0.001)**	59.02	48.64	10.38 **(<0.001)**
Etrumeus teres	18.83	8.12	10.71 **(<0.001)**	8.60	2.27	6.33 **(<0.001)**	0.58	0.44	0.14 (0.348)	0.26	0.17	0.09 (0.337)
Harengula jaguana	3.90	1.79	2.11 **(0.024)**	14.70	5.94	8.76 **(<0.001)**	6.96	14.02	-7.06 **(<0.001)**	17.01	25.03	-8.02 **(<0.001)**
Opisthonema oglinum	3.25	1.03	2.21 **(0.003)**	1.79	0.52	1.27 **(0.002)**	13.04	31.93	-18.89 **(<0.001)**	8.76	22.76	-14.00 **(<0.001)**
Sardinella aurita	0.65	1.72	-1.07 (0.153)	2.51	2.71	-0.20 (0.419)	19.13	21.62	-2.49 (0.131)	19.07	20.95	-1.88 (0.182)
Sternoptychidae	75.97	68.27	7.70 **(0.020)**	1.79	0.96	0.83 (0.077)	25.22	18.23	6.99 **(<0.001)**	0.26	0.34	-0.08 (0.391)
Synodontidae	53.90	35.10	18.80 **(<0.001)**	20.43	10.17	10.26 **(<0.001)**	80.29	66.00	14.29 **(<0.001)**	21.65	19.03	2.62 (0.094)
Paralepididae	74.68	70.41	4.27 (0.123)	5.38	5.24	0.14 (0.459)	23.48	18.79	4.69 **(0.013)**	1.03	0.45	0.58 **(0.045)**
Carapidae	3.25	1.65	1.59 (0.060)				4.64	2.51	2.12 **(0.006)**	0.26	0.06	0.20 **(0.048)**
Carapus bermudensis	5.19	4.34	0.86 **(<0.001)**				17.39	9.87	7.52 (0.300)			
Bregmacerotidae	92.21	80.18	12.03 **(<0.001)**	14.34	6.51	7.83 **(<0.001)**	66.38	58.20	8.17 **(<0.001)**	7.73	5.95	1.79 (0.068)
Mugilidae	8.44	5.44	3.00 (0.050)	46.95	30.70	16.25 **(<0.001)**	0.58	2.51	-1.93 **(0.011)**	2.06	13.36	-11.30 **(<0.001)**
Melamphaidae	23.38	33.10	-9.73 **(0.005)**	1.79	0.96	0.83 (0.077)	4.35	5.47	-1.12 **(0.180)**	0.52	0.28	0.23 (0.195)
Holocentridae	0.65	4.82	-4.17 **(0.008)**	3.23	7.64	-4.42 **(0.003)**	1.16	3.33	-2.17 **(0.012)**	2.32	4.02	-1.70 **(0.044)**
Serranidae	39.61	31.11	8.50 **(0.011)**	9.68	9.00	0.68 (0.345)	58.55	48.90	9.65 **(<0.001)**	7.73	6.96	0.77 (0.276)
Serraninae	14.29	17.00	-2.71 (0.185)	11.47	7.03	4.44 **(0.002)**	37.10	35.26	1.84 (0.237)	13.92	12.74	1.18 (0.243)
Anthiinae	19.48	18.51	0.97 (0.379)	4.66	3.89	0.77 (0.252)	7.54	4.34	3.20 **(0.002)**	0.77	0.40	0.38 (0.119)
Epinephelinae	1.95	1.86	0.09 (0.467)									
Grammistinae	4.55	4.68	-0.13 (0.469)	3.58	2.79	0.79 (0.212)	20.58	17.60	2.98 (0.073)	7.47	7.42	0.06 (0.483)
Priacanthidae	3.90	5.37	-1.47 (0.209)	4.30	4.24	0.07 (0.478)	14.20	14.20	0.00 (0.500)	10.82	10.02	0.80 (0.299)
Apogonidae	14.94	13.76	1.17 (0.337)	12.54	7.16	5.38 **(<0.001)**	21.74	28.66	-6.92 **(0.002)**	9.28	11.66	-2.39 (0.072)
Rachycentron canadum				1.08	0.79	0.29 (0.292)				0.52	3.11	-2.60 **(0.002)**

TABLE 3. *Continued*

	Spring Bongo			Spring Neuston			Fall Bongo			Fall Neuston		
Taxon	**UNIS %FO n = 154**	**GOM %FO n = 1453**	**Diff. (p)**	**UNIS %FO n = 279**	**GOM %FO n = 2290**	**Diff. (p)**	**UNIS %FO n = 345**	**GOM %FO n = 1591**	**Diff. (p)**	**UNIS %FO n = 388**	**GOM %FO n = 1766**	**Diff. (p)**
Coryphaenidae	9.74	12.11	-2.37 (0.183)	33.69	39.34	-5.65 **(0.027)**	3.48	2.89	0.59 (0.258)	17.01	14.95	2.06 (0.127)
Caranx spp.	12.34	17.14	-4.8 (0.057)	25.45	39.56	-14.12 **(<0.001)**	5.22	9.87	-4.65 **(0.002)**	19.33	24.75	-5.42 **(0.007)**
Chloroscombrus chyrsurus				0.36	0.57	-0.21 (0.321)	28.41	45.00	-16.60 **(<0.001)**	27.58	44.11	-16.53 **(<0.001)**
Decapterus spp.	7.14	7.43	-0.29 (0.445)	17.56	12.10	5.47 **(0.003)**	62.32	38.91	23.41 **(<0.001)**	52.58	31.77	20.81 **(<0.001)**
Selar crumenophthalmus	1.30	2.55	-1.25 (0.163)	0.72	3.67	-2.95 **(0.004)**	15.07	16.28	-1.21 (0.272)	10.82	11.72	-0.90 (0.292)
Selene spp.							4.93	11.00	-6.07 **(<0.001)**	4.38	5.44	-1.05 (0.180)
Seriola spp.	3.25	3.58	-0.33 (0.412)	26.88	20.83	6.05 **(0.006)**	0.87	2.33	-1.46 **(0.036)**	10.31	10.31	0.00 (0.499)
Trachinotus spp.				11.47	8.47	3.00 **(0.036)**				3.61	5.27	-1.66 (0.072)
Trachurus lathami	3.90	2.34	1.56 (0.101)	3.58	2.79	0.79 (0.212)						
Lutjanidae	3.25	4.13	-0.88 (0.291)	1.08	0.96	0.11 (0.422)	45.51	42.43	3.08 (0.123)	6.44	6.29	0.16 (0.449)
Lutjanus spp.							5.22	14.52	-9.30 **(<0.001)**	4.12	8.44	-4.31 **(<0.001)**
Lutjanus campechanus				0.36	0.66	-0.30 (0.270)	2.90	8.49	-5.59 **(<0.001)**	5.67	7.64	-1.97 (0.072)
Lutjanus griseus				0.36	0.17	0.18 (0.231)	1.74	2.01	-0.27 (0.359)	0.52	1.36	-0.84 (0.076)
Pristipomoides aquilonaris	2.60	2.00	0.60 (0.297)	0.36	1.05	-0.69 (0.129)	13.62	13.95	-0.33 (0.430)	5.67	6.51	-0.84 (0.251)
Rhomboplites aurorubens	1.30	1.72	-0.42 (0.344)	0.72	1.79	-1.07 (0.088)	32.46	25.96	6.51 **(0.003)**	14.95	13.36	1.58 (0.179)
Lobotes surinamensis				0.72	0.87	-0.16 (0.389)				5.41	4.59	0.83 (0.218)
Haemulidae				0.72	0.26	0.45 (0.069)	2.03	3.46	-1.43 (0.073)	0.26	1.08	-0.82 (0.059)
Cynoscion spp.	0.65	0.55	0.10 (0.434)	1.08	0.22	0.86 **(0.001)**	11.88	21.24	-9.36 **(<0.001)**	4.90	12.97	-8.07 **(<0.001)**
Sciaenops ocellatus							9.28	13.45	-4.18 **(0.012)**	4.12	10.65	-6.52 **(<0.001)**
Mullidae	19.48	11.15	8.33 **(0.001)**	75.63	50.87	24.75 **(<0.001)**	0.29	0.75	-0.46 (0.159)	6.70	6.00	0.70 (0.281)
Chaetodontidae	0.65	1.72	-1.07 (0.153)	0.36	2.58	-2.22 **(0.010)**	0.87	0.69	0.18 (0.345)	1.55	0.79	0.75 **(0.047)**
Pomacanthidae	0.65	2.27	-1.62 (0.088)	1.08	1.22	-0.15 (0.411)	0.29	0.82	-0.53 (0.138)	0.26	0.91	-0.65 (0.089)
Pomacentridae	1.95	8.05	-6.10 **(0.003)**	4.66	4.89	-0.23 (0.429)	8.70	8.36	0.34 (0.411)	4.38	8.49	-4.11 **(0.002)**
Labridae	24.68	31.11	-6.43 **(0.042)**	4.30	4.02	0.28 (0.405)	72.46	40.73	31.73 **(<0.001)**	14.95	8.55	6.40 **(<0.001)**
Scaridae	12.34	28.08	-15.74 **(<0.001)**	3.23	4.02	-0.79 (0.250)	20.58	22.31	-1.73 (0.220)	3.61	3.28	0.32 (0.360)

TABLE 3. *Continued*

	Spring Bongo			Spring Neuston			Fall Bongo			Fall Neuston		
Taxon	**UNIS %FO n = 154**	**GOM %FO n = 1453**	**Diff. (p)**	**UNIS %FO n = 279**	**GOM %FO n = 2290**	**Diff. (p)**	**UNIS %FO n = 345**	**GOM %FO n = 1591**	**Diff. (p)**	**UNIS %FO n = 388**	**GOM %FO n = 1766**	**Diff. (p)**
Acanthuridae	1.30	6.26	-4.96 (0.199)	0.36	1.66	-1.30 **(0.006)**				0.26	0.11	0.14 **(0.045)**
Trichiurus lepturus	8.44	3.44	5.00 **(<0.001)**	1.08	1.05	0.03 (0.482)	16.23	14.52	1.71 (0.183)	2.58	2.77	-0.20 (0.407)
Acanthocybium solandri							0.58	0.75	-0.17 (0.354)			
Katsuwonus pelamis	10.39	22.37	-11.98 **(<0.001)**	6.45	10.39	-3.94 **(0.016)**	5.80	5.15	0.64 (0.295)	2.32	2.60	-0.29 (0.362)
Scomberomorus cavalla							12.75	23.38	-10.63 **(<0.001)**	11.08	13.25	-2.17 (0.104)
Scomberomorus maculates	3.25	0.96	2.28 **(0.002)**	2.51	0.96	1.55 **(0.004)**	4.06	12.76	-8.70 **(<0.001)**	3.35	10.82	-7.46 **(<0.001)**
Thunnus spp.	12.99	22.02	-9.04 **(0.003)**	8.96	21.97	-13.00 **(<0.001)**	17.68	18.73	-1.05 (0.309)	16.75	21.74	-4.99 **(0.009)**
Thunnus thynnus	4.55	10.87	-6.33 **(0.006)**	6.81	10.44	-3.63 **(0.024)**						
Xiphius gladius				1.08	4.50	-3.42 **(0.003)**						
Istiophoridae	1.30	2.96	-1.66 (0.112)	3.94	9.43	-5.49 **(0.001)**	0.58	1.13	-0.55 (0.166)	5.93	9.74	-3.81 **(0.006)**
Peprilus alepidotus	0.65	0.28	0.37 (0.188)				10.14	13.14	-2.99 **(0.050)**	3.87	4.30	-0.44 (0.336)
Peprilus burti	1.30	1.79	-0.49 (0.323)	2.15	1.09	1.06 **(0.044)**	26.09	11.38	14.71 **(<0.001)**	4.38	1.59	2.80 **(<0.001)**

but in the fall was 2% lower than would be expected based on the number of survey samples taken in the study area. Observed differences in UNIS study area and Gulfwide survey total catch were even more pronounced for fish larvae collected in neuston samples. During spring surveys, the study area contributed only 12% of the total number of samples but larvae captured in neuston samples there accounted for 21% of the total standardized abundance Gulfwide. During fall surveys, the study area contributed 22% of the total number of samples but larvae captured in neuston samples there accounted for only 16% of the Gulfwide total.

Information is provided below on the number of larvae captured and frequency of occurrence (Table 1), mean abundance, mean CPUE, and distribution (Figures 5—62) and size for the early life stages of 61 taxa of fishes collected in bongo and neuston samples during SEAMAP spring and fall surveys within the UNIS study area. Also provided are comments on taxonomic resolution and relative ease or difficulty of larval stage identification for certain taxa. Percent frequency of occurrence (Table 3) and percent of total standardized abundance or total standardized CPUE, i.e. relative abundance of the select taxa, in the study area are compared to Gulfwide values (Table 4).

Taxon Specific Information

Elopidae (7 occurrences; 16 larvae; Figure 5)

Elopomorph species have a leptocephalus larval form with a forked tail which distinguishes them from the leptocephali of spiny and true eels. It is likely that all these Elopomorph larvae were ladyfish, either *Elops saurus* or *E. smithi* (McBride et al. 2010). Other fork—tailed leptocephali from closely related families are tarpon (Megalopidae) and bonefish (Albulidae), which are morphologically distinct and rare in the northern GOM. Elopid leptocephali, 13.5—29.2 mm BL (n = 8 specimens measured), occurred only 7 times, all during fall surveys, with captures almost equally divided between bongo (3) and neuston (4) net samples. Eleven of the 16 specimens captured were taken in neuston collections (Table 1). The stations where elopid larvae were found in bongo samples and in 3 of the 4 neuston samples were located along or west of 87°W longitude (Figure 5). Percent occurrence of elopid larvae in the UNIS study area did not differ significantly from their occurrence Gulfwide (Table 3). Relative abundance and CPUE in the 2 areas were similar, differing by < 0.1% (Table 4).

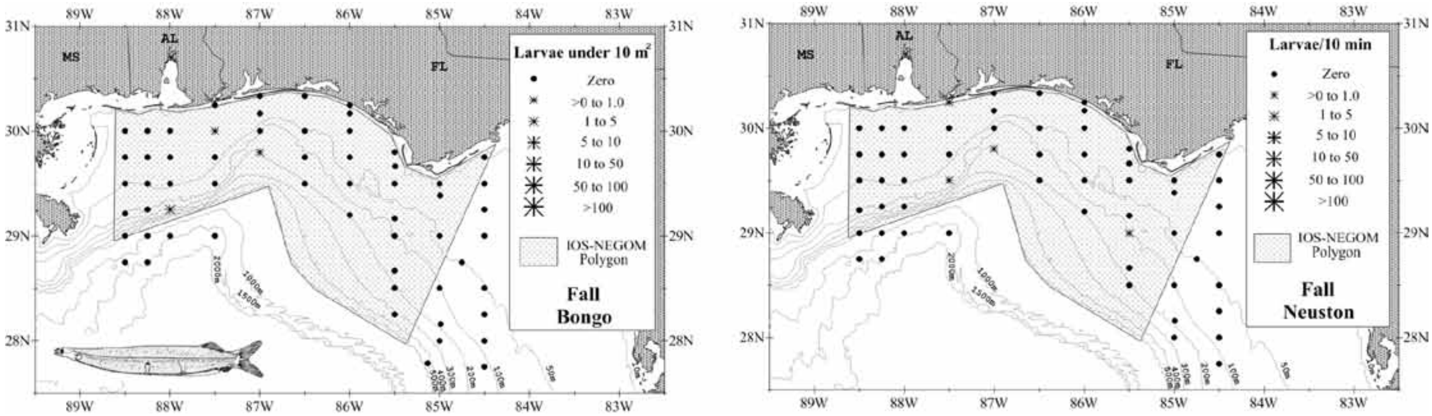

Figure 5. *Mean abundance and mean CPUE of ladyfish (Elopidae) larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

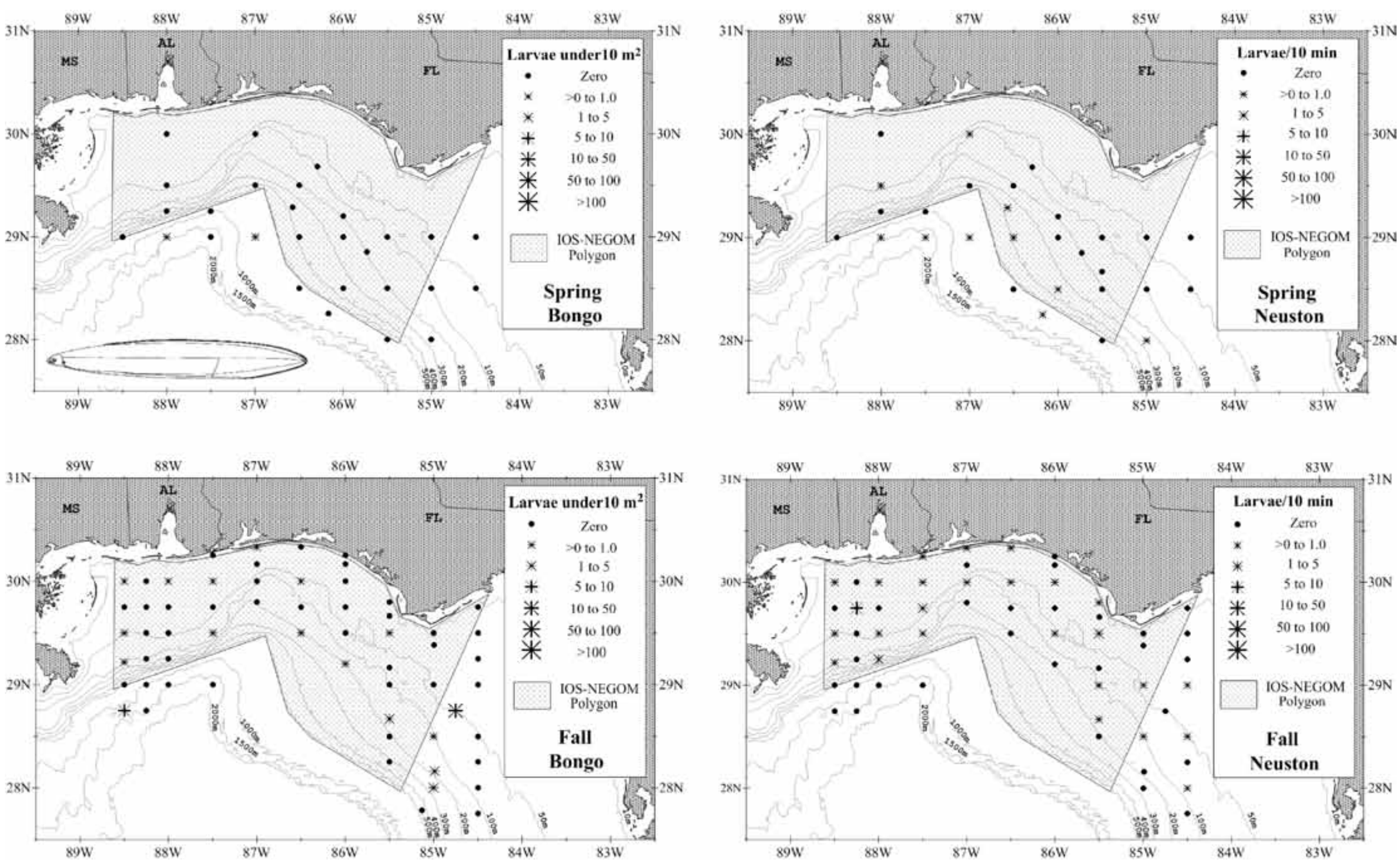

Figure 6. *Mean abundance and mean CPUE of moray eel (Muraenidae) larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

MURAENIDAE (83 occurrences; 188 larvae; Figure 6)

Moray eels are a characteristic component of hard or live bottom communities throughout the GOM. Their leptocephalus larvae can be distinguished from the young of other eel families by the complete absence or greatly reduced state of their pectoral fins. Moray eel leptocephali, 3.5—107 mm BL (n = 65), occurred more frequently in fall surveys than in spring (71 vs. 12 occurrences) and were captured more often in neuston than in bongo samples (60 vs. 23, Table 1). These larvae were found, for the most part, at the most offshore localities during spring surveys but were dispersed throughout the study area during fall surveys, from the closest inshore to the farthest offshore stations (Figure 6). During spring surveys muraenid eel larvae were as common in UNIS collections as they were throughout the GOM; i.e. there was no significant difference in occurrence between the 2 areas. In fall surveys, however, muraenid eel larvae occurred significantly more often in UNIS neuston collections

TABLE 4. *Relative abundance of 61 select ichthyoplankton taxa captured in USGS Northeastern Gulf of Mexico Ichthyoplankton Synopsis (UNIS) study area samples alone and in all Gulfwide (GOM) survey samples combined during Southeast Area Monitoring and Assessment Program (SEAMAP) spring and fall plankton surveys over the period 1982-1999. PTA = percent of total abundance in bongo samples. PTC = percent of total CPUE in neuston samples. n = number of samples.*

	Spring survey				**Fall survey**			
	Bongo PTA		**Neuston PTC**		**Bongo PTA**		**Neuston PTC**	
Taxon	**UNIS n = 154**	**GOM n = 1453**	**UNIS n = 279**	**GOM n = 2290**	**UNIS n = 345**	**GOM n = 1591**	**UNIS n = 388**	**GOM n = 1766**
Elopidae	0	<0.01	0	0.01	0.01	<0.01	0.02	0.01
Muraenidae	0.01	0.02	0.05	0.07	0.03	0.03	0.25	0.14
Engraulidae	1.66	1.34	5.98	3.27	14.12	10.13	40.75	28.14
Etrumeus teres	0.88	0.39	2.31	0.57	<0.01	<0.01	<0.01	<0.01
Harengula jaguana	0.15	0.04	5.78	1.71	0.08	0.31	2.43	3.31
Opisthonema oglinum	0.09	0.03	0.47	0.13	0.42	4.04	0.31	7.52
Sardinella aurita	<0.01	0.26	0.08	0.99	1.16	3.42	4.77	6.67
Sternoptychidae	6.02	4.47	0.29	0.09	1.64	0.96	<0.01	<0.01
Synodontidae	2.34	2.84	0.88	0.86	6.48	4.86	0.66	0.69
Paralepididae	2.11	1.75	0.05	0.11	0.37	0.23	0.01	<0.01
Carapidae	0.02	0.01	0	0	0.08	0.03	<0.01	<0.01
Carapus bermudensis	0.03	0.03	0	<0.01	0.25	0.12	0	<0.01
Bregmacerotidae	7.03	8.09	0.75	0.69	8.47	8.30	0.24	0.08
Mugilidae	0.09	0.08	3.91	5.33	<0.01	<0.01	0.03	0.40
Melamphaidae	0.18	0.36	0.01	0.02	0.03	0.03	<0.01	<0.01
Holocentridae	<0.01	0.07	0.04	0.52	0.01	0.02	0.02	0.05
Serranidae	0.63	1.29	0.14	0.39	1.01	0.84	0.14	0.09
Serraninae	0.13	0.27	0.45	0.39	0.87	0.67	0.65	0.72
Anthiinae	0.18	0.45	0.13	0.18	0.09	0.04	0.01	0.01
Epinephelinae	0.01	0.03	0	<0.01	0	<0.01	0	0
Grammistinae	0.04	0.04	0.07	0.05	0.13	0.10	0.08	0.09
Priacanthidae	0.08	0.06	0.07	0.12	0.09	0.11	0.19	0.26
Apogonidae	0.09	0.13	0.35	0.24	0.29	0.40	0.17	0.29
Rachycentron canadum	0	<0.01	0.04	0.02	0	<0.01	0.01	0.04
Coryphaenidae	0.06	0.10	0.63	1.29	0.02	0.01	0.25	0.14
Caranx spp.	0.17	0.54	1.86	5.77	0.04	0.07	1.06	0.75
Chloroscombrus chrysurus	0	<0.01	0.02	0.03	0.82	4.45	2.96	9.36
Decapterus spp.	0.05	0.14	0.92	0.65	3.46	1.87	5.15	2.56
Selar crumenophthalmus	0.01	0.03	<0.01	0.12	0.13	0.22	1.03	0.37
Selene spp.	0	<0.01	0	0.01	0.04	0.11	0.04	0.07
Seriola spp.	0.03	0.04	0.91	0.77	<0.01	0.01	0.13	0.10
Trachinotus spp.	0	<0.01	0.15	0.17	0	<0.01	0.04	0.04
Trachurus lathami	0.05	0.03	0.11	0.11	0	<0.01	0	<0.01
Lutjanidae	0.02	0.06	0.01	0.04	0.66	0.71	0.10	0.10
Lutjanus spp.	0	0.01	0	0.02	0.03	0.11	0.07	0.27
Lutjanus campechanus	0	<0.01	<0.01	0.03	0.01	0.05	0.10	0.15
Lutjanus griseus	0	<0.01	<0.01	<0.01	0.01	0.01	<0.01	0.02
Pristipomoides aquilonaris	0.01	0.02	<0.01	0.03	0.15	0.17	0.14	0.14
Rhomboplites aurorubens	0.01	0.01	0.05	0.10	0.31	0.26	0.54	0.50
Lobotes surinamensis	0	<0.01	<0.01	0.01	0	<0.01	0.06	0.03
Haemulidae	0	<0.01	<0.01	0.01	0.13	0.07	<0.01	0.02
Cynoscion spp.	<0.01	0.01	0.04	0.01	0.27	0.96	0.15	2.16
Sciaenops ocellatus	0	0	0	<0.01	0.14	0.40	0.19	1.04
Mullidae	0.26	0.27	47.36	26.96	<0.01	<0.01	0.36	0.16
Chaetodontidae	<0.01	0.01	<0.01	0.06	0.01	<0.01	0.01	0.01
Pomacanthidae	<0.01	0.02	0.01	0.02	<0.01	<0.01	<0.01	0.01
Pomacentridae	0.12	0.12	0.09	0.18	0.05	0.05	0.07	0.11
Labridae	0.30	0.64	0.14	0.14	3.67	1.22	0.32	0.15
Scaridae	0.08	0.70	0.03	0.12	0.36	0.38	0.05	0.03
Acanthuridae	0.01	0.08	<0.01	0.03	0	0.01	<0.01	<0.01
Trichiurus lepturus	0.13	0.07	0.03	0.03	0.20	0.16	0.04	0.03
Acanthocybium solandri	0	<0.01	0	<0.01	<0.01	<0.01	0	<0.01
Katsuwonus pelamis	0.07	0.28	0.10	0.36	0.05	0.05	0.06	0.05
Scomberomorus cavalla	0	<0.01	0	0.03	0.06	0.19	0.16	0.30
Scomberomorus maculatus	0.03	0.01	0.18	0.06	0.02	0.12	0.05	0.50
Thunnus spp.	0.20	0.40	0.36	1.29	0.18	0.27	0.67	0.99
Thunnus thynnus	0.04	0.21	0.30	0.71	0	0	0	0
Xiphias gladius	0	<0.01	0.01	0.07	0	0	0	<0.01
Istiophoridae	0.02	0.03	0.05	0.30	<0.01	<0.01	0.09	0.16
Peprilus alepidotus	<0.01	<0.01	0	<0.01	0.10	0.10	0.08	0.08
Peprilus burti	0.01	0.02	0.04	0.02	0.76	0.22	0.14	0.03

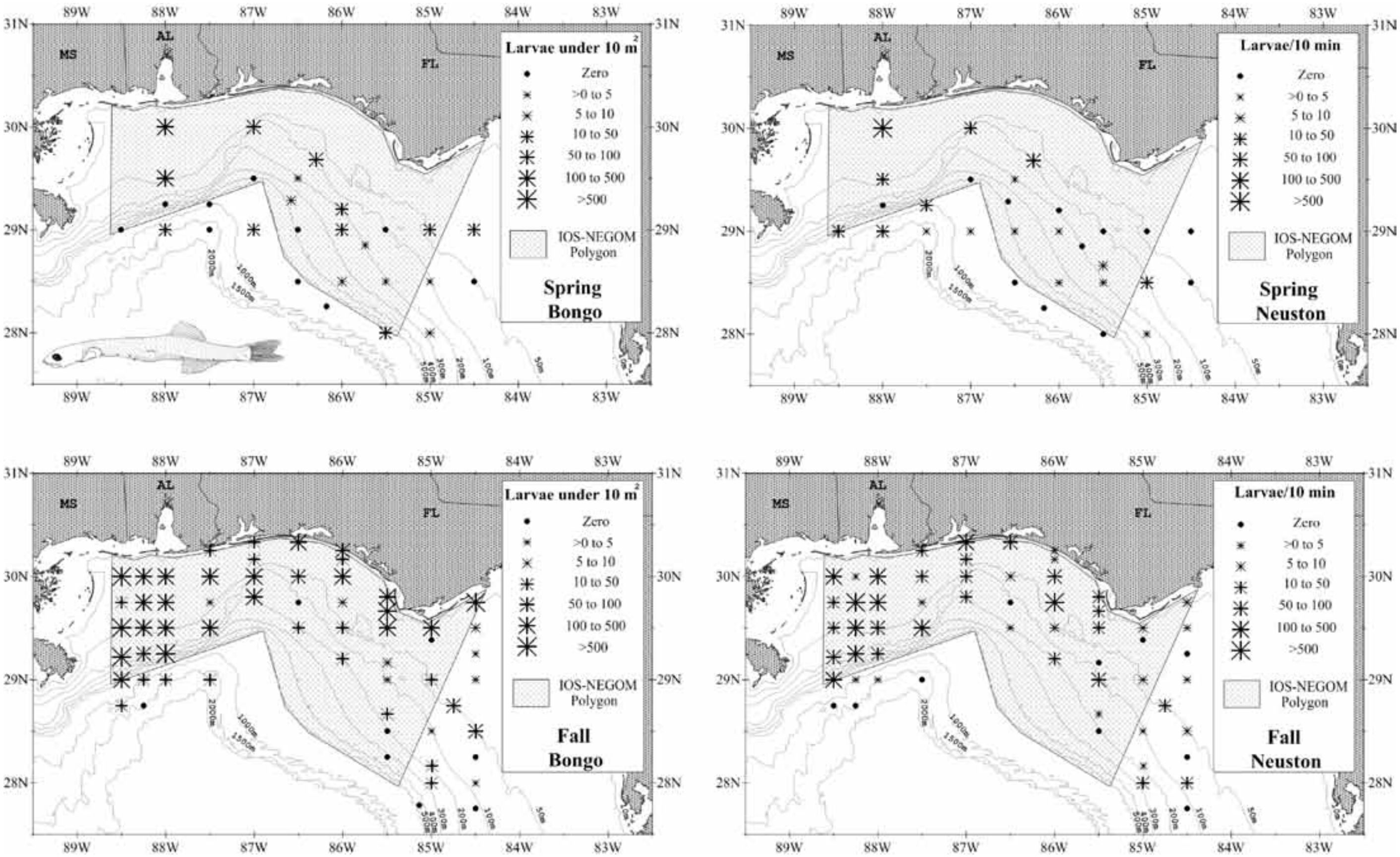

Figure 7. *Mean abundance and mean CPUE of anchovy (Engraulidae) larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

than in neuston collections Gulfwide (Table 3). The relative abundance and CPUE in the 2 areas were similar, differing by < 0.2% (Table 4).

ENGRAULIDAE (573 occurrences; 40,732 larvae; Figure 7)

Anchovy larvae were the most frequently caught and most numerous of all fish larvae in UNIS study area collections. At least 6 species of engraulids are known to occur over the continental shelf in the NEGOM but their larvae cannot be easily distinguished from one another until later in the juvenile stage (Farooqi et al. 2006). All but 97 of 573 occurrences took place during fall surveys with specimens taken in fall collections outnumbering those in spring collections by an order of magnitude (Table 1). The overall size range of larvae captured in UNIS study area collections was 1.2—34 mm BL (n= 678). Anchovy larvae were taken as frequently in bongo as in neuston samples but larvae were somewhat more numerous in neuston samples. As would be expected, anchovy larvae occurred throughout the survey area but highest mean abundances were consistently observed in the westernmost region from nearshore to the most offshore stations and elsewhere in the study area inshore of the 50 m contour (Figure 7). During both seasons, anchovy larvae occurred significantly more often in UNIS study area samples than in Gulfwide samples (Table 3). Relative abundance and CPUE in spring samples (both bongo and neuston) and fall bongo samples in the 2 areas differed by < 5% (Table 4), whereas, the relative CPUE in UNIS study area fall neuston samples exceeded the Gulfwide value by 12%. This was disproportionately higher than expected given the fewer samples taken in the study area.

CLUPEIDAE

Etrumeus teres (56 occurrences; 1,306 larvae; Figure 8)

Larvae of the round herring were found in the study area almost exclusively during spring surveys. Incidence of capture in bongo and neuston samples was similar but larvae were nearly 3 times more numerous in neuston than in bongo collections (Table 1). The overall size range of larvae captured in UNIS study area collections was 3.0—18.0 mm BL (n= 144). Most occurrences and the highest mean abundances were observed at localities along or east of 87°W longitude (Figure 8). Round herring were taken significantly more often in UNIS samples than in Gulfwide samples during spring surveys but at comparable frequencies (i.e., no statistical difference) during fall surveys (Table 3). The relative abundances and CPUEs in the two areas differed by < 2% during spring surveys and < 0.01% during fall surveys (Table 4).

Harengula jaguana (137 occurrences; 3,909 larvae; Figure 9)

Scaled sardine larvae ranked second in occurrence and abundance among the clupeid larvae identified to species. Although fall survey collections accounted for two—thirds of

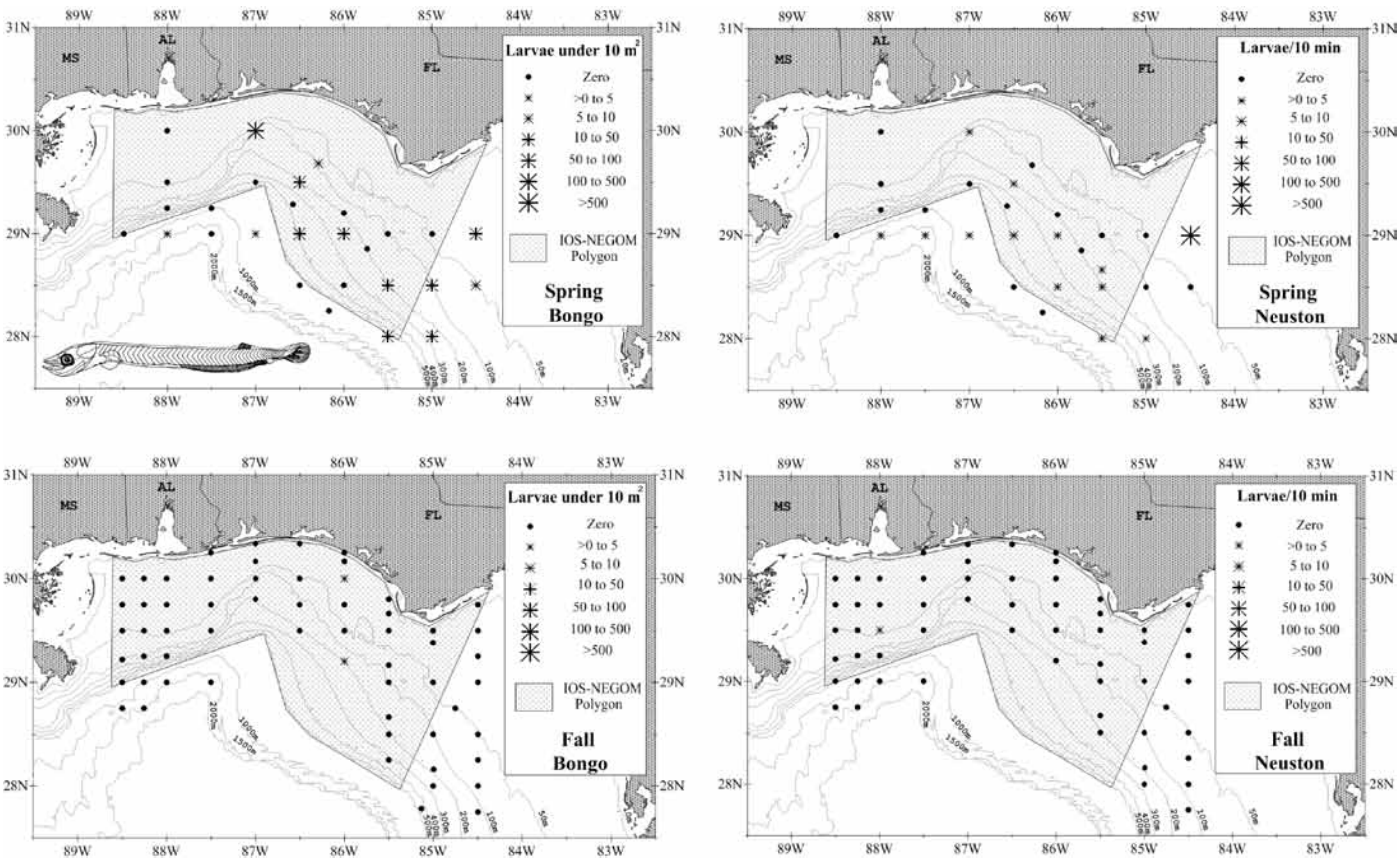

Figure 8. *Mean abundance and mean CPUE of round herring,* Etrumeus teres*, larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

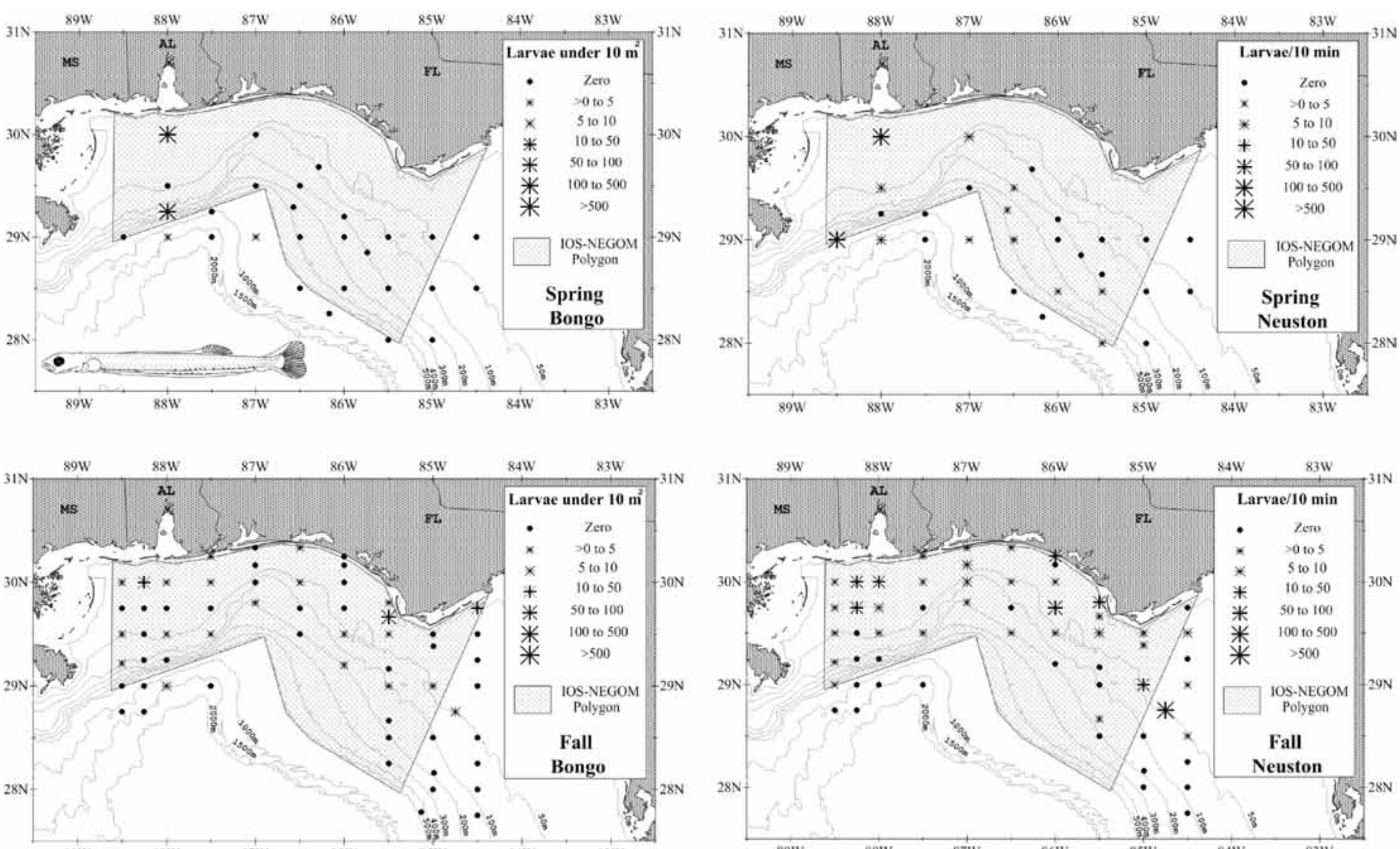

Figure 9. *Mean abundance and mean CPUE of scaled sardine,* Harengula jaguana*, larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

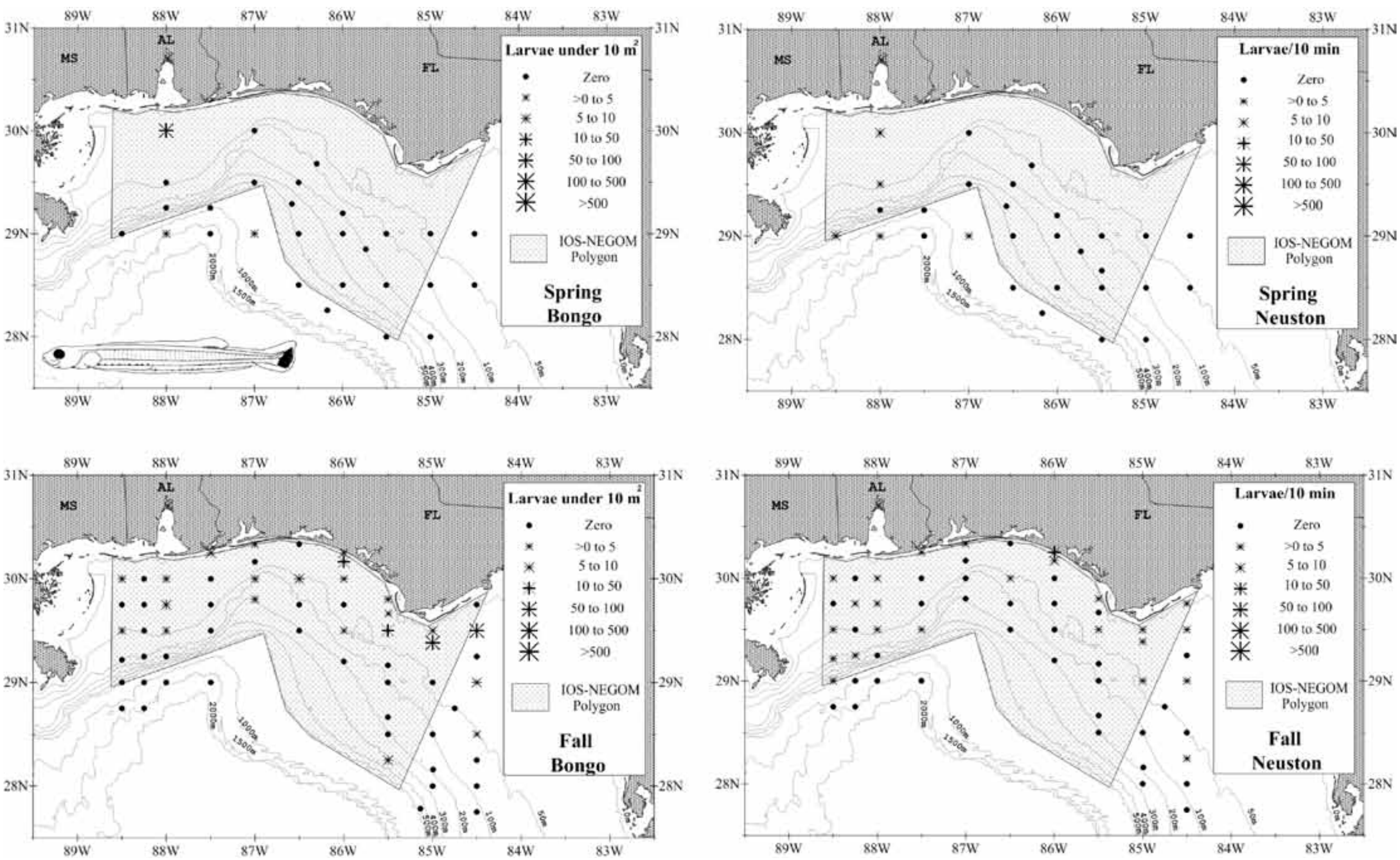

Figure 10. *Mean abundance and mean CPUE of thread herring, Opisthonema oglinum, larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

their occurrences, nearly twice as many scaled sardine larvae were taken during spring surveys (Table 1). The overall size range of larvae captured in UNIS study area collections was 3.0— 21.0 mm BL (n= 250). Larvae were captured 3.5 times more often and were an order of magnitude more numerous in neuston than bongo net samples. In the spring, highest mean abundances of scaled sardine larvae were observed west of 87°W longitude while during fall surveys larvae were distributed across the study area with greatest mean abundances inshore of the 50 m contour (Figure 9). During spring surveys scaled sardine larvae were taken significantly more often in the study area than Gulfwide, but the reverse was true during fall surveys when larvae were significantly less common in study area samples than Gulfwide (Table 3). The relative abundances and CPUEs in the two areas differed by < 5% (Table 4).

Opisthonema oglinum (89 occurrences; 1,163 larvae; Figure 10)

Atlantic thread herring larvae were more numerous and occurred more frequently in fall than in spring surveys. Unlike the other abundant clupeid larvae, they were more frequently taken and more numerous in bongo than in neuston net samples (Table 1). The overall size range of larvae captured in UNIS study area collections was 1.2—25.5 mm BL (n= 299). Larvae were not found east of 87° W longitude during spring surveys but occurred throughout the study area during fall surveys when most occurrences and highest mean abundances were observed inshore of the 50 m contour and east of 87°W longitude (Figure 10). During spring surveys, Atlantic thread herring larvae were taken significantly more often in the study area than Gulfwide but the reverse was true during fall surveys when larvae were significantly less common in study area samples than Gulfwide (Table 3). The relative abundance during spring surveys and fall bongo samples in the two areas was similar, differing by < 5% (Table 4). However, relative CPUE of threadfin herring larvae was 7% lower than Gulfwide in fall neuston samples.

Sardinella aurita (148 occurrences; 4,360 larvae; Figure 11)

Larvae of the Spanish sardine were the most frequently taken and most abundant larval clupeid in the study area. Larvae were taken almost exclusively during fall surveys and were comparably represented in bongo and neuston samples (Table 1). Mean size in bongo samples was 6.5 mm BL (n = 171; range = 2.7—16.0 mm) and mean size in neuston samples was 10.1 mm BL (n = 256; range = 1.5—74 mm). Larvae occurred most frequently and in highest abundance at stations east of 87° W longitude and generally over depths ≤100 m (Figure 11). Spanish sardine larvae occurred as frequently

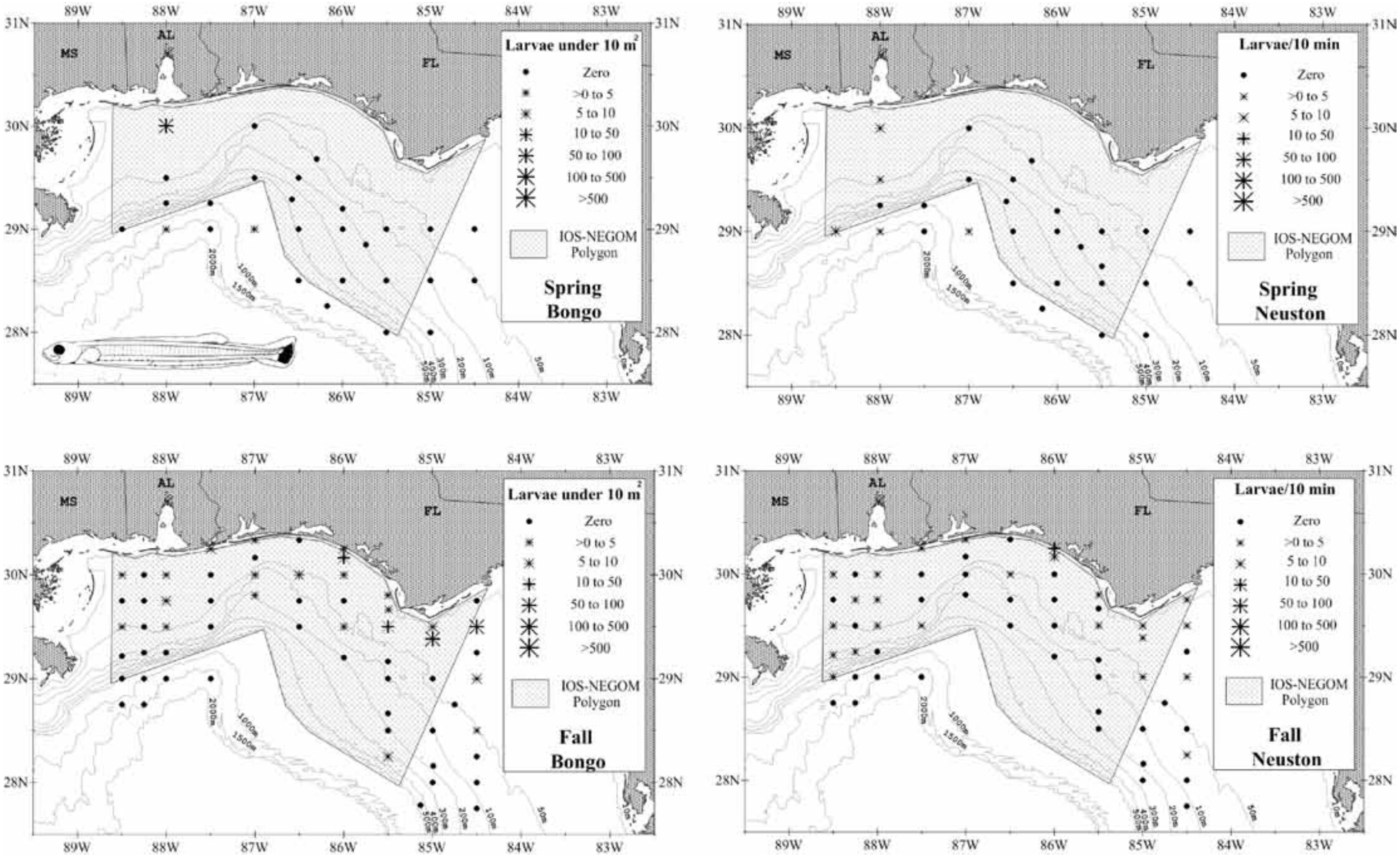

Figure 11. *Mean abundance and mean CPUE of Spanish sardine,* Sardinella aurita, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

in the UNIS study area as Gulfwide (Table 3). Relative abundance and CPUE in the 2 areas differed by < 2% (Table 4).

STERNOPTYCHIDAE (210 occurrences; 3,533 larvae; Figure 12)

Larvae of the bioluminescent meso— and bathypelagic hatchet fishes were fairly numerous in UNIS study area collections during both spring and fall surveys (Table 1). The overall size range of larvae captured in UNIS study area collections was 1.7—29.5 mm BL (n = 115). Hatchet fish larvae were taken almost exclusively in bongo samples, at localities beyond 50 m, and along the contours outlining the DeSoto Canyon (Figure 12). Mean abundances at offshore stations consistently ranged from 10—100 larvae/10 m^2. Hatchet fish larvae occurred significantly more often in bongo samples in the study area than Gulfwide during both spring and fall surveys but were found at comparable frequencies in both areas in spring and fall neuston samples (Table 3). Relative abundances and CPUEs in the 2 areas were similar differing by < 2% (Table 4).

SYNODONTIDAE (501 occurrences; 7,229 larvae; Figure 13)

The lizardfishes are an important group of benthic predatory fishes common on soft bottom substrates of the continental shelf in the GOM and are considered an important member of halo communities extending away from reefs. The larvae of this family of 6 GOM species were among the most frequently taken and numerous larvae in SEAMAP plankton collections. Most lizardfish larvae were taken in bongo net samples during fall surveys and were collected at all but 3 UNIS stations (Table 1, Figure 13). The overall size range of larvae captured in UNIS study area collections was 1.3—43 mm BL (n = 545). The highest mean abundances were found at stations between the 50 and 200 m contours. Lizardfish larvae were captured significantly more often in the study area bongo samples than Gulfwide in both spring and fall. However, neuston—caught lizardfish larvae were found significantly more often in the UNIS study area only in the spring (Table 3). Relative abundances and CPUEs in the 2 areas were similar, differing by < 2% (Table 4).

PARALEPIDIDAE (215 occurrences; 1,053 larvae; Figure 14)

The barracudinas occur in epi—, meso—, and bathypelagic zones of the GOM and their larvae were not uncommon in the UNIS study area, occurring most often and in greatest numbers in bongo net collections during spring surveys (Table 1). The overall size range of larvae captured in UNIS study area collections was 2.0—31 mm BL (n = 181). The distribution of barracudina larvae, like hatchet fish larvae, followed the isobaths outlining the DeSoto Canyon across the full east—west extent of the study area (Figure 14). Mean abundances in bongo samples at most localities beyond the 100 m contour were typically between 10—50 larvae under 10 m^2. Barracudina larvae were captured significantly more

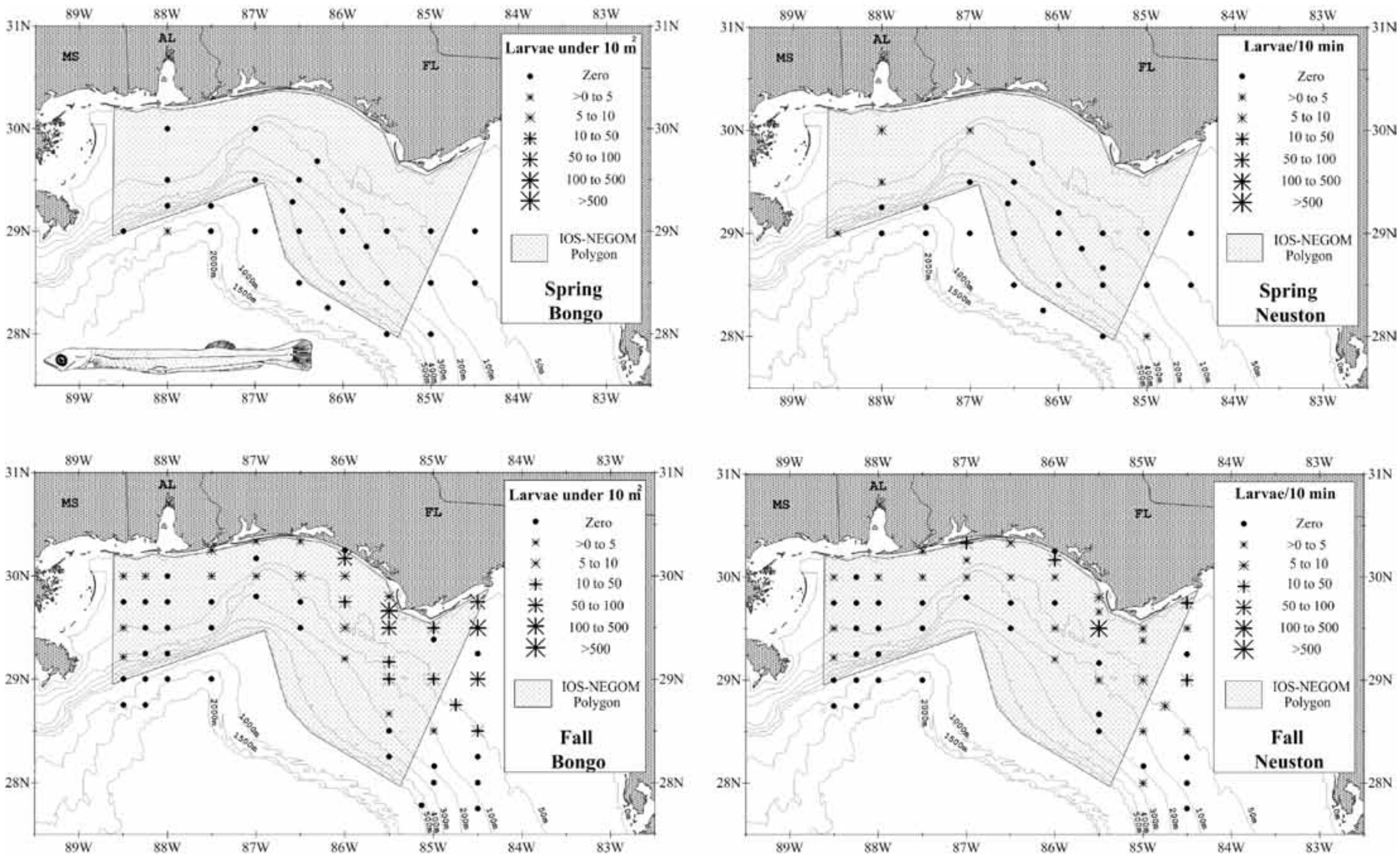

Figure 12. *Mean abundance and mean CPUE of hatchetfish (Sternoptychidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

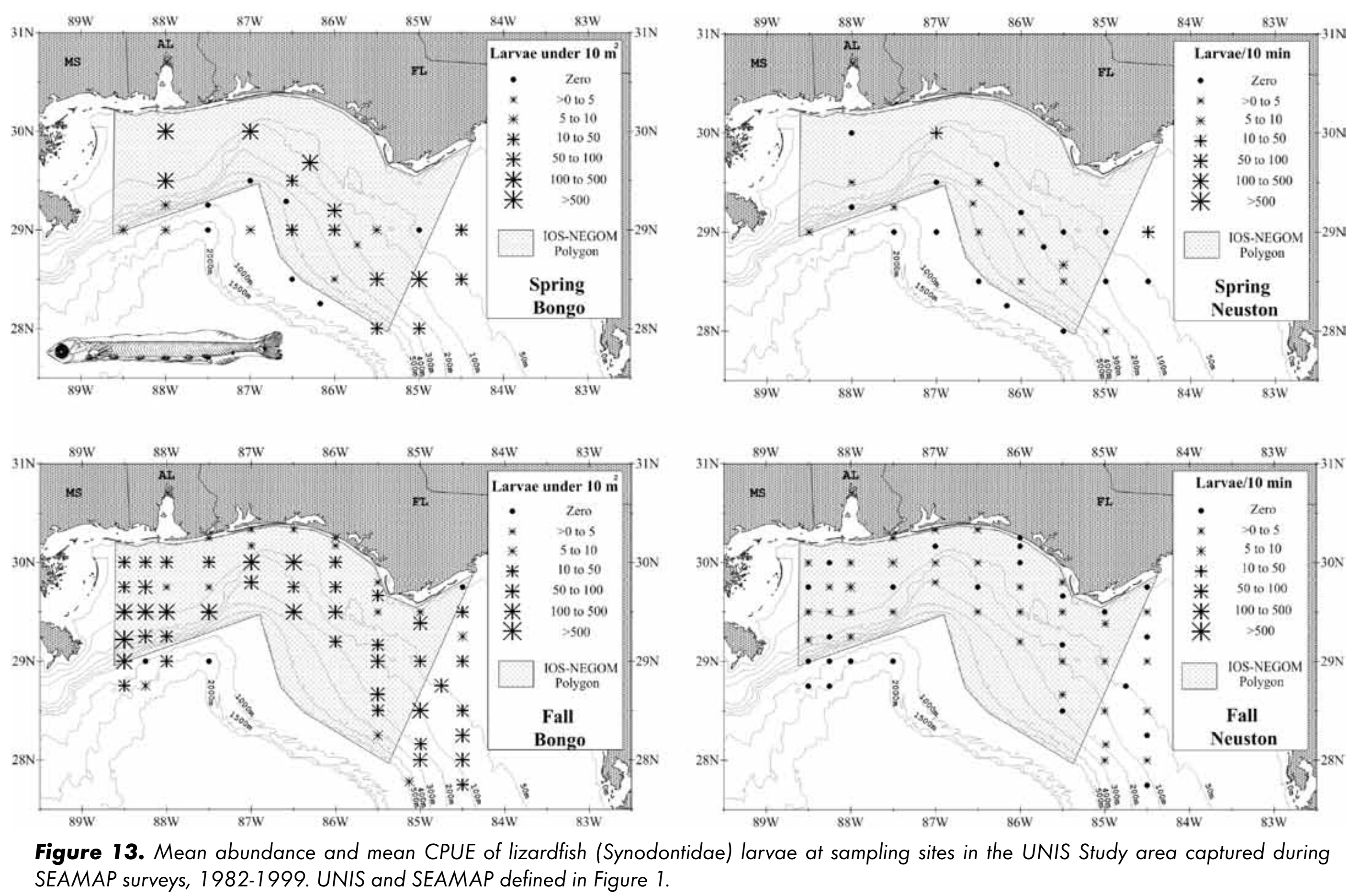

Figure 13. *Mean abundance and mean CPUE of lizardfish (Synodontidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

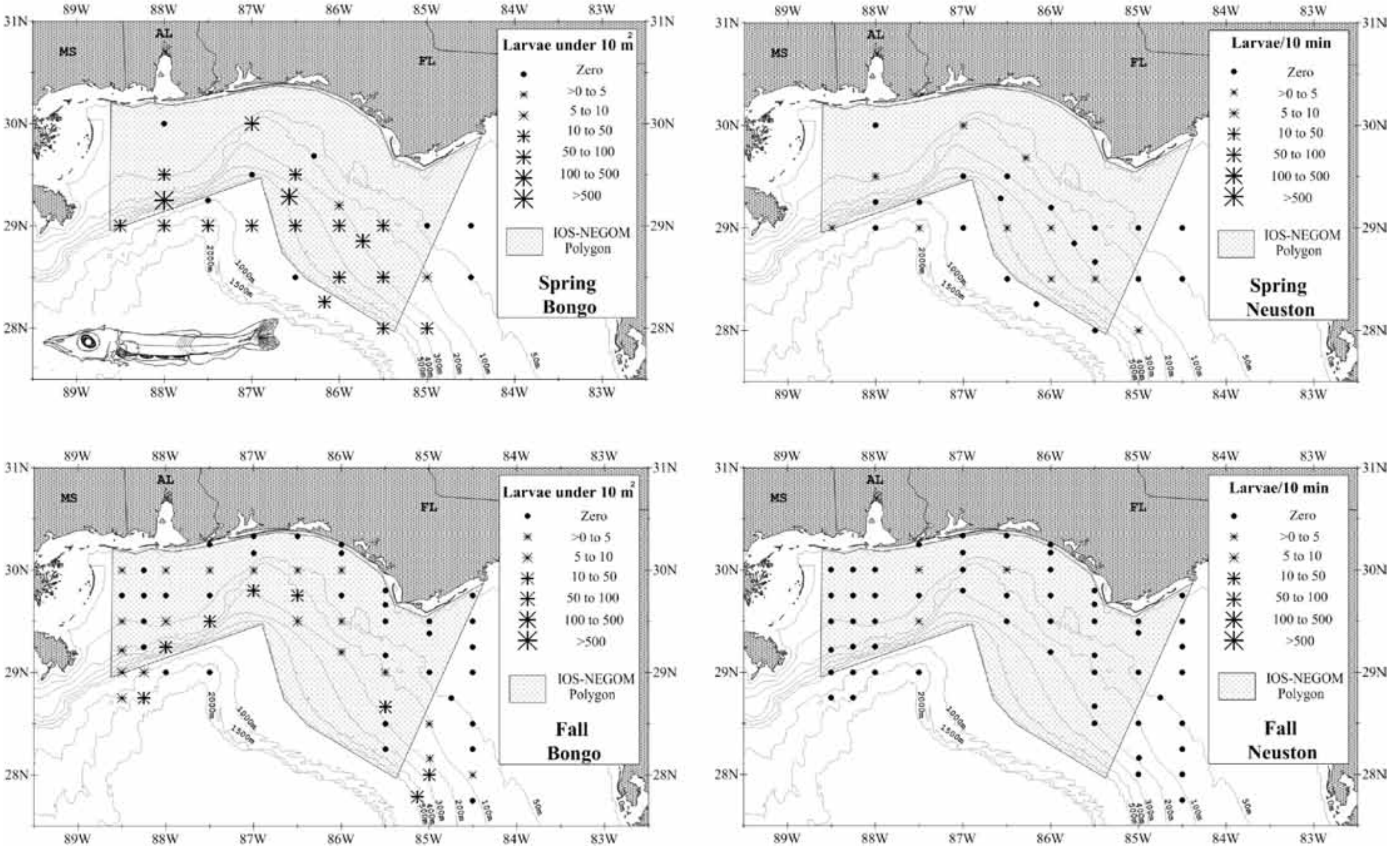

Figure 14. *Mean abundance and mean CPUE of barracudina (Paralepididae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

often in the study area than Gulfwide only in the fall, but occurrence in spring samples was comparable in the 2 areas (Table 3). Relative abundances and CPUEs in the 2 areas were similar, differing by < 0.5% (Table 4).

Carapidae (22 occurrences; 62 larvae; Figure 15)

Planktonic larvae of the pearlfishes are distinctive in having a vexillum or long, thread—like process anterior to the dorsal fin. Most species live as inquilines in the body cavity of certain benthic invertebrates but have free living planktonic larvae. Three species occur in the western central Atlantic; *Carapus bermudensis, Echiodon dawsonii*, and *Snyderidia canina.* The last species is thought to be free—living, but has been observed sheltering beneath the recumbent spines of the large, white, deepwater 'pancake' urchin, *Araeosoma* sp. (K. Sulak, unpublished data, USGS, Gainesville, FL). Pearlfish larvae not identified as *C. bermudensis* (see below) were captured almost exclusively in bongo collections during fall surveys (Table 1). The overall size range of pearlfish larvae captured in UNIS study area collections was 2.6—56 mm BL (n = 27). Highest mean abundances were found at stations in the southwest and southeast corners of the IOS—NEGOM research polygon in bongo samples during the fall (Figure 15). Three occurrences in spring bongo samples (not shown in Figure 15) were located in the same locality as the captures in fall samples. Pearlfish larvae were captured significantly more often in the study area than Gulfwide during fall surveys but at comparable frequencies in spring bongo samples (Table 3). Relative abundances and CPUEs in the 2 areas were similar, differing by < 0.1% (Table 4).

Carapus bermudensis (68 occurrences; 210 larvae; Figure 16)

Larvae of this species of pearlfish were taken more frequently and in greater numbers during fall than spring surveys in bongo samples; larvae were never taken in neuston collections (Table 1). Mean size of captured *C. bermudensis* larvae was 14.2 mm BL (n = 56; range = 2.9—74 mm). Most captures of pearlfish larvae were made at localities east of 87°W longitude and generally over water depths ≤ 50 m (Figure 16). This was unlike the pattern among larvae identified only to the family level which were captured somewhat more often in the southwestern corner of the IOS—NEGOM research polygon (Figure 15). *Carapus bermudensis* larvae were captured significantly more often in the study area than in Gulfwide samples during fall surveys (Table 3). Occurrence during spring surveys and relative abundance (differing by < 0.1%) were comparable in the 2 areas (Table 4).

Bregmacerotidae (441 occurrences; 9,918 larvae; Figure 17)

Codlets are generally known as epipelagic planktivores, but have been documented feeding epibenthically and intensely on reef—top habitat at night on NEGOM "Pinnacles Tract" reefs (K. Sulak, unpublished video data, USGS,

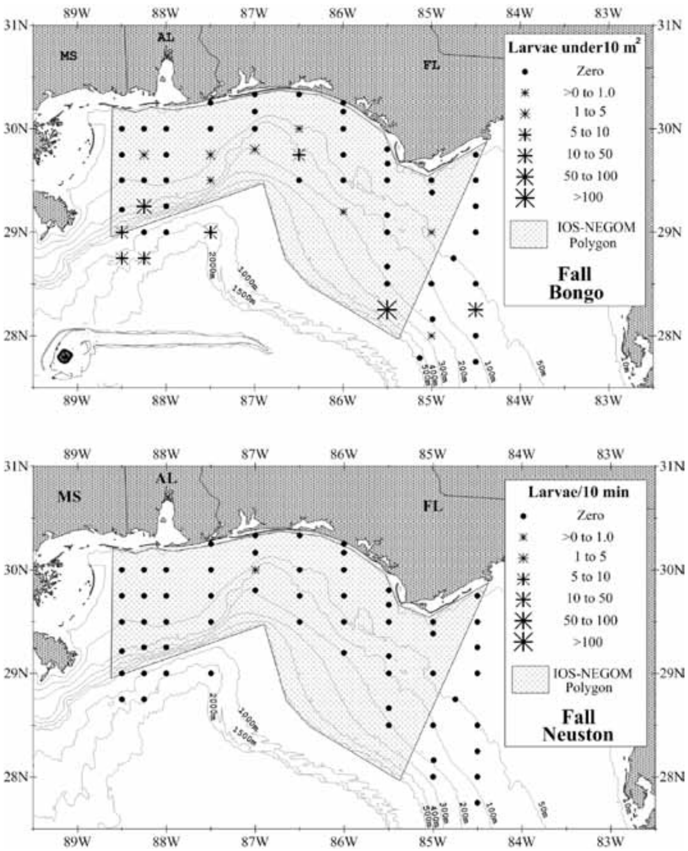

Figure 15. *Mean abundance and mean CPUE of the pearlfish (Carapidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of three occurrences in spring survey bongo samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

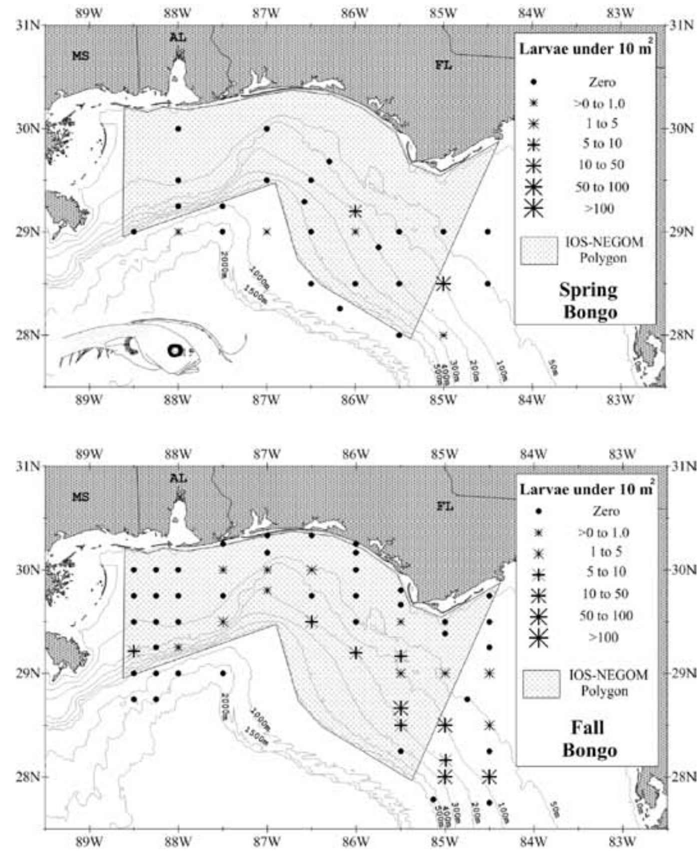

Figure 16. *Mean abundance of pearlfish, Carapus bermudensis, larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

Gainesville, FL). Codlet larvae were common throughout the UNIS study area during both spring and fall but most larvae were taken in bongo samples during fall surveys (Table 1). The overall size range of codlet larvae captured in UNIS study area collections was 1.6—28.3 mm BL (n = 493). Mean abundances of > 100 larvae under 10 m² were typical especially in the southwestern corner of the study area, the head of the DeSoto Canyon, and its eastern 'slopes' (Figure 17). Codlet larvae were taken in over 80% of bongo samples in the spring and over 55% in the fall in both the UNIS study area and Gulfwide. The occurrence of codlet larvae in neuston samples was much lower than in bongo samples with values never exceeding 15% during either spring or fall surveys. The frequency of capture in UNIS study area samples was significantly greater than in Gulfwide survey samples during both seasons except in fall neuston samples when frequency of capture was comparable in the 2 areas (Table 3). Relative abundances and CPUEs in both areas were similar, differing by < 2% (Table 4).

MUGILIDAE (154 occurrences; 1,669 larvae; Figure 18)

As silvery, pelagic juveniles, mullet inhabit surface waters of the open ocean for up to several months before migrating inshore. Young of the abundant species of mullets in the GOM are likely to be present in UNIS study area plankton collections despite their differing spawning seasons; *Mugil cephalus* spawns in late fall and winter while *M. curema* spawns in the spring (Ditty and Shaw 1996). Young mullet were taken almost exclusively in neuston samples during spring surveys throughout the study area (Table 1, Figure 18). The overall size range of young mullet captured in UNIS study area collections was 2.1—11.0 mm BL (n = 16) in bongo samples and 3.0—27.5 mm BL (n = 302) in neuston samples. Springtime occurrence of young mullet in the UNIS study area neuston samples exceeded their occurrence in Gulfwide samples, 47% vs. 31%, but frequency of capture in spring bongo samples was comparable in the 2 areas (Table 3). The difference in percent occurrence between the 2 areas was statistically significant (Table 3). Larvae were significantly less common in the study area than Gulfwide during fall surveys. Relative abundances and CPUEs in both areas were similar, differing by < 2% (Table 4).

MELAMPHAIDAE (58 occurrences; 90 larvae; Figure 19)

The melamphaids are meso— and bathypelagic fishes whose larvae were taken in the UNIS study area almost exclusively in bongo samples, and were more common during spring than fall surveys (Table 1). The overall size range of

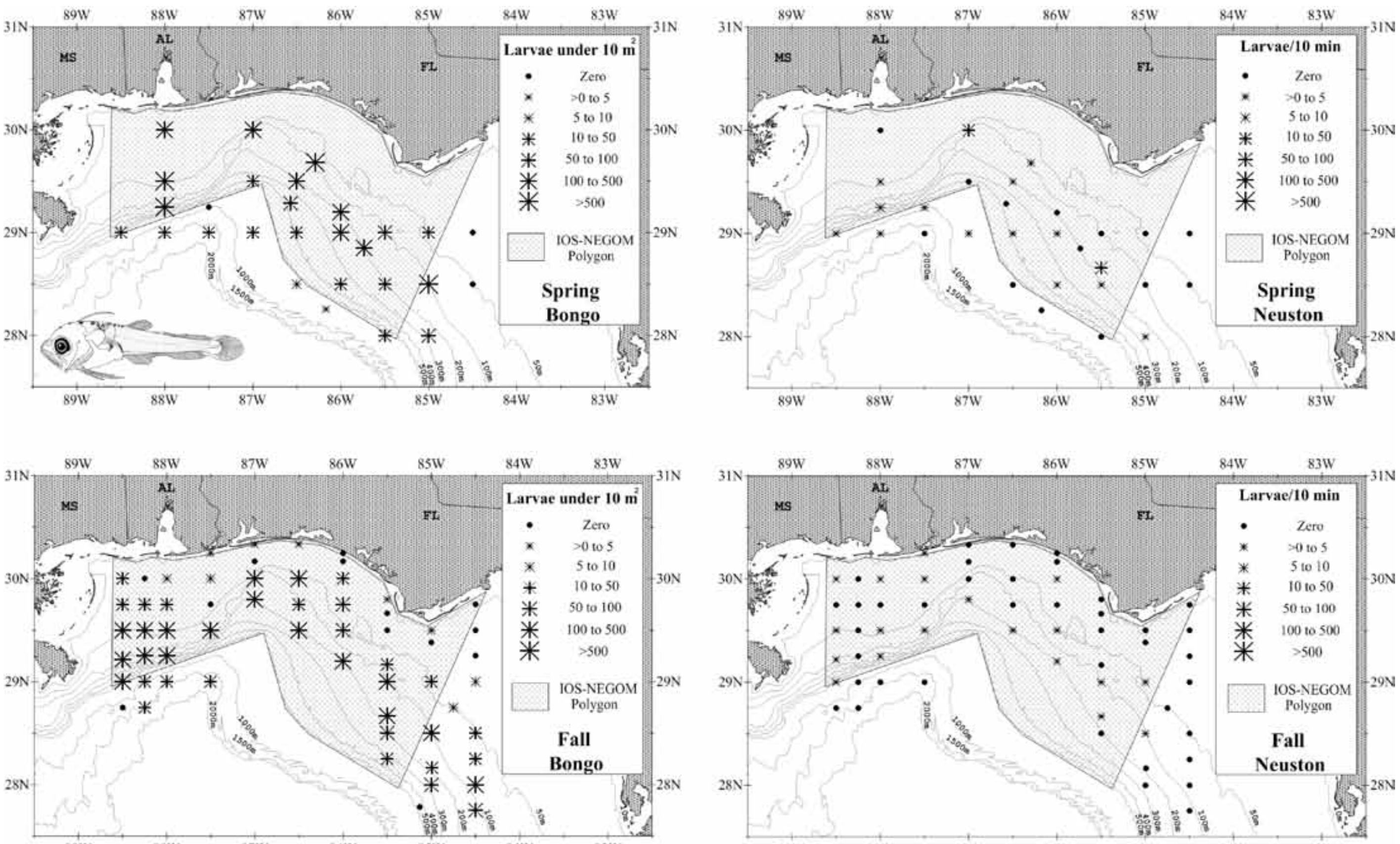

Figure 17. *Mean abundance and mean CPUE of codlet (Bregmacerotidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

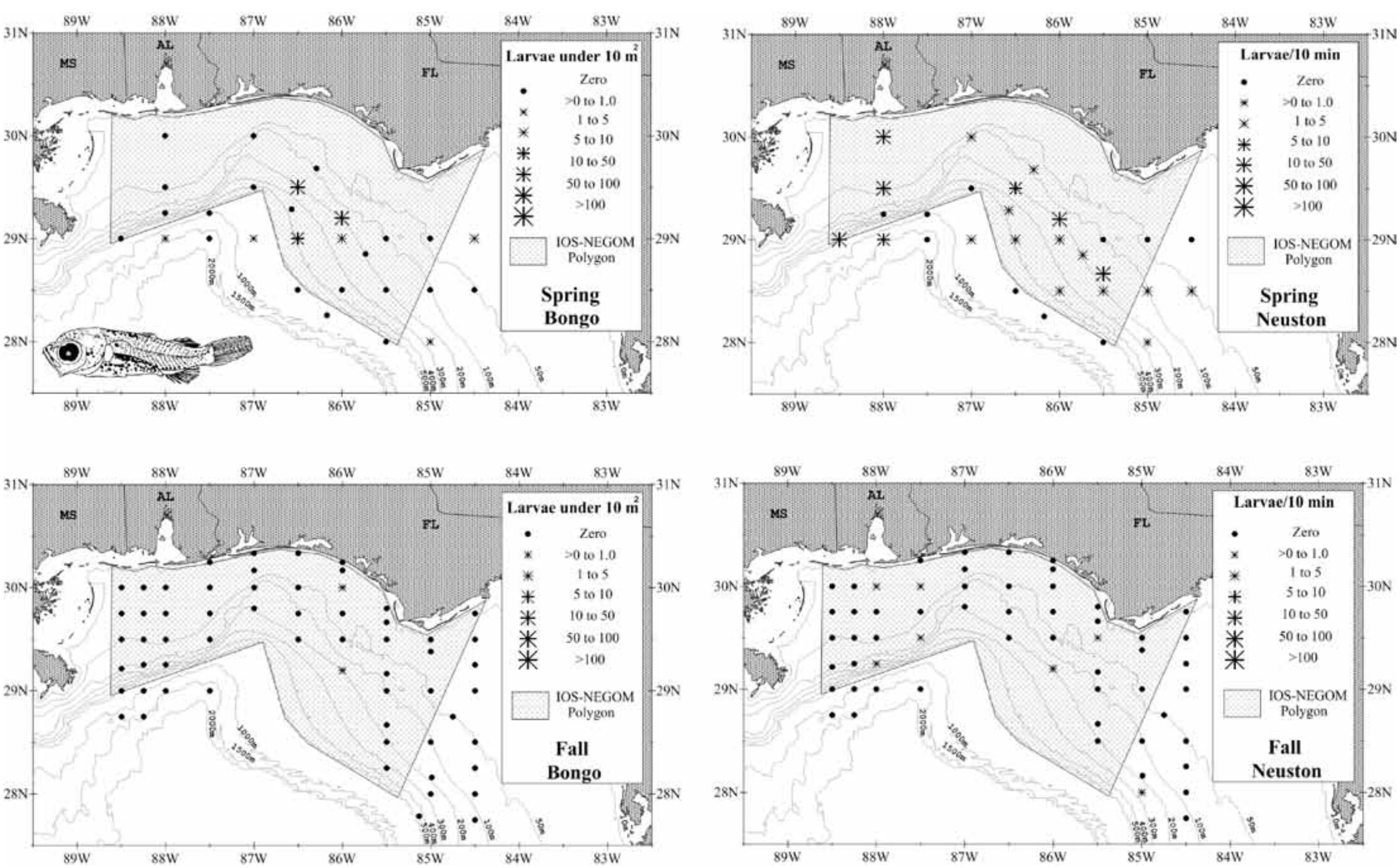

Figure 18. *Mean abundance and mean CPUE of mullet (Mugilidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

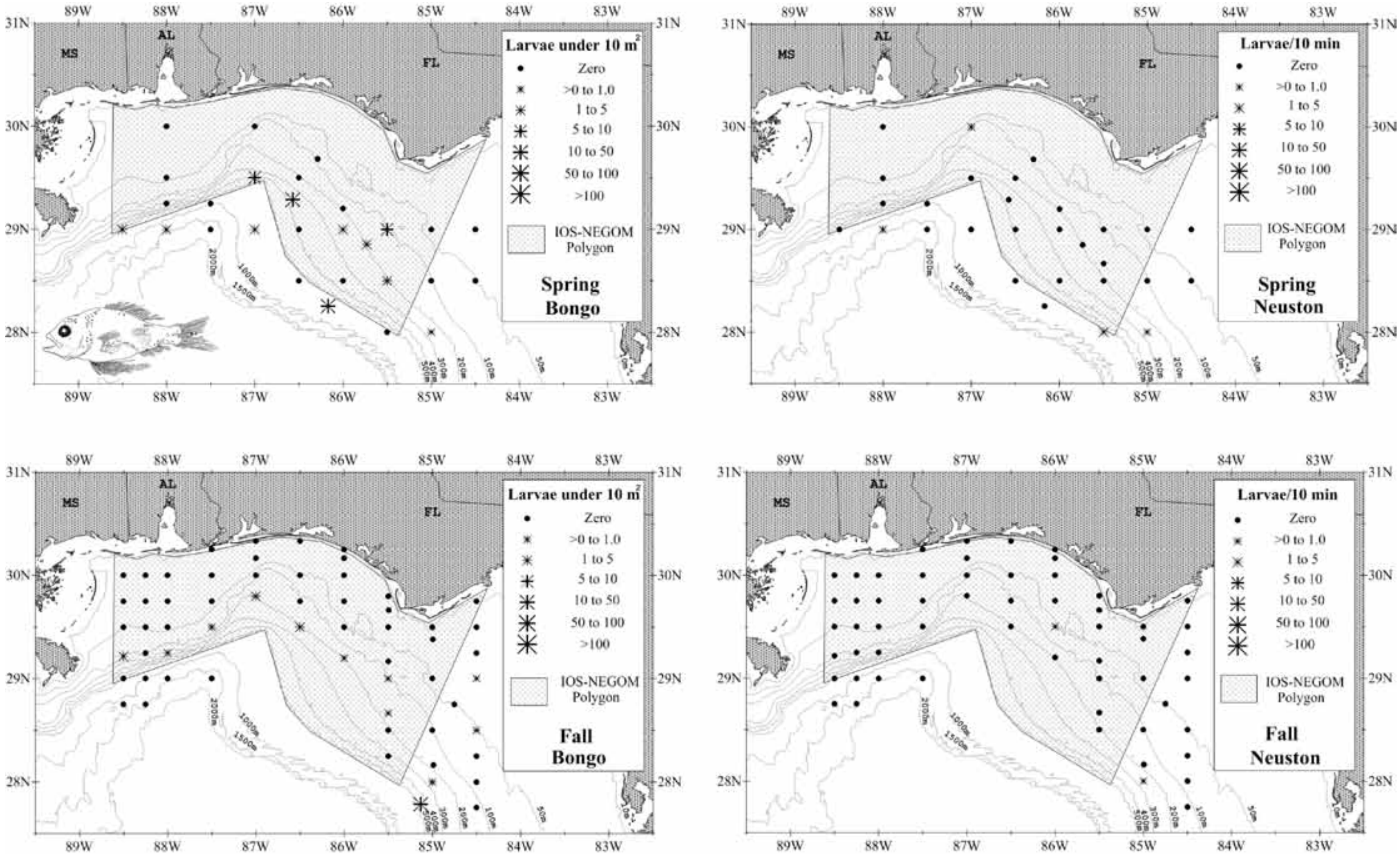

Figure 19. *Mean abundance and mean CPUE of bigscales (Melamphaidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

melamphaid larvae captured in UNIS study area collections was 1.6—15.7 mm BL (n = 43). Most occurrences and highest mean abundances were observed at localities where station depths were ≥ 100 m (Figure 19). Bigscales or ridgehead larvae were taken significantly less often in study area bongo samples than Gulfwide during spring surveys (Table 3). Occurrence in spring neuston samples and during fall surveys was comparable in the 2 areas. Relative abundances and CPUEs in both areas were similar, differing by < 0.1% (Table 4).

Holocentridae (23 occurrences; 34 larvae; Figure 20)

The larvae and neustonic prejuvenile ('rhynchichthys') stage of these nocturnally active reef fishes are distinctive and unique among early life stages, yet identification beyond the family level is problematic (Lyczkowski—Shultz et al. 2000, Richards et al. 2006a). Squirrelfish larvae were taken primarily in neuston collections and were as frequently taken and as numerous in both spring and fall surveys (Table 1). Mean size in neuston collections was 10.4 mm BL (n = 18; range = 3.0—26.8 mm) and mean size in bongo samples was 2.0 mm BL (n = 4; range = 1.8—2.2 mm). Occurrences within the UNIS study area were restricted to localities where depths were ≥ 200 m (Figure 20). Most squirrelfish larvae, however, were taken at stations outside the IOS—NEGOM research polygon; either at more offshore localities over depths > 500 m or to the southeast at comparable or shallower depths. Squirrelfish larvae were significantly less common in the study area than Gulfwide during both surveys (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.5% (Table 4).

Serranidae (320 occurrences; 1,415 larvae)

Serranid larvae were nearly ubiquitous and homogeneously distributed throughout the UNIS study area and therefore, no distribution map is presented here. However, the distributions of 4 subfamilies did show differences and are presented below. Larvae were taken more frequently in bongo than neuston samples, during fall than spring surveys, and relatively more often in the study area than Gulfwide (Tables 1, 3). Mean size in bongo samples was 2.6 mm BL (n = 739; range = 1.2—11.0 mm) and mean size in neuston samples was 4.2 mm BL (n = 153; range = 2.7—11.5 mm). Larvae in this category were not identified beyond the family level because they had not developed certain key characteristics that would permit identification to one of the 5 serranid subfamilies. Larvae within these subfamilies are distinctive and can be identified once diagnostic characters such as head, dorsal and pelvic spines are developed (Richards 2006). It is likely that most of the larvae identified to the family level only belonged to the Subfamily Serraninae since larvae of this taxon were the most numerous among larvae that could be identi-

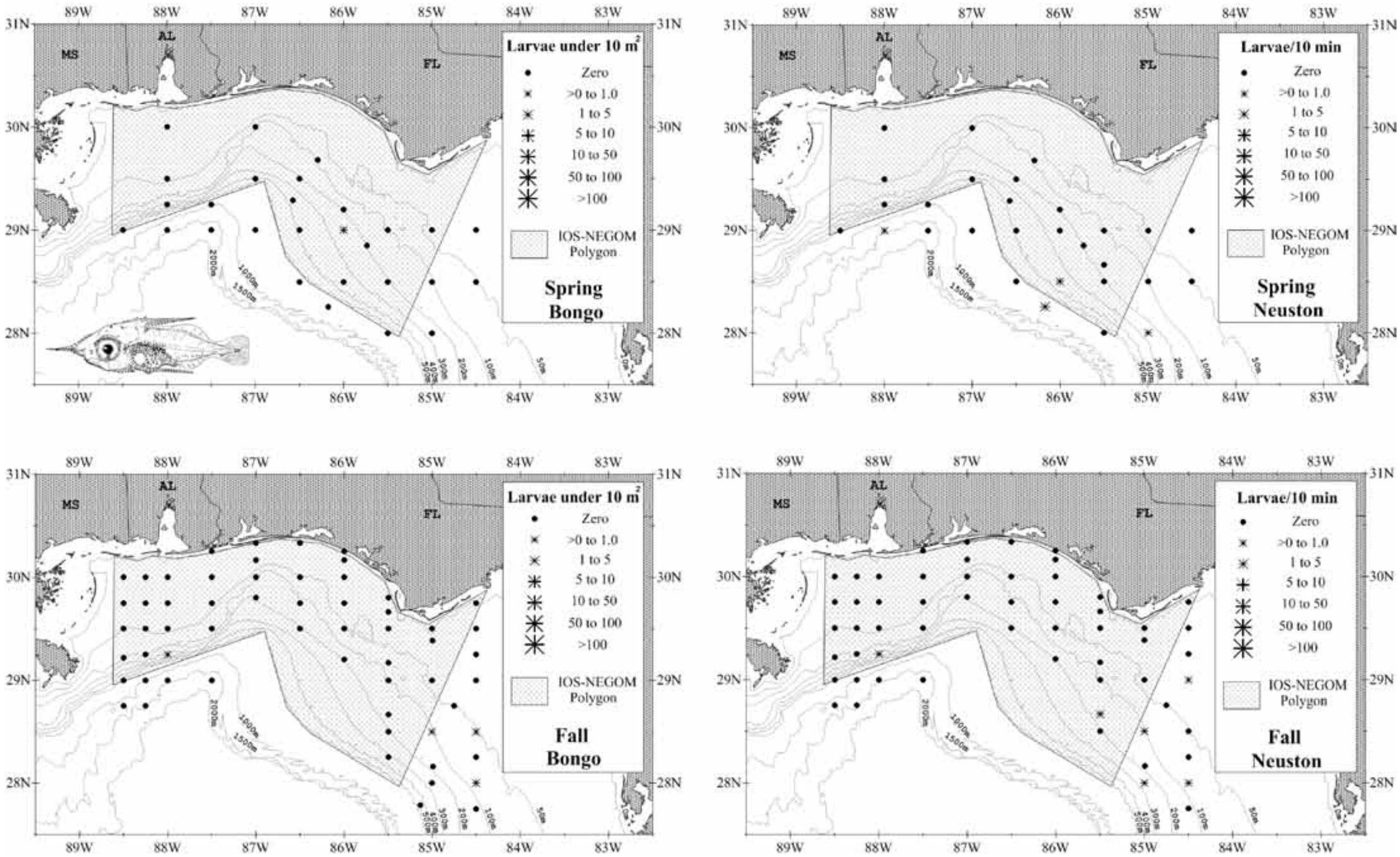

Figure 20. *Mean abundance and mean CPUE of squirrelfish (Holocentridae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

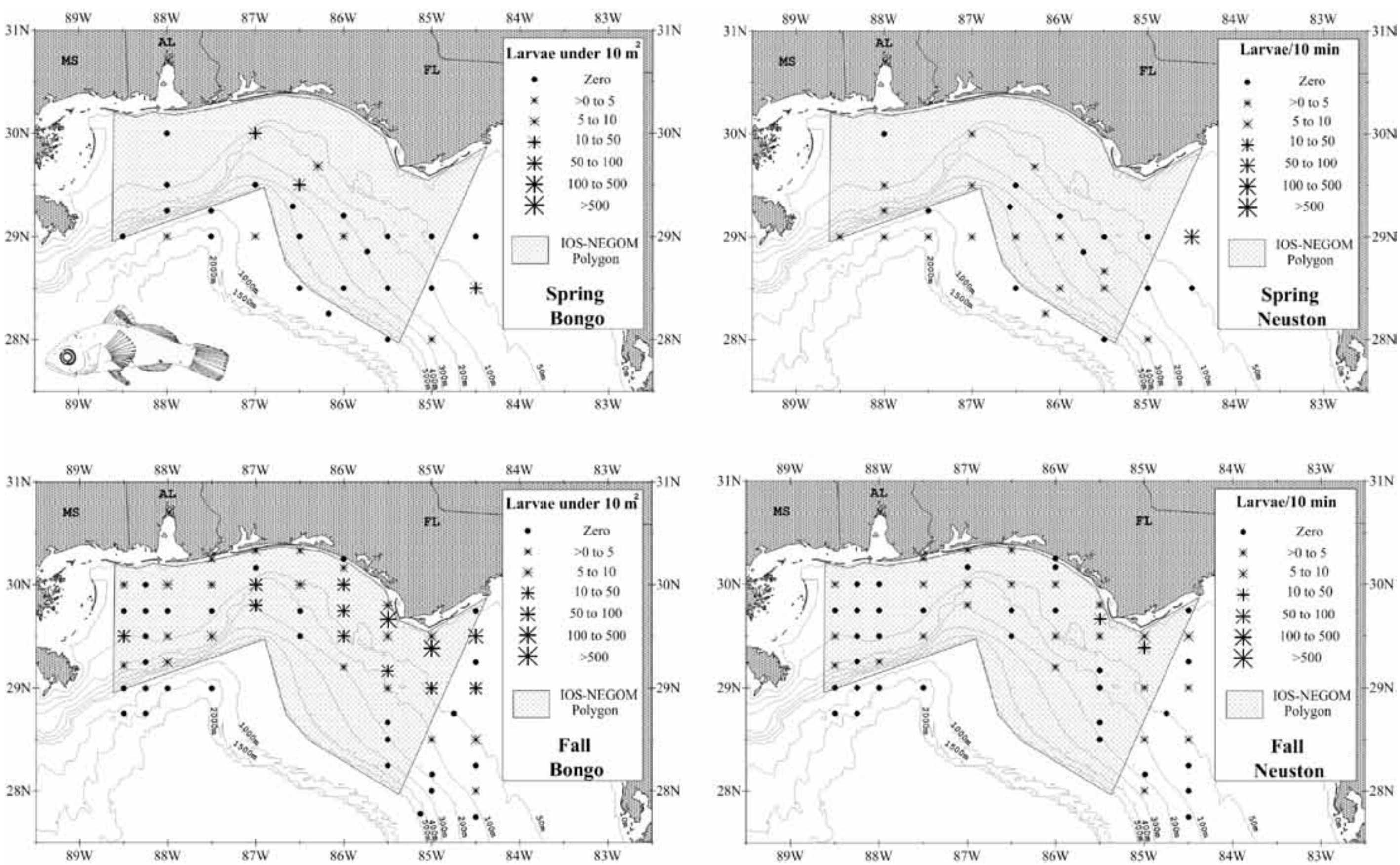

Figure 21. *Mean abundance and mean CPUE of Serraninae larvae (Family Serranidae) at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

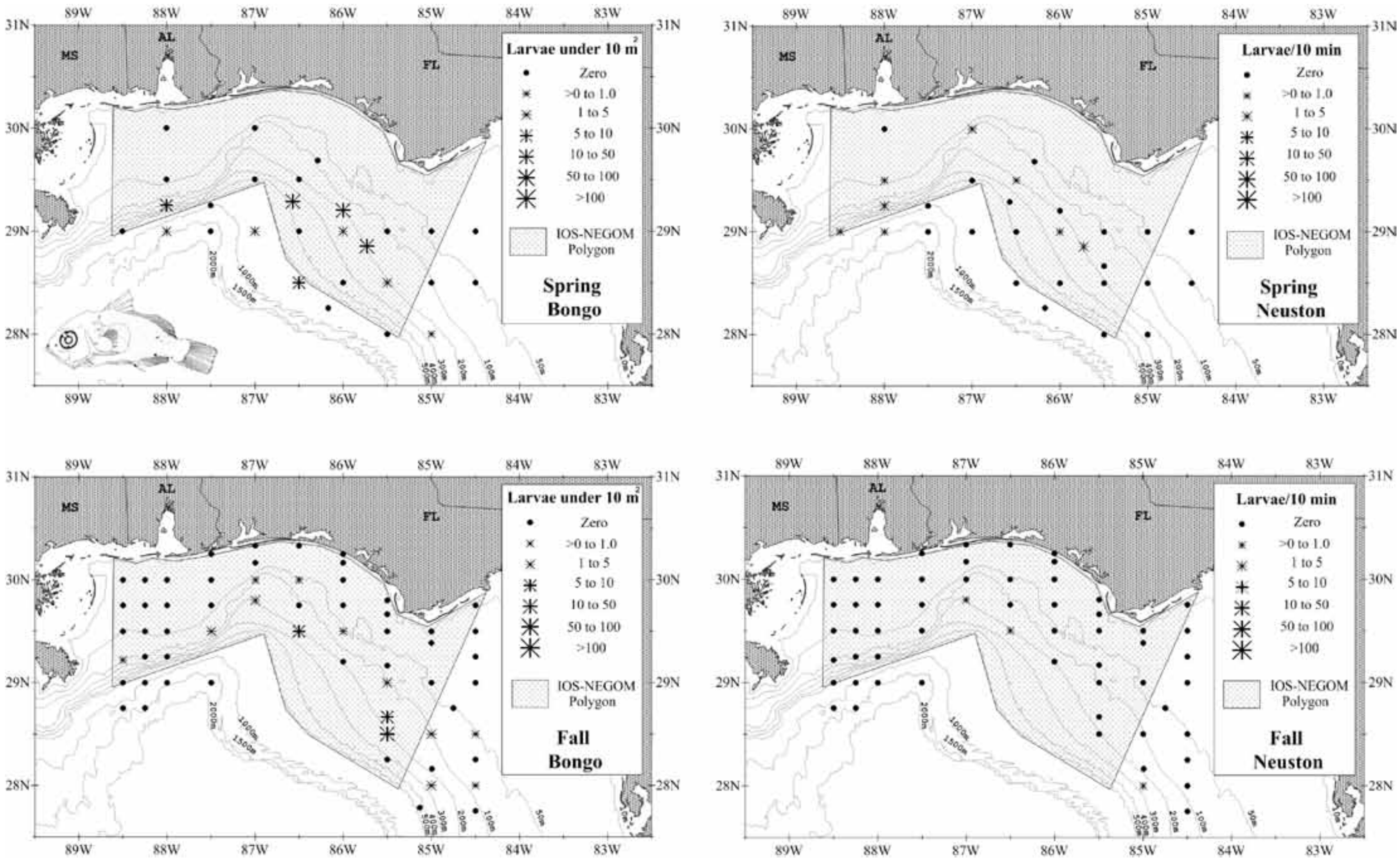

Figure 22. *Mean abundance and mean CPUE of Anthiinae larvae (Family Serranidae) at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

fied to the subfamily level. Frequency of occurrence did not differ statistically between the UNIS and Gulfwide survey areas except in fall when serranid larvae were taken significantly more often in the study area than Gulfwide in bongo samples (Table 3). Relative abundances and CPUEs in the two areas differed by < 0.1% (Table 4).

SERRANINAE (236 occurrences; 1,672 larvae; Figure 21)

Sea bass larvae of the Subfamily Serraninae occurred most frequently and in greater numbers than the larvae of any of the other 4 subfamilies of sea basses. This taxon comprises species of genera such as the soft bottom dwelling *Centropristis* and *Diplectrum* and the reef dwelling *Hypoplectrus* and *Serranus*, among others. Over 67% of the occurrences and specimens of serranine larvae were captured in bongo samples and over 75% of the larvae were collected during fall surveys (Table 1). Mean size in neuston collections was 4.2 mm BL (n = 297; range = 2.1—11.5 mm) and mean size in bongo samples was 3.6 mm BL (n = 508; range = 1.5—12.1 mm). Larvae were found at both the shallowest and deepest localities during spring surveys, whereas during fall surveys, serranine larvae occurred most often at localities inshore of the 100 m isobath with highest mean abundances in the eastern region of the study area (Figure 21). Frequency of occurrence did not differ statistically between the UNIS and Gulfwide survey areas except in spring, when serranine larvae were taken significantly more often in the study area than Gulfwide in neuston samples (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.2% (Table 4).

ANTHIINAE (72 occurrences; 182 larvae; Figure 22)

Larvae of the Subfamily Anthiinae (streamer basses) were third in occurrence and abundance among sea bass larvae taken in the UNIS study area. In the GOM this subfamily comprises species in the genera, *Anthias*, *Hemanthias*, and *Pronotogrammus*. All species are abundant planktivores and ecologically important components of deep reef communities in the NEGOM (Weaver et al. 2002). Most larvae were taken in bongo samples and during spring surveys when the greatest mean abundances were found at localities between 200—400 m (Figure 22). Mean size in neuston collections was 3.9 mm BL (n = 55; range = 2.5—5.5 mm) and mean size in bongo samples was 3.1 mm BL (n = 108; range = 1.8—10.0 mm). Distribution of anthiine larvae during fall surveys closely followed the isobaths outlining the DeSoto Canyon between 87.5 and 85.5°W longitudes with larvae being collected at localities between 50—200 m (Figure 22). Frequency of occurrence did not differ statistically between the UNIS and Gulfwide survey areas except in fall when anthiine larvae were taken significantly more often in the study area than Gulfwide in bongo samples (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.3% (Table 4).

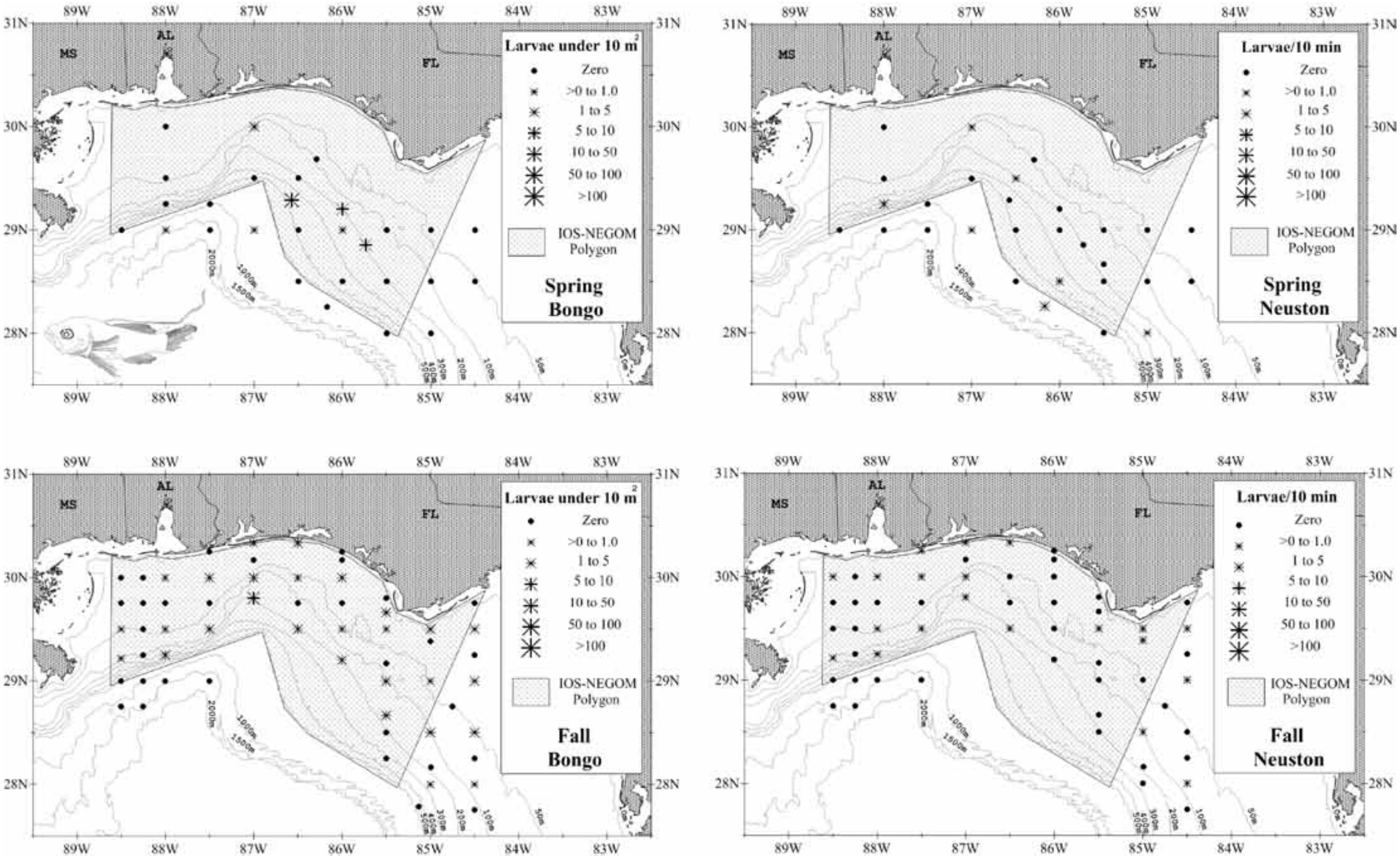

Figure 23. *Mean abundance and mean CPUE of Grammistinae larvae (Family Serranidae) at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

Epinephelinae (3 occurrences; 3 larvae)

This subfamily includes the groupers, many of which are important resource species, and most of which are reef associates. A total of only 3 grouper larvae, ranging in size from 1.6—4.0 mm BL, were taken; all in bongo samples and all during spring surveys (Table 1). Larvae were taken at 3 localities within the IOS—NEGOM research polygon located on the 200 m isobath between 86 and 85.5°W longitudes and at a third site outside the IOS—NEGOM research polygon along the 87°W meridian between 500—1000 m. Grouper larvae were captured an additional 32 times Gulfwide: in spring (27 occurrences) and fall (5 occurrences); and in bongo (30 occurrences) and neuston (2 occurrences) samples (Table 3). A recent re—examination of all grouper larvae (n = 474) collected Gulfwide during SEAMAP surveys (1982—2005) now provides a more comprehensive description of the abundance and distribution of grouper larvae in the GOM (Marancik et. al. 2010, 2012); therefore, no distribution map is presented here.

Grammistinae (117 occurrences; 215 larvae; Figure 23)

Larvae of the soapfish subfamily were the second most common among serranid larvae in the UNIS study area. Larvae were most often captured in bongo than neuston samples, and over 80% were taken during fall surveys. Mean size in neuston collections was 5.4 mm BL (n = 61; range = 2.8—16.0 mm) and mean size in bongo samples was 3.9 mm BL (n = 125; range = 1.8—11.8 mm). Soapfish larvae were distributed throughout the study area but were more commonly found east of longitude 87.5°W (Figure 23). Frequencies of occurrence in the UNIS and Gulfwide survey areas were not statistically different during either survey (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Priacanthidae (109 occurrences; 239 larvae; Figure 24)

Priacanthids (bigeyes) are shallow to deep water, hard—bottom dwelling fishes, and typical inhabitants of NEGOM deep reefs (Weaver et. al. 2002). Their life history includes a pelagic juvenile stage (Watson 1996a). Larvae were equally represented in bongo and neuston collections in the UNIS study area; however, most occurrences and specimens were taken during fall surveys (Table 3). Mean size in neuston collections was 4.7 mm BL (n = 49; range = 2.4—18.0 mm) and mean size in bongo samples was 2.9 mm BL (n = 71; range = 1.4—6.8 mm). Priacanthid larvae were distributed throughout the study area but larvae were taken more often at localities east of 87°W longitude (Figure 24). Frequencies of occurrence in the UNIS and Gulfwide survey areas were not statistically different and relative abundances and CPUEs in the 2 areas differed by < 0.1% (Tables 3, 4).

Apogonidae (169 occurrences; 579 larvae; Figure 25)

The cardinalfishes are planktivorous, nocturnal fishes usually associated with reefs whose larvae hatch with func-

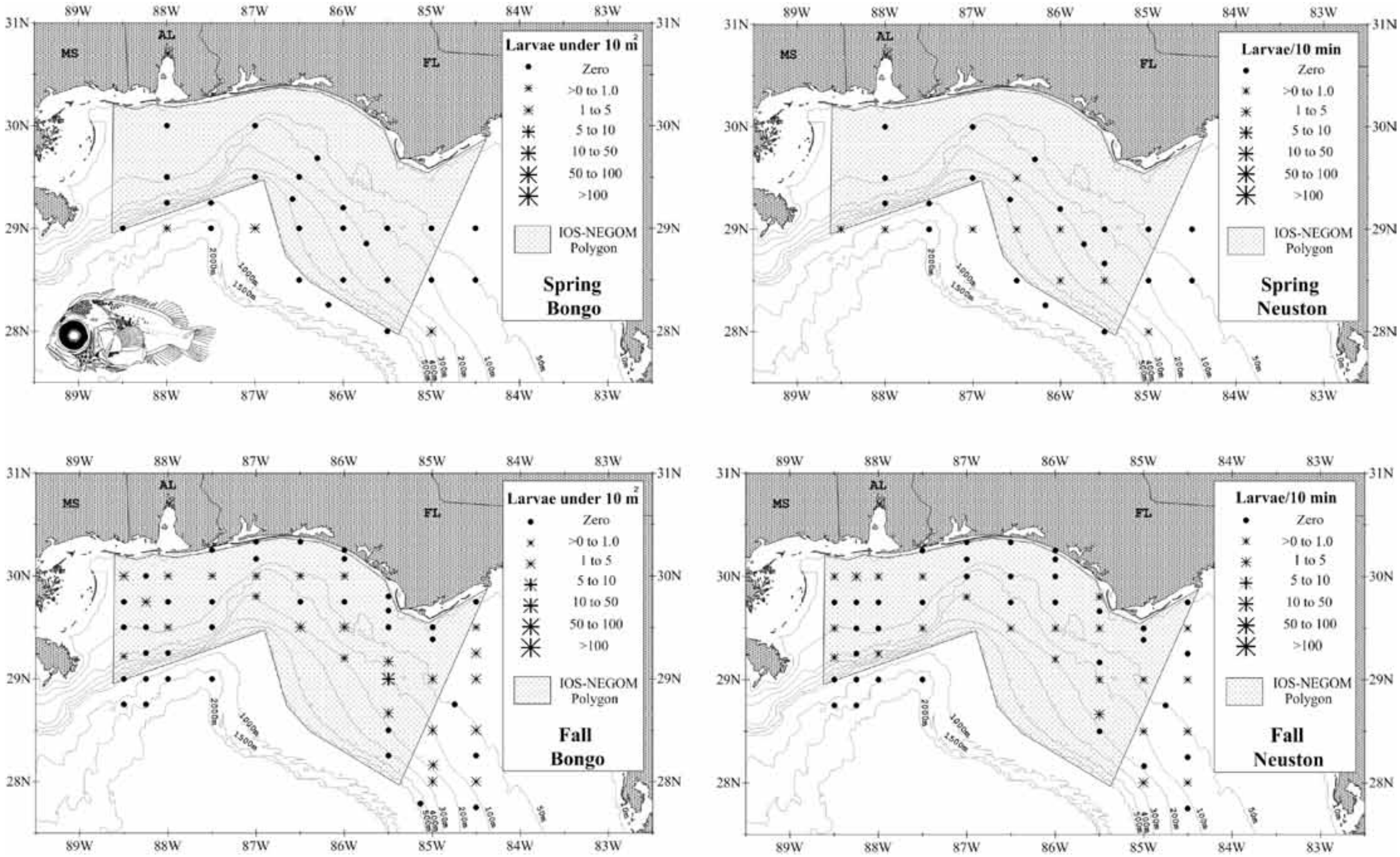

Figure 24. *Mean abundance and mean CPUE of bigeye (Priacanthidae) larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

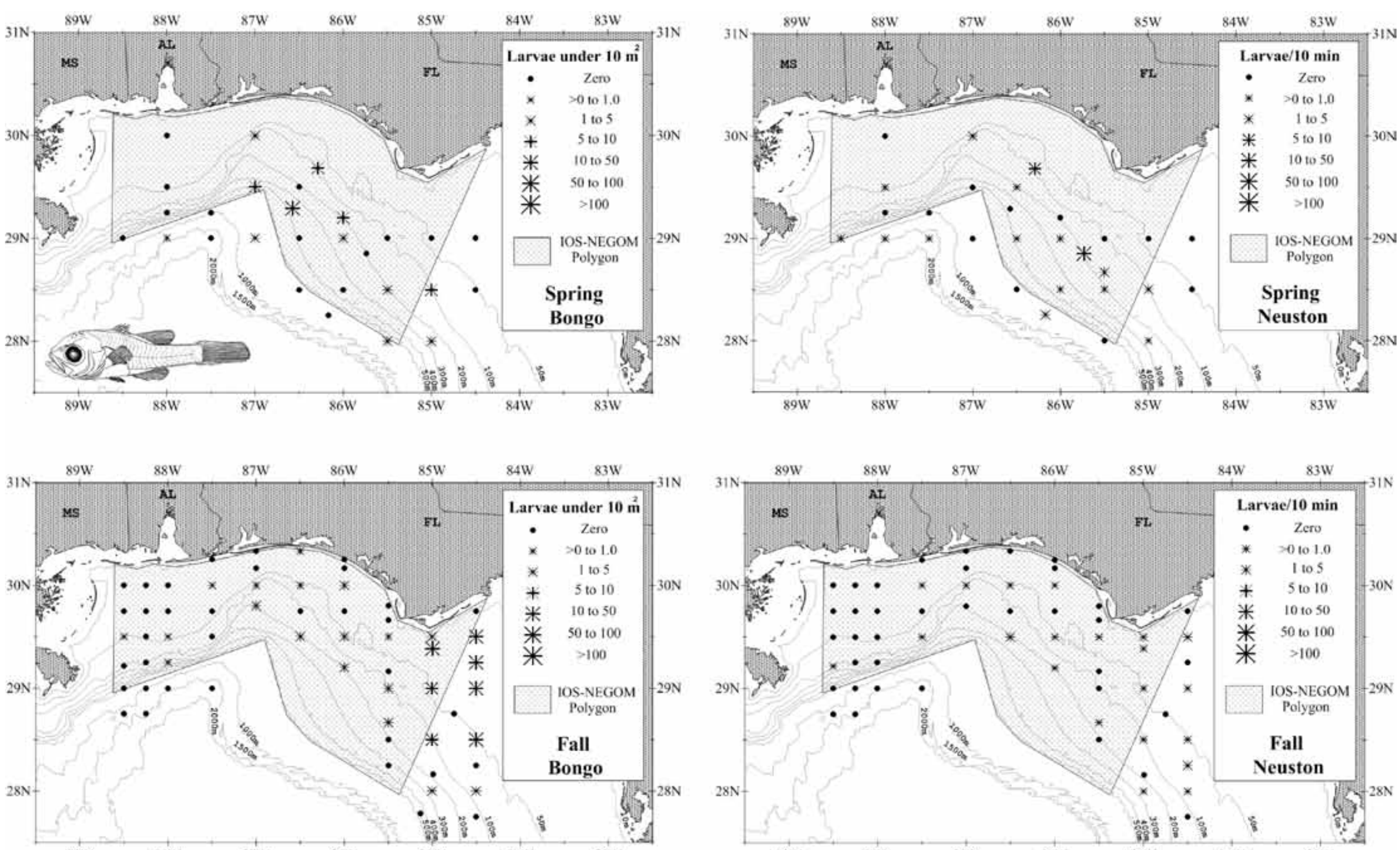

Figure 25. *Mean abundance and mean CPUE of cardinalfish (Apogonidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

tional mouths and pigmented eyes; subsequently, the larvae of many species are mouth—brooded prior to dispersal into the plankton (Thresher 1984). Definitive identification of larvae as belonging to the family Apogonidae is problematic prior to median fin base formation (Leis and Rennis 1983). Despite this uncertainty, data on SEAMAP collected larvae identified as apogonids are summarized herein. Potentially misidentified larvae (i.e., belonging to another fish family) are likely an insignificant fraction of the total putative apogonids. Cardinalfish larvae were captured only slightly more often in bongo than in neuston samples but larvae were more common and numerous in fall than in spring survey samples (Table 1). Mean size in neuston collections was 4.5 mm BL (n = 60; range = 2.9—15.0 mm) and mean size in bongo samples was 3.6 mm BL (n = 94; range = 1.5—10.5 mm). Apogonid larvae were taken more often and were more numerous at localities east of 87°W longitude during both surveys (Figure 25). Larvae were significantly more common in the UNIS than Gulfwide survey area during spring surveys in neuston samples but were significantly less common in the UNIS study area during fall surveys in bongo samples (Table 3). Frequencies of occurrence in spring bongo and fall neuston samples were not significantly different in the 2 areas. Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

RACHYCENTRIDAE

Rachycentron canadum (5 occurrences; 21 larvae; Figure 26)

The larvae of this highly prized recreational and coastal migratory species are rarely taken in plankton collections. Cobia larvae occurred only 5 times in UNIS study area collections, all in neuston samples and most specimens (17) during spring surveys (Table 1). Mean size of larvae was 10.9 mm BL (n = 7; range = 7.0—21 mm). Larvae were captured at 4 different stations, all along or west of 87°W longitude (Figure 26). Water depth at the sites of capture during spring surveys was ≥ 500 m, whereas water depth at capture sites during fall surveys was ~200 m. More cobia larvae were taken in the study area during spring than fall surveys while the reverse was true Gulfwide. Frequency of occurrence of cobia larvae was not significantly different between the study area and Gulfwide during spring surveys (Table 3). However, despite the few captures overall, occurrence in neuston samples was significantly less than in study area samples during fall surveys than Gulfwide. Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

CORYPHAENIDAE (187 occurrences; 438 larvae; Figure 27)

The young of two species of dolphins are combined in this taxon, *Coryphaena equisetis* and *C. hippurus*. Although taken in bongo samples as well, most *Coryphaena* larvae were collected in neuston samples, with over half the occurrences and over 60% of the specimens being taken during spring surveys (Table 1). The overall size range of young dolphin captured in UNIS study area collections was 3.0—31 mm BL (n = 14) in bongo samples and 3.0—105 mm BL (n = 251) in neuston samples. Young dolphins were distributed throughout the UNIS study area during both survey timeframes. Mean abundances were fairly uniform across the study area in the spring but higher mean abundances were observed in the western region during fall surveys (Figure 27). The frequency of occurrence of dolphin larvae in spring bongo samples and during fall surveys was not significantly different between the study area and Gulfwide (Table 3), but occurrence in spring survey neuston samples was significantly less in the study area than Gulfwide. Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

CARANGIDAE

Caranx spp. (183 occurrences; 1,449 larvae; Figure 28)

The young of 6 species of jacks, all important forage fish, cannot be reliably separated, although identification to genus even at small sizes is straightforward. Larvae were taken primarily in neuston samples but with equal frequency in both spring and fall surveys (Table 1). The overall size range of jack larvae captured in UNIS study area collections was 2.2—55 mm BL. Jack larvae occurred more consistently and

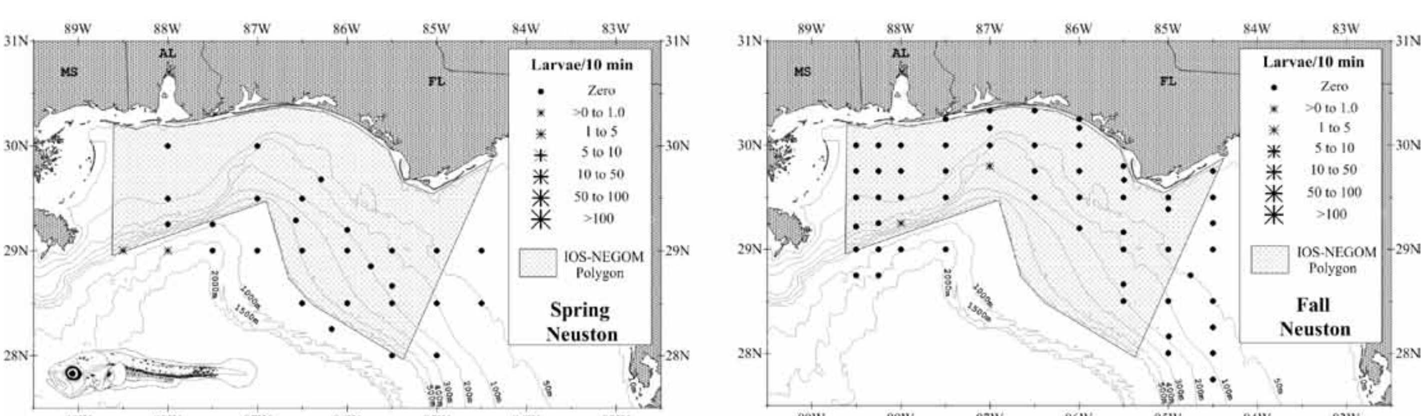

Figure 26. *Mean CPUE of cobia,* Rachycentron canadum, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

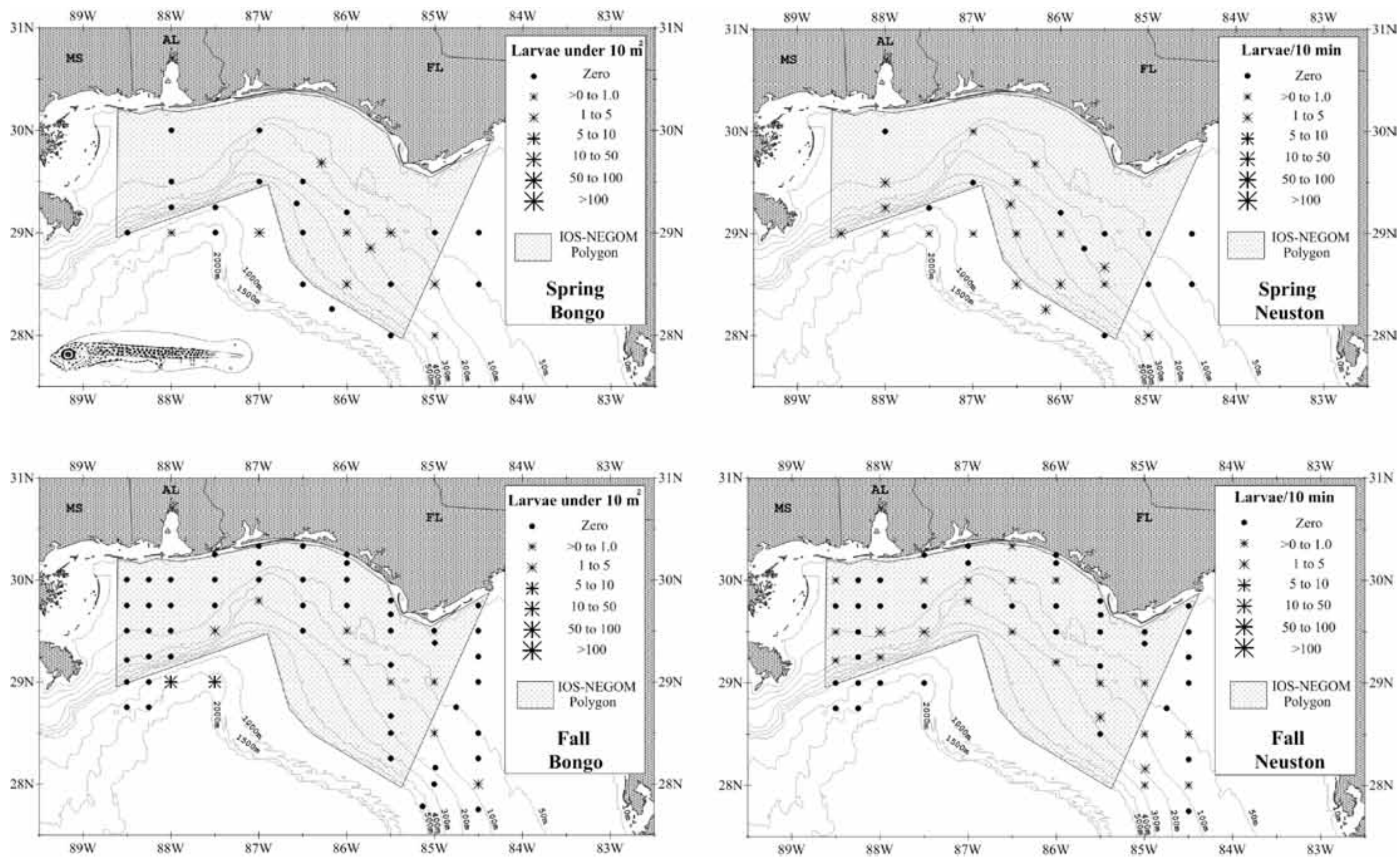

Figure 27. *Mean abundance and mean CPUE of dolphin (Coryphaenidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

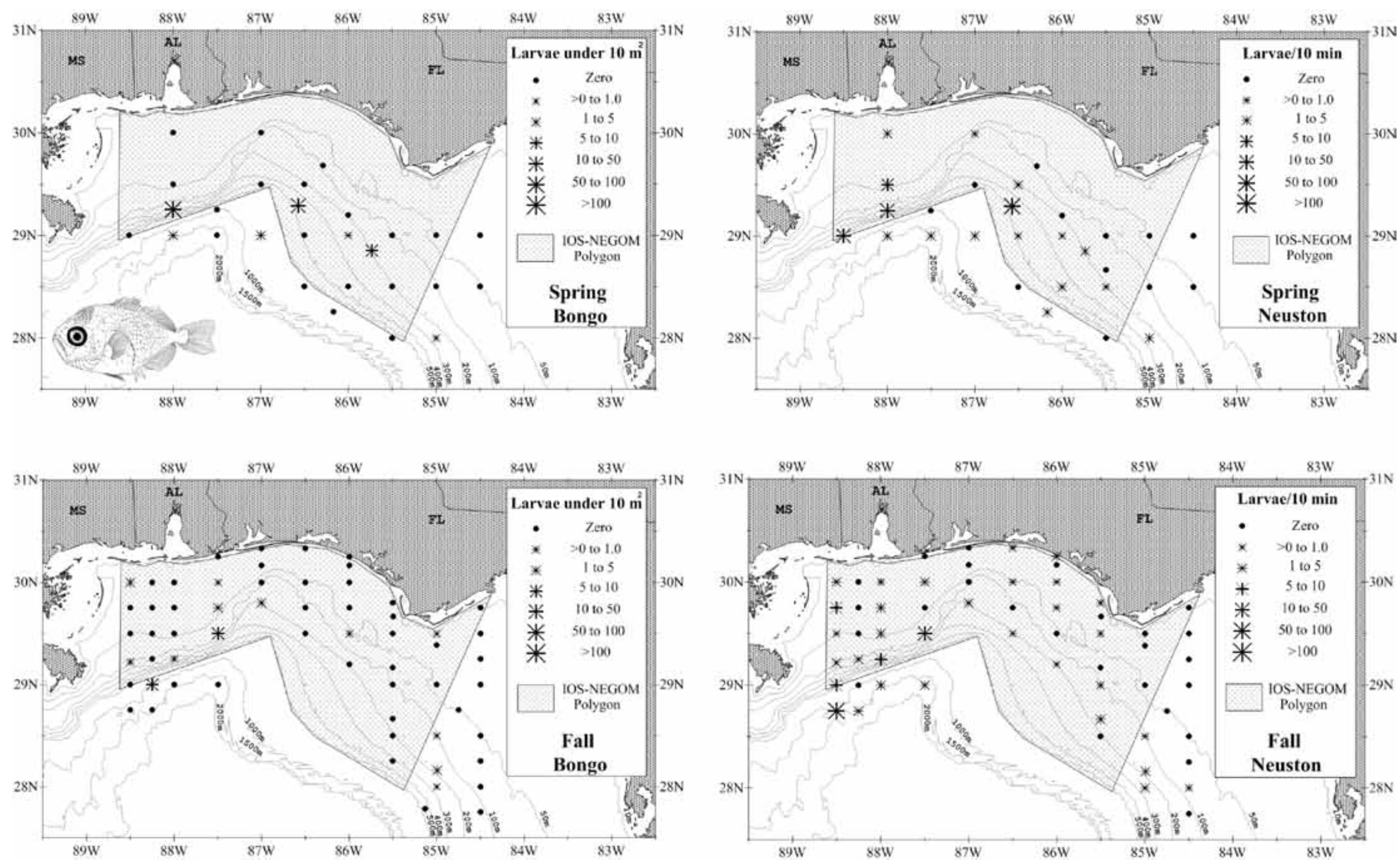

Figure 28. *Mean abundance and mean CPUE of jack larvae, genus Caranx, at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

in greater numbers in the western region of the IOS—NEGOM research polygon (west of 87°W longitude) then in the eastern region (Figure 28).

Jack larvae were significantly less common in study area spring neuston samples and during fall surveys than Gulfwide (Table 3). Frequency of occurrence in spring bongo samples was not significantly different between the 2 areas. Relative abundances and CPUEs in the 2 areas differed by < 4% (Table 4).

Chloroscombrus chrysurus (206 occurrences; 14,916 larvae; Figure 29)

Throughout the species range, Atlantic bumper young are most often seen in commensal association with jellyfishes. Larvae and juveniles were second in occurrence but first in abundance among carangid larvae captured in the UNIS study area. Although they were taken almost as frequently in bongo as in neuston samples, over 90% of specimens were captured in neuston collections and all but one occurrence (8 specimens) came during fall surveys (Table 1). Mean size in bongo samples was 3.2 mm BL (n = 281; range = 1.2—40 mm) and mean size in neuston samples was 7.3 mm BL (n = 252; range = 1.8—42 mm). Larvae were taken throughout the study area, but the highest mean abundances were well within the 50 m isobath and at the northernmost localities of the study area (Figure 29). The single occurrence of a larvae in spring (not shown in Figure 29) was at station B176 over 50 m water depth. Atlantic bumper, like *Caranx* spp., larvae were taken more consistently and in greater numbers farther offshore in the southwestern than the southeastern region of the study area. The occurrence of Atlantic bumper larvae in spring neuston samples was comparable in both areas but larvae were significantly less common in the study area than Gulfwide in fall bongo and neuston samples (Table 3). Relative abundance and CPUE in the 2 areas differed by < 0.1% in spring survey samples and by < 7% in fall survey samples (Table 4).

Decapterus spp. (479 occurrences; 7,101 larvae; Figure 30)

Three species of *Decapterus* may occur in the GOM but the most common one is the round scad, *D. punctatus*. Therefore, it is likely that the majority of larvae identified to this taxon are *D. punctatus* larvae. *Decapterus* larvae were the most frequently captured and second most abundant among carangid larvae in the UNIS study area. These larvae were as frequently captured in bongo as in neuston samples but, unlike Atlantic bumper larvae, they were also as numerous in bongo as in neuston samples (Table 1). Most larvae, 87% of occurrences and 94% of specimens, were taken during fall surveys. Mean size in bongo samples was 3.2 mm BL (n = 1002; range = 1.2—61 mm) and mean size in neuston samples was 8.5 mm BL (n = 866; range = 1.5—57 mm). Unlike the 2 previous carangid taxa, *Decapterus* larvae were nearly homogeneously distributed throughout the UNIS study area from east to west and onshore to offshore (Figure 30). *Decapterus* larvae also differed from *Caranx* and *Chloroscombrus* larvae in that they occurred more frequently in the study area than Gulfwide in all but one survey/gear combination (Table 3). The frequency of occurrence of *Decapterus* larvae in spring neuston samples and fall bongo and neuston samples was significantly higher in the study area than Gulfwide (Table 3). Occurrence in spring bongo samples was comparable in the 2 areas. Relative abundances and CPUEs in the 2 areas differed by < 3% (Table 4).

Selar crumenophthalmus (99 occurrences; 710 larvae; Figure 31)

Young bigeye scad, although relatively numerous, did not occur as frequently as the previously treated carangid taxa. Bigeye scad larvae were captured about as often in bongo and neuston collections but most specimens (83%) were taken in neuston samples during fall surveys (Table 1). Mean size in bongo samples was 2.7 mm BL (n = 81; range = 1.4—7.0 mm) and mean size in neuston samples was 4.3 mm BL (n = 83; range = 2.8—11.0 mm). Larvae were widely distributed from east to west within the IOS—NEGOM research polygon but were more restricted in onshore/offshore distribution, with

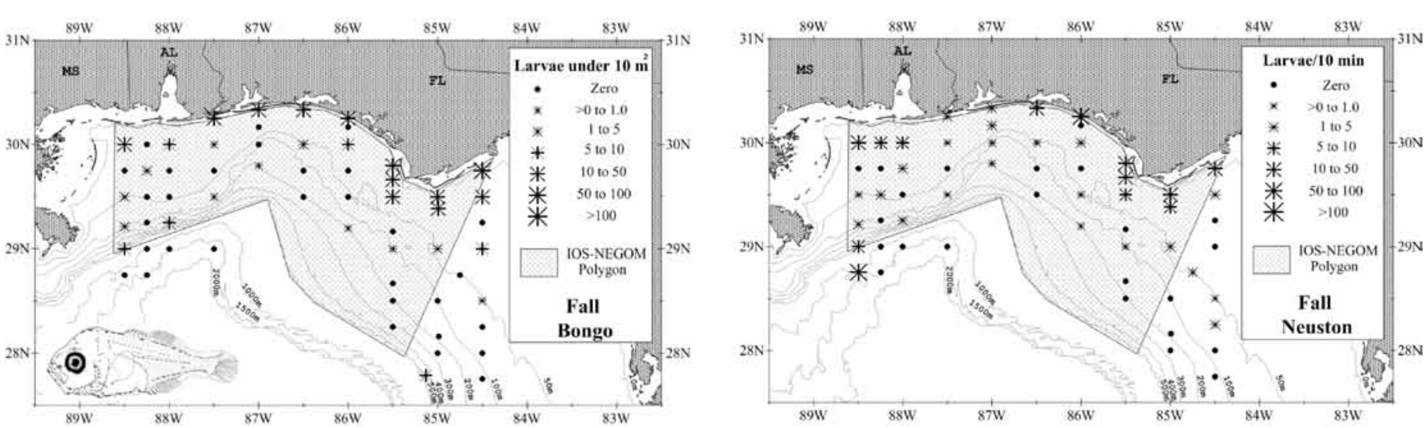

Figure 29. *Mean abundance and mean CPUE of Atlantic bumper,* Chloroscombrus chrysurus, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of one occurrence in spring survey neuston samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

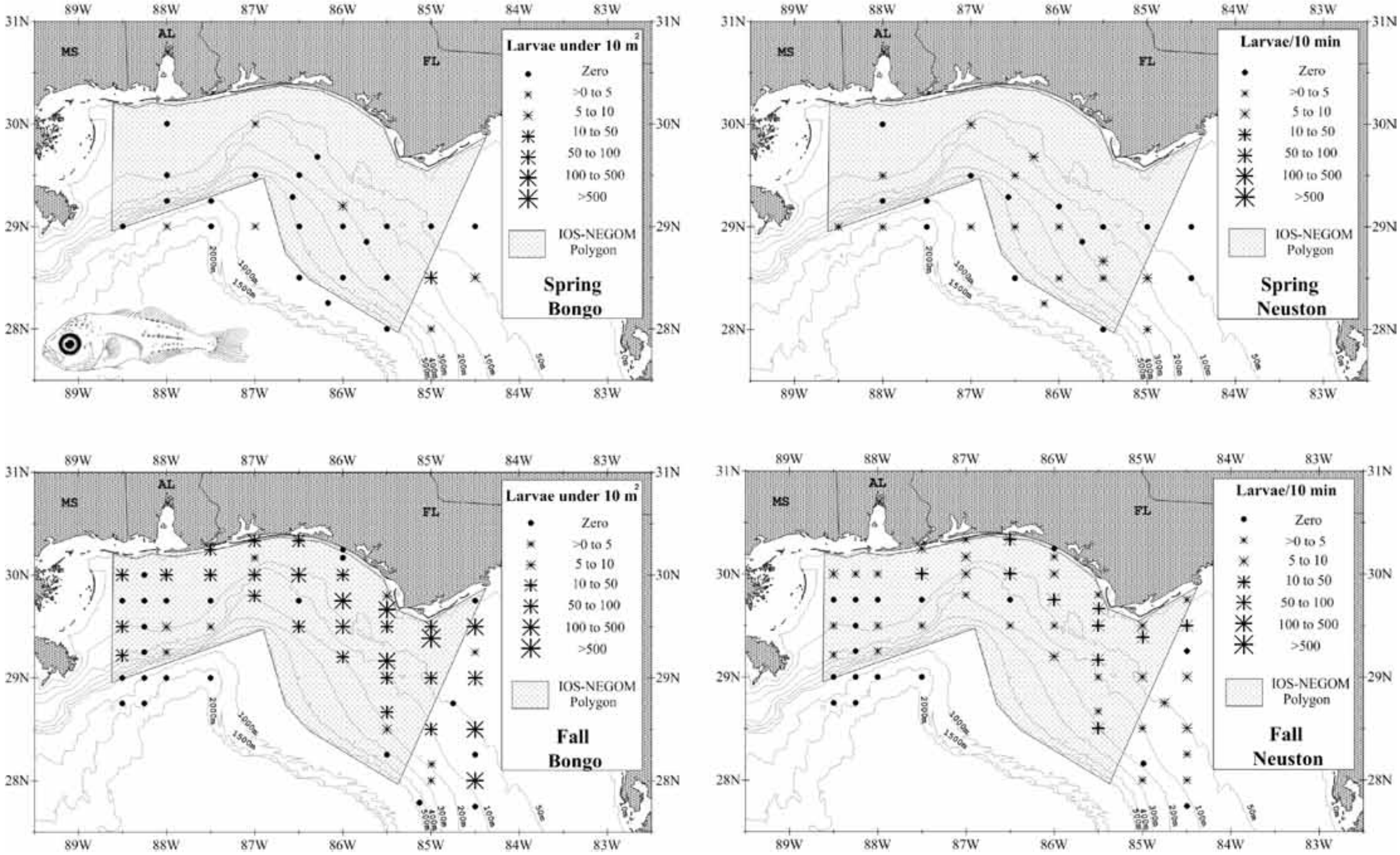

Figure 30. *Mean abundance and mean CPUE of scad larvae, genus* Decapterus*, at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

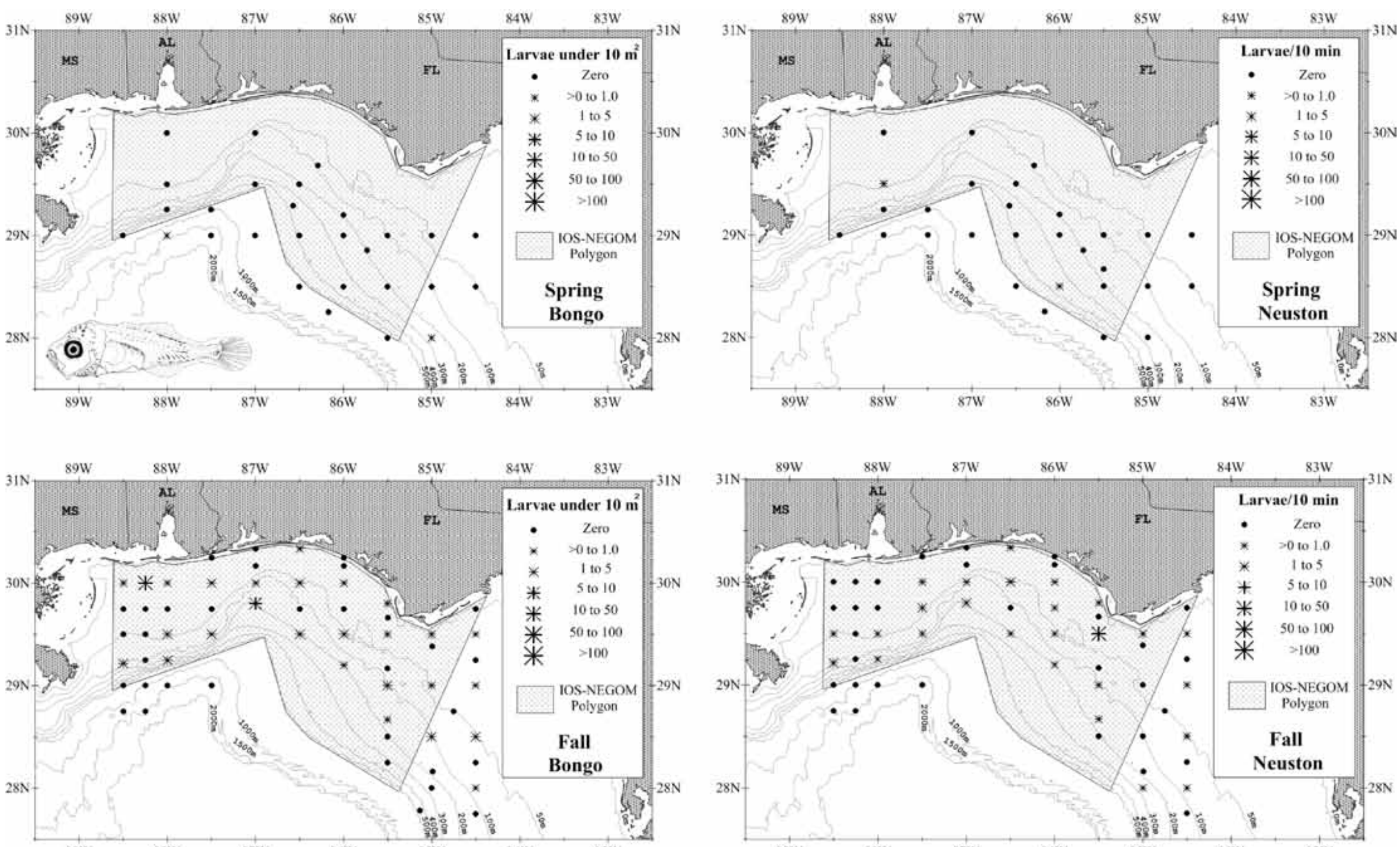

Figure 31. *Mean abundance and mean CPUE of bigeye scad,* Selar crumenophthalmus*, larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

most occurrences at localities between the 50—200 m isobaths (Figure 31). Frequency of occurrence of bigeye scad was comparable in the 2 areas in all instances except for spring neuston samples, when occurrence was significantly less in the study area than Gulfwide (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.7% (Table 4).

Selene spp. (34 occurrences; 53 larvae; Figure 32)

The young of 3 species of moonfish and lookdowns may occur in the GOM. Larvae were taken as often and in about the same numbers in bongo and neuston samples, but all captures were made during fall surveys (Table 1). Larvae ranged in overall size from 2.0—20.2 mm. Mean length in bongo and neuston samples was 3.7 mm (n = 24) and 5.3 mm (n = 18), respectively. Most occurrences were at localities between 50—200 m, but captures over greater depths were made in the southwestern region of the UNIS study area (Figure 32). *Selene* larvae were taken significantly less frequently in UNIS area bongo samples than Gulfwide, but occurrence in neuston samples was comparable in the 2 areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Seriola spp. (123 occurrences; 461 larvae; Figure 33)

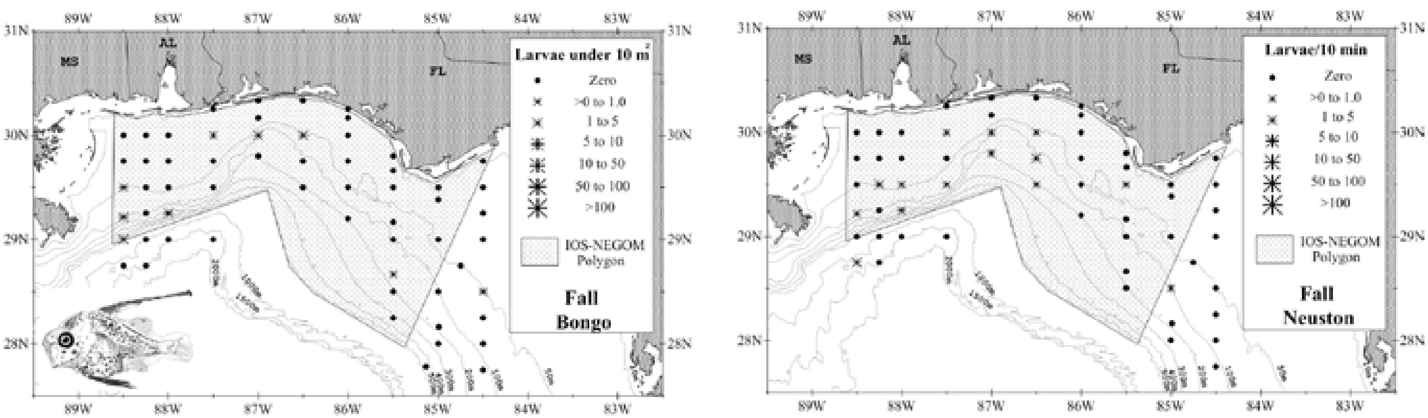

Figure 32. *Mean abundance and mean CPUE of moonfish and lookdown larvae, genus* Selene, *at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

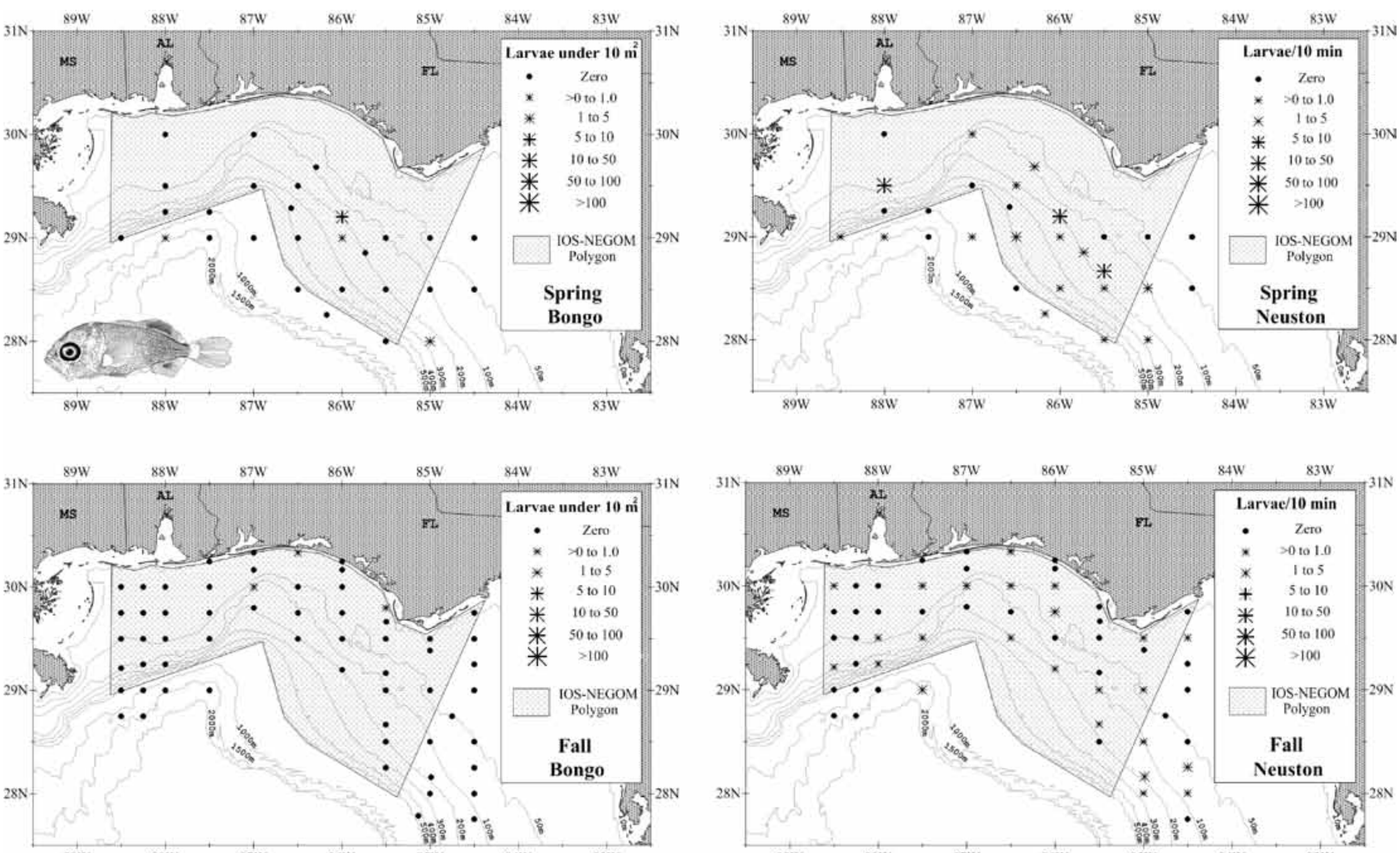

Figure 33. *Mean abundance and mean CPUE of amberjack larvae, genus* Seriola, *at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

Four species of amberjacks may be represented among specimens in this taxon since species identification among *Seriola* larvae remains problematic despite a few incomplete larval descriptions (Laroche et al. 2006). Young amberjack were taken almost exclusively in neuston collections and during spring surveys (Table 1). Amberjack larvae ranged in size from 2.7—44 mm in UNIS study area collections. Mean length in bongo samples was 8.2 mm (n = 186). Although amberjack larvae were taken throughout the study area most captures were made at localities east of 87°W longitude (Figure 33). *Seriola* larvae were captured significantly more often in spring neuston samples but less often in fall bongo samples in the study area than Gulfwide (Table 3). Frequency of capture in spring bongo and fall neuston samples was comparable in the 2 areas. Relative abundances and CPUEs in the 2 areas differed by < 0.2% (Table 4).

Trachinotus spp. (46 occurrences; 85 larvae; Figure 34)

Three or 4 species of pompanos may be represented among the larvae and juveniles in this taxon, all of which were captured in neuston samples and mostly during spring surveys (Table 1). Mean size of young pompano was 7.1 mm BL (n = 61; range = 4.5—11.4 mm). Pompano young occurred not only at the shallowest, nearshore stations but also at some of the furthest offshore sites. This pattern may be indicative of species—specific distribution patterns among the larvae of the different *Trachinotus* species included in this taxon (Figure 34). Pompano larvae were taken statistically more often in spring neuston samples in the UNIS than Gulfwide survey area, but during fall surveys frequency of occurrence was comparable in the 2 survey areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by <0. 1% (Table 4).

Trachurus lathami (16 occurrences; 61 larvae; Figure 35)

The young of this late winter spawning species were taken mostly in neuston samples and only during spring surveys (Table 1). Mean size in bongo samples was 4.1 mm BL (n = 7; range = 3.0—4.6 mm) and mean size in neuston samples was 4.5 mm BL (n = 28; range = 3.0—6.3 mm). Most rough scad larvae were captured at localities near or beyond the 200 m isobath across the NEGOM research polygon (Figure 35). Frequencies of occurrence in the UNIS and Gulfwide survey areas were comparable (Table 3). Relative abundances and

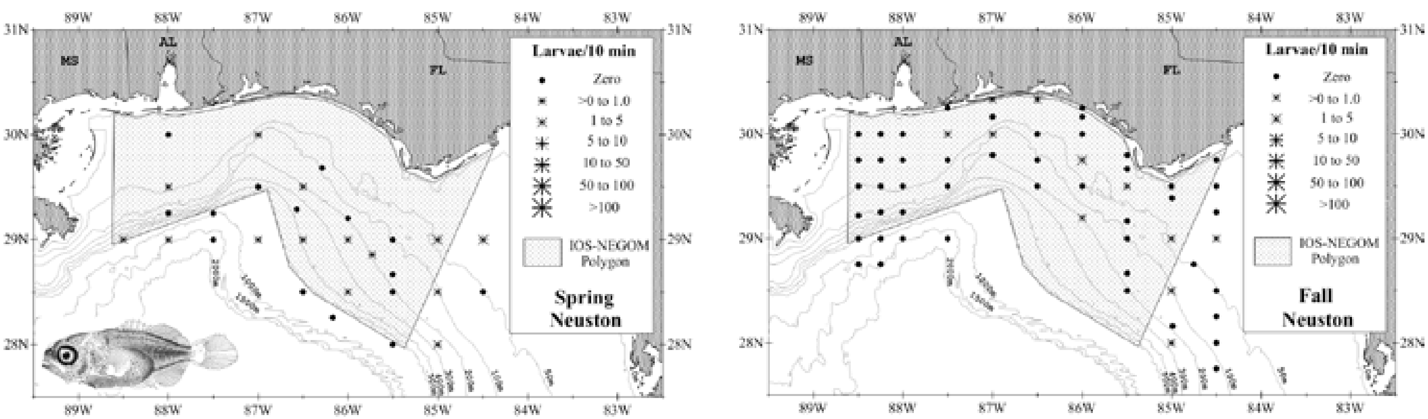

Figure 34. *Mean CPUE of pompano larvae, genus* Trachinotus, *at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

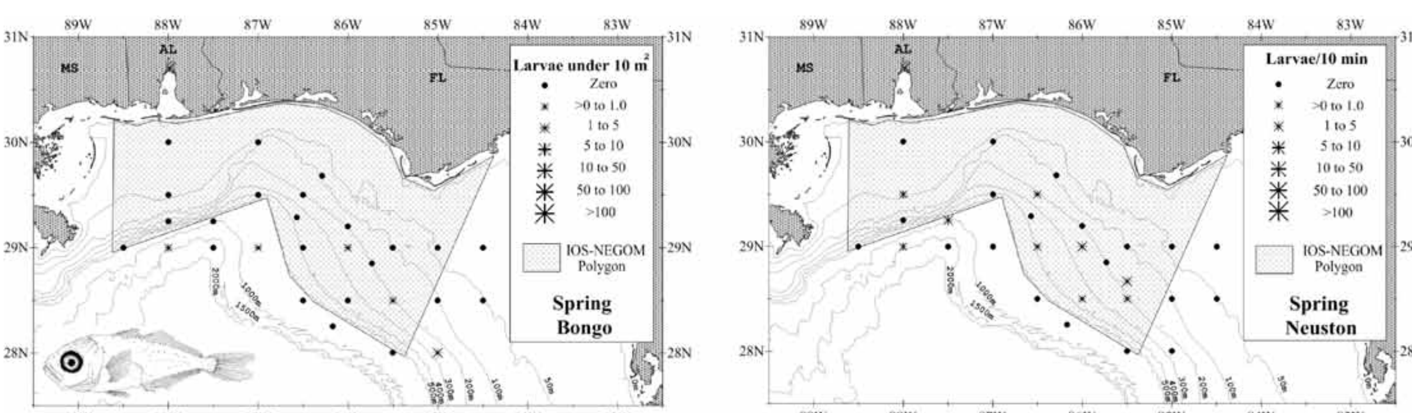

Figure 35. *Mean abundance and mean CPUE of rough scad,* Trachurus lathami, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

CPUEs in the 2 areas differed by < 0.1% (Table 4).

LUTJANIDAE (190 occurrences; 728 larvae; Figure 36)

Snapper larvae in this taxon were generally < 3.0 mm in length and/or did not exhibit enough dorsal spine development to permit positive identification to genus (Lindeman et. al. 2006; Lyczkowski–Shultz and Hanisko 2007). Larvae were taken predominately in bongo samples and during fall surveys (Table 1). Mean size in bongo samples was 2.4 mm BL (n = 457; range = 1.3–4.2 mm) and mean size in neuston samples was 3.2 mm BL (n = 32; range = 2.3–5.4 mm). Small, early–stage snapper larvae were ubiquitously distributed with typical mean abundances of 10–50 larvae under 10 m2 throughout the area (Figure 36). Frequency of occurrence of snapper larvae in the UNIS and Gulfwide survey areas was comparable in both seasons and for both sampling gears (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Lutjanus spp. (34 occurrences; 64 larvae; Figure 37)

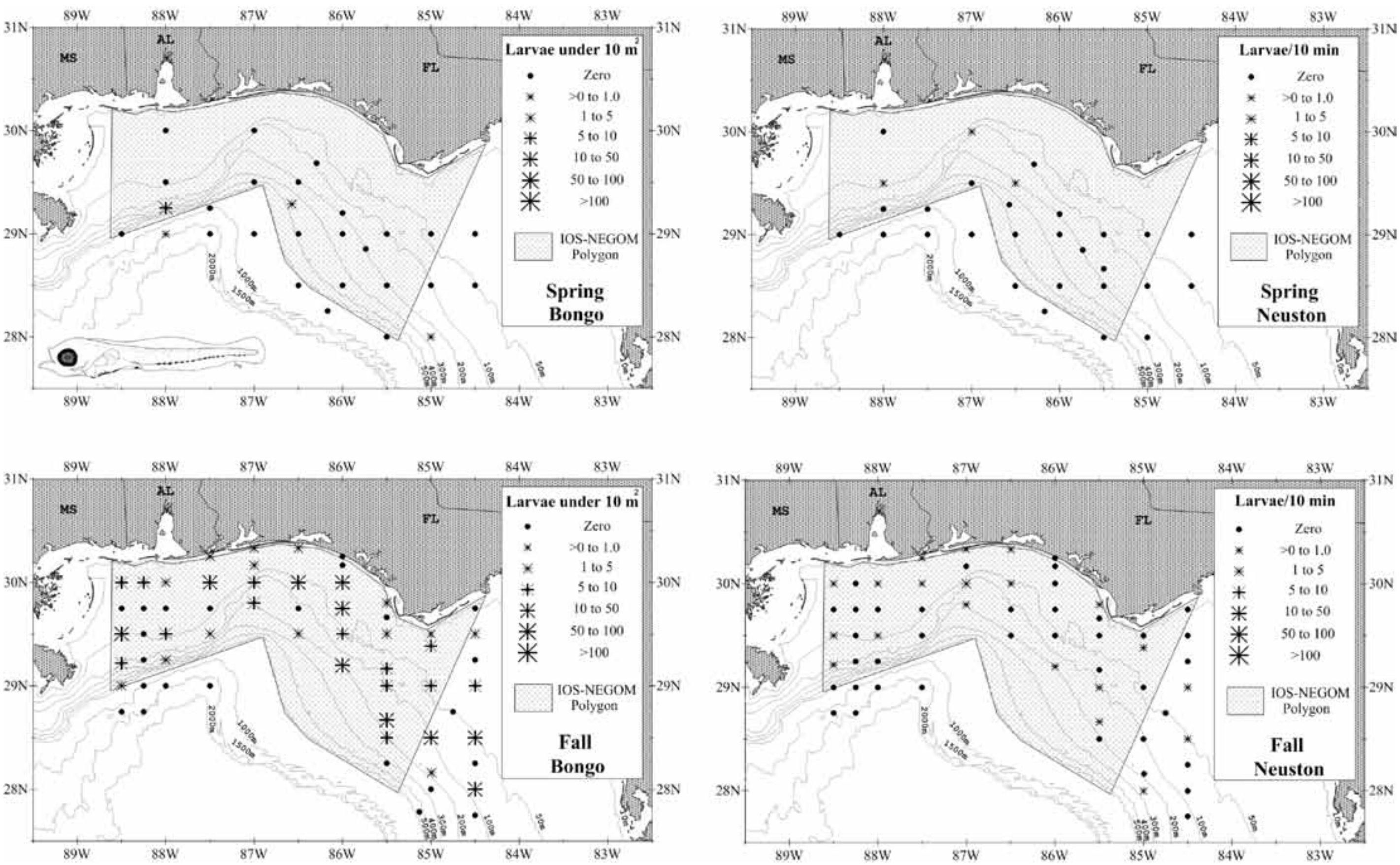

Figure 36. *Mean abundance and mean CPUE of snapper (Lutjanidae) larvae (<3.0 mm) at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

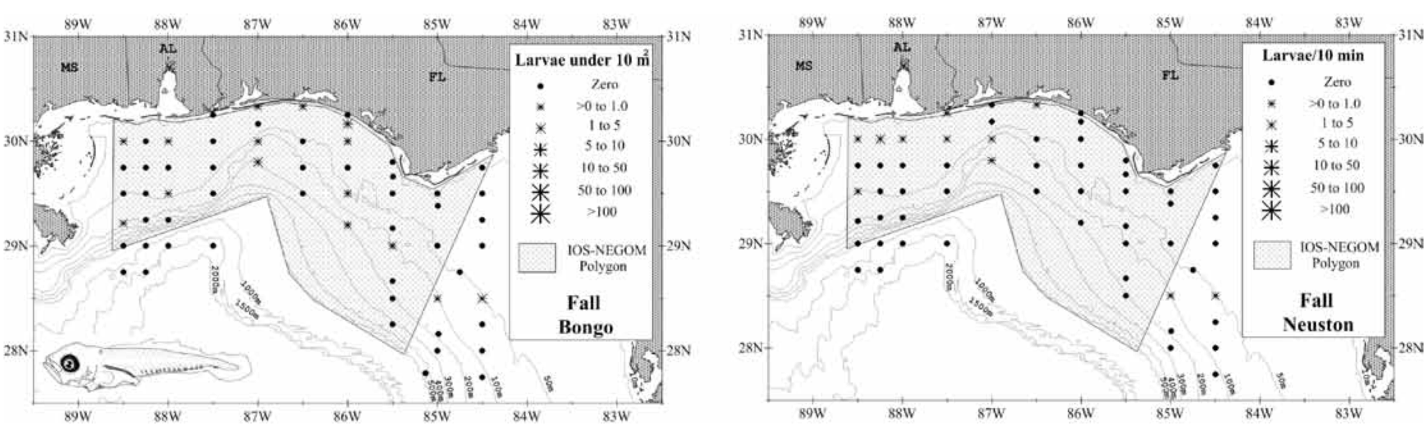

Figure 37. *Mean abundance and mean CPUE of snapper larvae, genus* Lutjanus, *at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

The larvae in this taxon could be reliably identified only to genus because dorsal spine development was not advanced enough to permit identification to species (Lindeman et. al. 2006; Lyczkowski–Shultz and Hanisko 2007). *Lutjanus* spp. larvae were taken as often in bongo as in neuston samples but were nearly twice as numerous in neuston collections; all specimens were taken during fall surveys (Table 1). Mean size in bongo samples was 3.3 mm BL (n = 20; range = 2.0–7.6 mm) and mean size in neuston samples was 3.5 mm BL (n = 22; range = 2.4–4.9 mm). Most occurrences and specimens were found at localities within the 100 m isobath (Figure 37). *Lutjanus* larvae were significantly less common in UNIS study area bongo and neuston samples than Gulfwide (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Lutjanus campechanus (33 occurrences; 71 larvae; Figure 38)

Larvae of the red snapper, a commercially important species in the GOM, were taken more often and in greater numbers in neuston than in bongo samples and, except for one occurrence of 2 specimens, were all taken during fall surveys (Table 1). Mean size in bongo samples was 4.6 mm BL (n = 12; range = 3.5–6.3 mm) and mean size in neuston samples was 4.2 mm BL (n = 38; range = 3.2–6.5 mm). Red snapper larvae occurred most often and in greater numbers along or west of 87°W longitude (Figure 38). A single occurrence in spring (not shown in Figure 38) was far offshore at station B001 over water depth of 1500 m. Frequency of occurrence (bongo and neuston samples) and relative abundance (bongo samples) were greater Gulfwide than in the UNIS study area, but relative abundance in neuston samples was comparable (Table 3). In a recent examination of SEAMAP ichthyoplankton data from 1982–2003, Lyczkowski–Shultz and Hanisko (2007) described the seasonal occurrence, distribution, and abundance of red snapper larvae throughout the northern GOM. Red snapper were significantly less common in the UNIS study area than Gulfwide in fall bongo samples (Table 3). Their occurrence in spring bongo and fall neuston samples was comparable in the 2 areas. Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Lutjanus griseus (9 occurrences; 9 larvae; Figure 39)

Gray snapper larvae were present in both bongo and neuston collections and all occurrences but one were during fall surveys (Table 1). Mean size in bongo samples was 5.0 mm BL (n = 4; range = 4.2–6.6 mm) and mean size in neuston samples was 4.0 mm BL (n = 3; range = 3.5–4.8 mm). Lar-

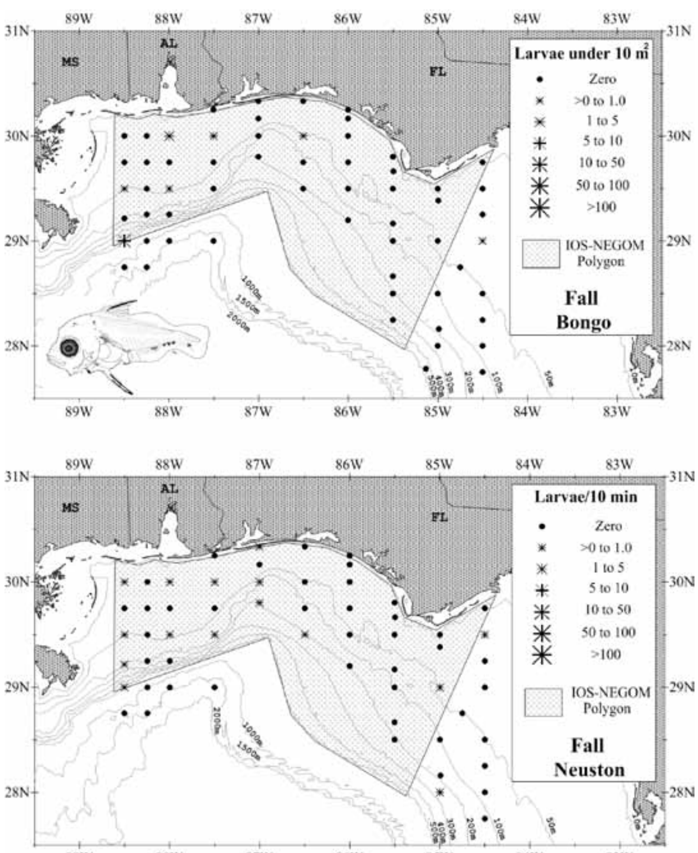

Figure 38. *Mean abundance and mean CPUE of red snapper,* Lutjanus campechanus, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of one occurrence in spring survey neuston samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

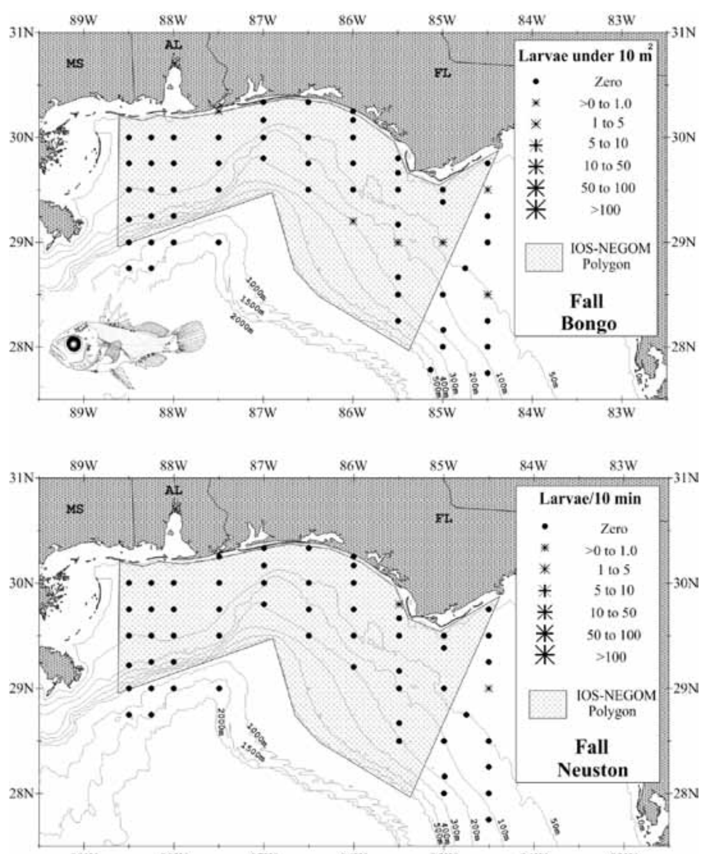

Figure 39. *Mean abundance and mean CPUE of gray snapper,* Lutjanus griseus, *larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. (Map of one occurrence in spring survey neuston samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

vae were almost exclusively found at localities in the eastern UNIS study area, along or east of 86°W longitude (Figure 39). The single occurrence in spring (not shown in Figure 39) was at station B172 over 100 m water depth. The occurrence of gray snapper larvae was comparable in the UNIS and Gulfwide survey areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Pristipomoides aquilonaris (74 occurrences; 208 larvae; Figure 40)

Larvae of this small snapper, the wenchmen, were commonly taken in the UNIS study area primarily in bongo samples and almost exclusively during fall surveys (Table 1). Mean size in bongo samples was 3.8 mm BL (n = 113; range = 1.9—9.0 mm) and mean size in neuston samples was 4.3 mm BL (n = 54; range = 2.8—5.7 mm). Wenchmen larvae were distributed in a band along the 50—300 m isobaths outlining the DeSoto Canyon across the full extent of the UNIS study area (Figure 40). The occurrence of wenchmen larvae was comparable in the UNIS and Gulfwide survey areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Rhomboplites aurorubens (174 occurrences; 644 larvae; Figure 41)

Vermilion snapper larvae were the second most frequently taken and abundant among snapper larvae in the UNIS study area; only larvae identified to family were more numerous. Although more total specimens were collected in neuston samples, 67% of all occurrences resulted from bongo net samples (Table 1). Mean size in bongo samples was 4.1 mm BL (n = 254; range = 2.6—11.2 mm) and mean size in neuston samples was 3.8 mm BL (n = 227; range = 2.5—6.8 mm). All but 4 occurrences and 97% of specimens were taken during fall surveys. Vermilion snapper larvae were widely distributed through the study area but were taken more consistently at localities at or east of 87°W longitude (Figure 41). Vermilion snapper larvae were significantly more common in the UNIS than Gulfwide survey area in fall bongo samples, but their occurrence in the 2 areas was comparable during spring surveys and in fall neuston samples (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.2% (Table 4).

Lobotidae

Lobotes surinamensis (23 occurrences; 39 larvae; Figure 42)

Tripletail larvae were taken only in neuston samples and primarily during fall surveys (Table 1). The 2 springtime occurrences were located well off the continental shelf (Figure 42). Mean length of larvae was 9.7 mm (n = 10; range = 6.0—17). Tripletail larvae were more consistently taken and more

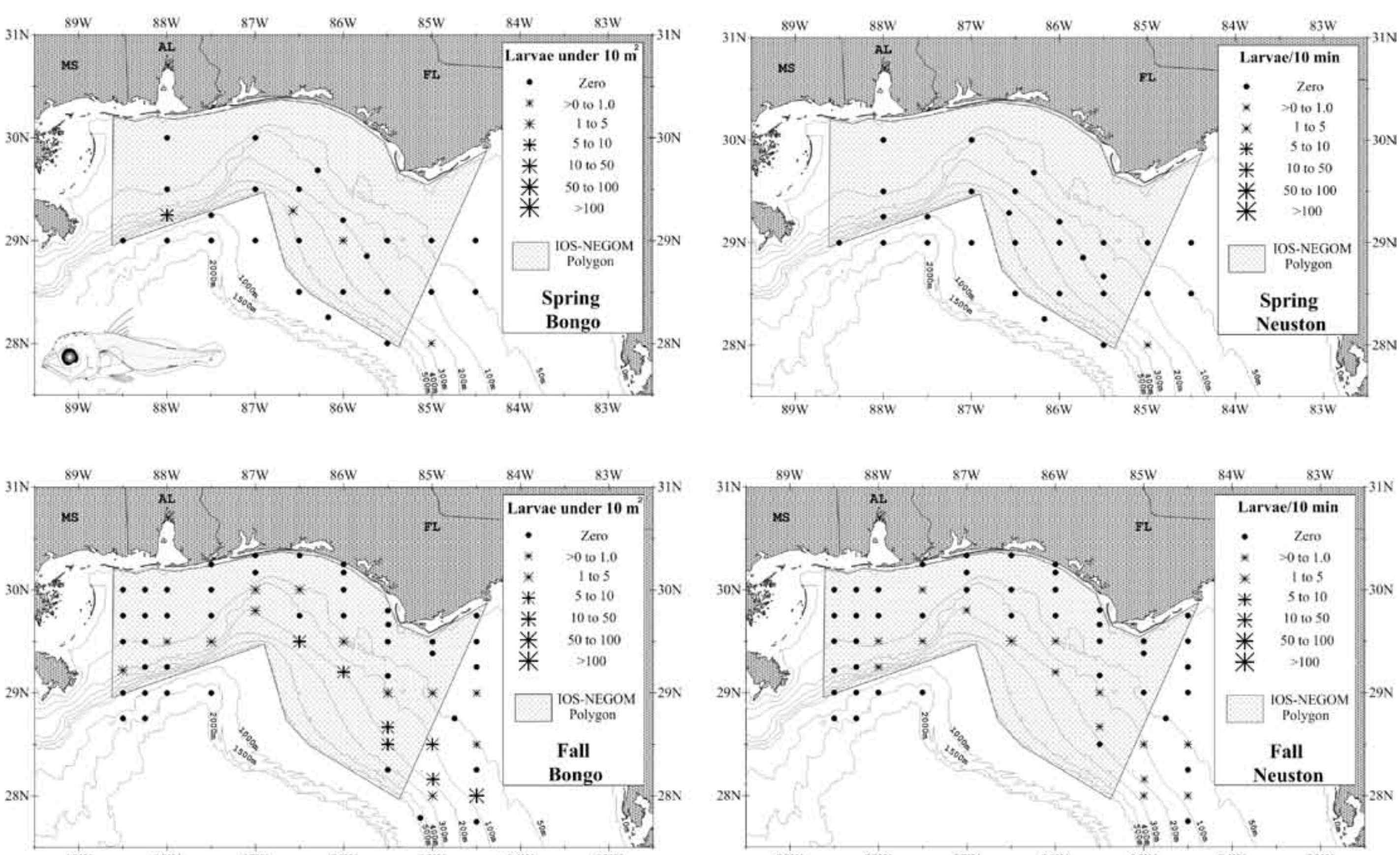

Figure 40. *Mean abundance and mean CPUE of wenchman,* Pristipomoides aquilonaris, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

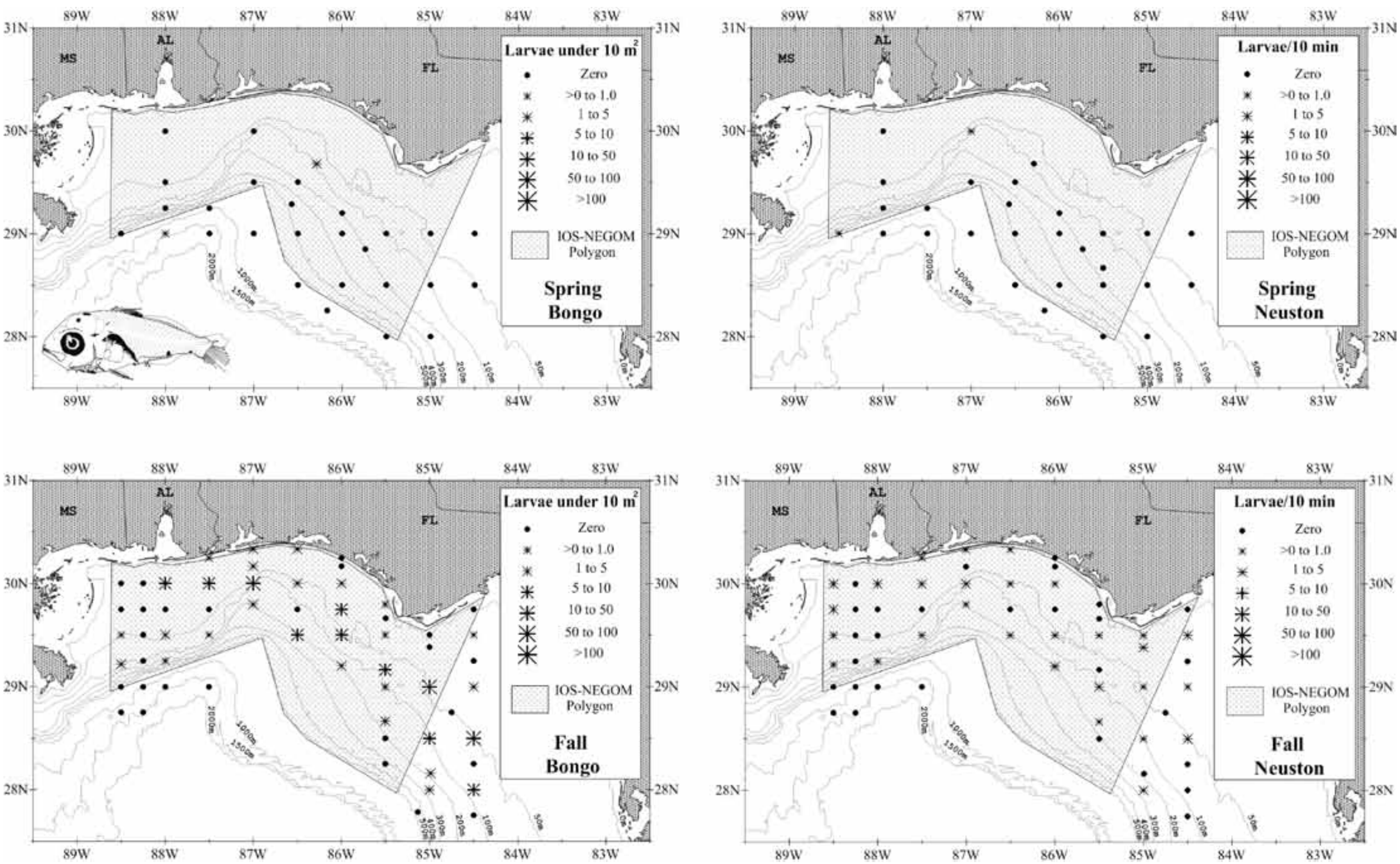

Figure 41. *Mean abundance and mean CPUE of vermilion snapper,* Rhomboplites aurorubens, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

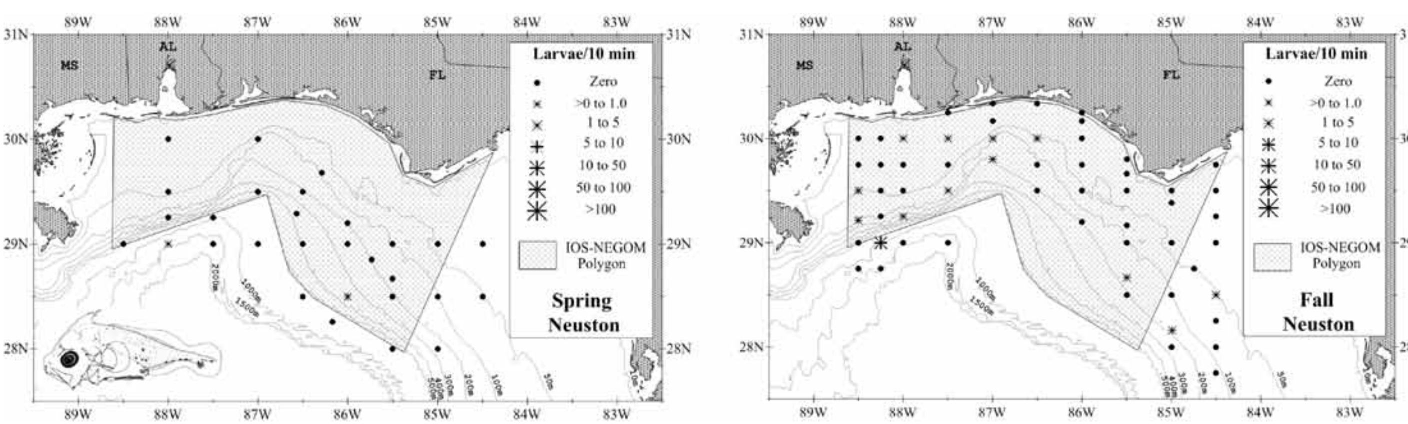

Figure 42. *Mean CPUE of tripletail,* Lobotes surinamensis, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

abundant in the western region of the UNIS study area, along or west of 87°W longitude. Frequency of occurrence of tripletail larvae was comparable in the UNIS and Gulfwide survey areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

HAEMULIDAE (10 occurrences; 139 larvae; Figure 43)

Grunts are important predators on offshore reefs throughout the GOM (Hoese and Moore 1977). Larvae hatch from pelagic eggs in a relatively undeveloped state and early stage larvae are difficult to distinguish from the larvae of many other percoid families (Leis and Rennis 1983; Lindeman and Lindeman 2006). There is no specialized pelagic juvenile in the early life history of grunts and it appears that grunt larvae are not widely dispersed but settle to bottom habitats within 13—20 d of hatching at 6.5—9 mm in length (Lindeman et al. 2001). Grunt larvae were taken mostly in bongo samples and

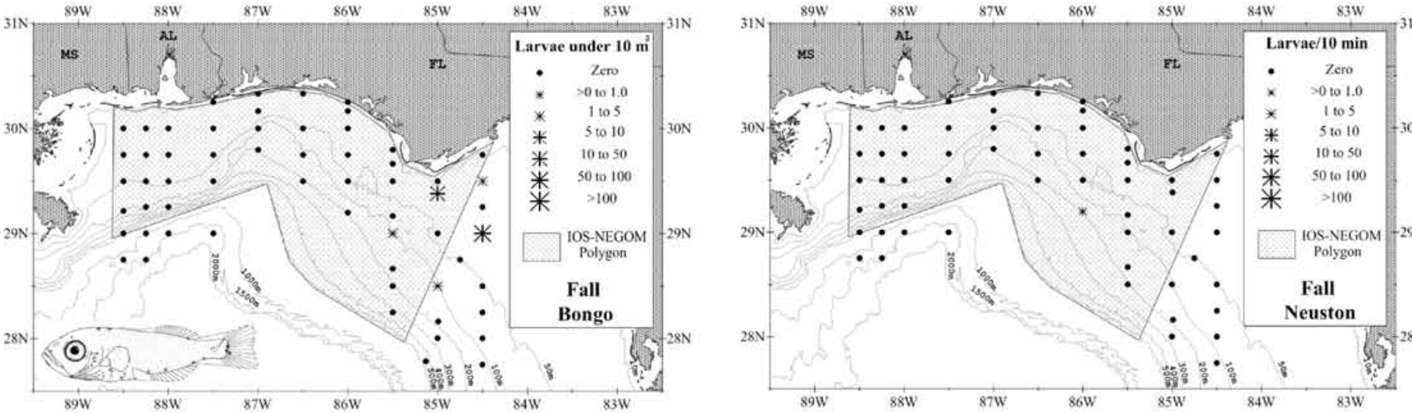

Figure 43. *Mean abundance and mean CPUE of grunt (Haemulidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of two occurrences in spring survey neuston samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

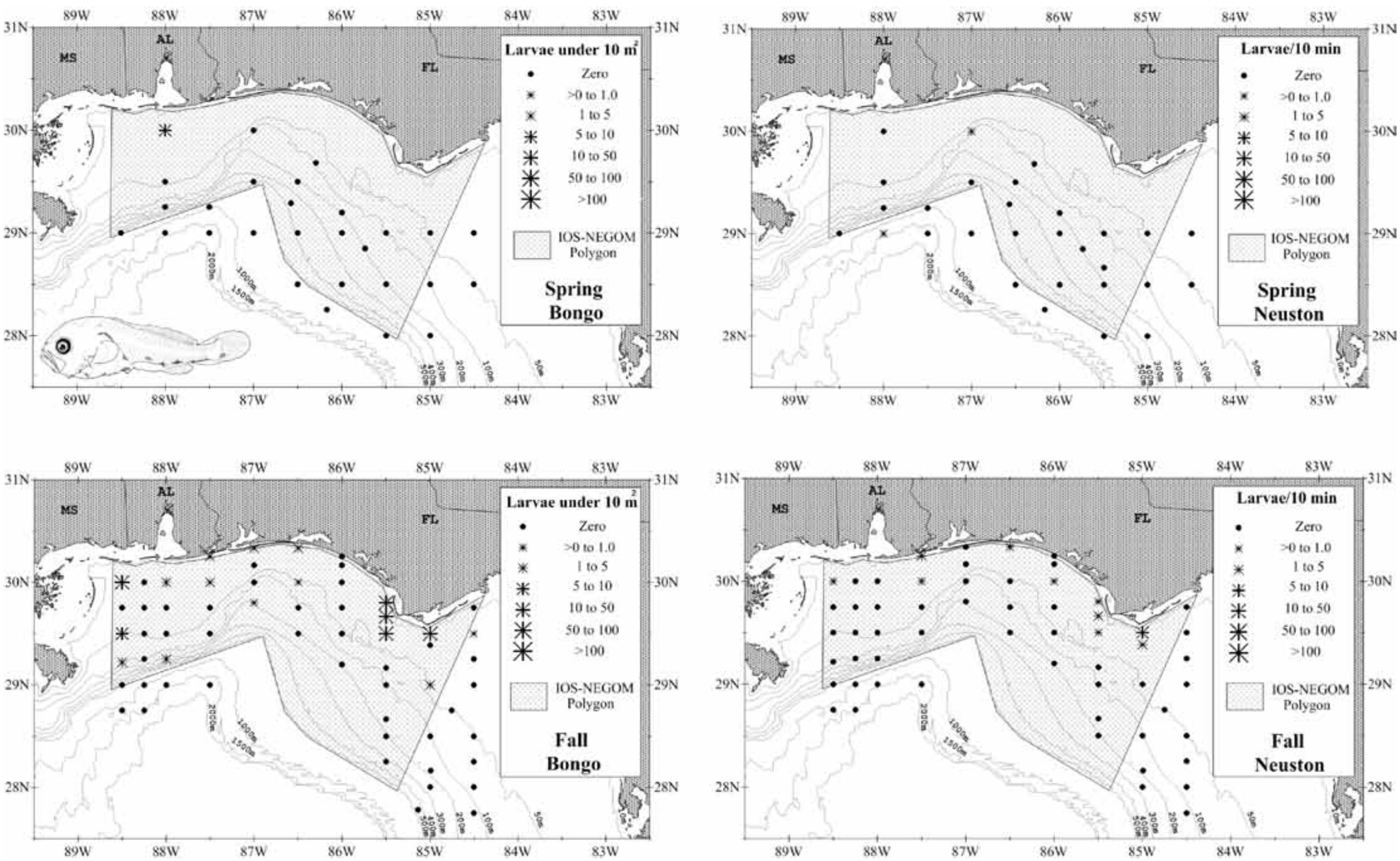

Figure 44. *Mean abundance and mean CPUE of seatrout (Cynoscion spp.) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

almost exclusively during fall surveys (Table 1). Mean size in bongo samples was 3.5 mm BL (n = 6; range = 2.0–6.0 mm) and mean size in neuston collections was 3.3 mm BL (n = 3; range = 2.8–3.7 mm). Haemulid larvae occurred 3 times in neuston collections between longitudes 87 and 86°W in the vicinity of the head of the DeSoto Canyon over 100–200 m water depth. However, most occurrences and highest mean abundances were at localities east of 86°W longitude and inshore of the 100 m isobath (Figure 43). This pattern corresponds with the general and striking absence of grunts from the list of species inhabiting the Pinnacles deep reefs off Alabama and Mississippi (Weaver et. al. 2002). There were 2 occurrences (not in Figure 43) in spring neuston samples at stations B172 and U015 over 100 m water depth. Frequency of occurrence of grunt larvae was comparable in the UNIS and Gulfwide survey areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

SCIAENIDAE

Cynoscion spp. (64 occurrences; 515 larvae; Figure 44)

This taxon is comprised of the larvae of *Cynoscion arenar-*

ius (sand seatrout) and *C. nothus* (silver seatrout). Although spawning is somewhat separated in time and space, the larvae of these 2 species of sciaenids are difficult to distinguish from each other. Over 80% of sea trout larvae were taken in bongo samples and most during fall surveys (Table 1). Mean size in bongo samples was 2.7 mm BL (n = 160; range = 1.2—6.6 mm) and mean size in neuston collections was 3.9 mm BL (n = 52; range = 1.8—6.1 mm). Sea trout larvae consistently occurred inshore of the 200 m isobath with the highest mean abundances being found inshore in the northeastern corner of the IOS—NEGOM research polygon, i.e. around Cape San Blas (Figure 44). *Cynoscion* spp. larvae occurred significantly less frequently in the UNIS study area than Gulfwide during fall surveys (Table 3). Larvae were taken significantly more frequently in spring neuston samples in the UNIS study area than Gulfwide but at comparable frequency in spring bongo samples. Relative abundances and CPUEs in the 2 areas differed by < 2.5% (Table 4).

Sciaenops ocellatus (48 occurrences; 351 larvae; Figure 45)

The larvae of the late summer to fall spawning red drum were taken in both bongo and neuston samples during fall surveys only (Table 1). Mean size in bongo samples was 2.4 mm BL (n = 110; range = 1.4—5.2 mm) and mean size in neuston collections was 3.8 mm BL (n = 46; range = 2.7—6.7 mm). Along or west of longitude 87°W, red drum larvae occurred inshore of the 200 m isobath while east of that meridian larvae were only found inshore of the 50 m isobath (Figure 45). Red drum larvae occurred significantly less frequently in the study area than Gulfwide (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Mullidae (268 occurrences; 19,855 larvae; Figure 46)

The young of the bottom—dwelling, reef associated goatfishes are abundant in the surface waters of the NEGOM and were among the most numerous of taxa collected in SEAMAP neuston collections. Goatfishes pass through a pelagic juvenile stage when they superficially resemble young mullet and occupy the same niche in offshore surface waters. Goatfish young were almost exclusively taken during spring surveys in the UNIS study area (Table 1). Larvae in ranged in size from 2.5—18 mm in bongo samples and 2.4—44.5 in neuston samples. Larvae were distributed throughout the area during spring with the highest mean abundances of 100—500 larvae/10 min at 2 localities on the 200 m isobath between longitudes 86.5 and 86°W (Figure 46). Larvae were significantly more common in the UNIS study area than Gulfwide during spring surveys but occurrence during fall surveys was comparable in the 2 areas (Table 3). Relative abundance and CPUE in the 2 areas differed by < 0.2% in spring bongo samples and during fall surveys, whereas, the relative CPUE in UNIS study area fall neuston samples exceeded the Gulfwide value by 20.4% (Table 4). This was disproportionately higher than expected given the fewer samples taken in the study area.

Chaetodontidae (11 occurrences; 12 larvae; Figure 47)

Butterflyfishes are among the most characteristic inhabitants of the reef fish fauna. Their larvae are distinctive especially after formation of the unique bony head plates that mark their specialized, pelagic 'tholichthys' stage (Leis and Rennis 1983, Kelley 2006). Chaetodontid larvae are a rare component of plankton collections and tend to be more numerous in distant oceanic waters than near the adult reef habitat (Leis 1989). In the UNIS study area chaetodontid larvae were slightly more common in neuston than bongo samples and over 80% of occurrences and specimens were captured during fall surveys (Table 1). Mean size in neuston collections was 4.8 mm BL (n = 5; range = 3.0—8.2 mm) and mean size in bongo samples was 3.6 mm BL (n = 5; range = 2.5—5.2 mm). Larvae were taken only at localities along or east of longitude 86.5°W but were found over water depths ranging from < 50 to > 500 m (Figure 47). Butterflyfish larvae were significantly less common in spring neuston samples in the study area than Gulfwide (Table 3). Their occurrence in spring and fall bongo samples was comparable in both areas.

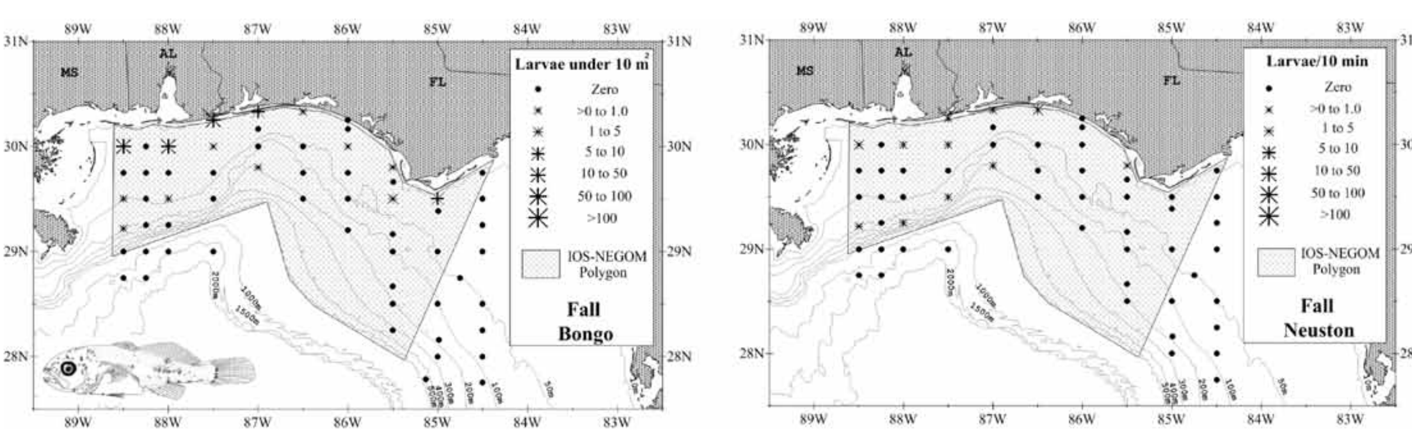

Figure 45. *Mean abundance and mean CPUE of red drum,* Sciaenops ocellatus, *larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

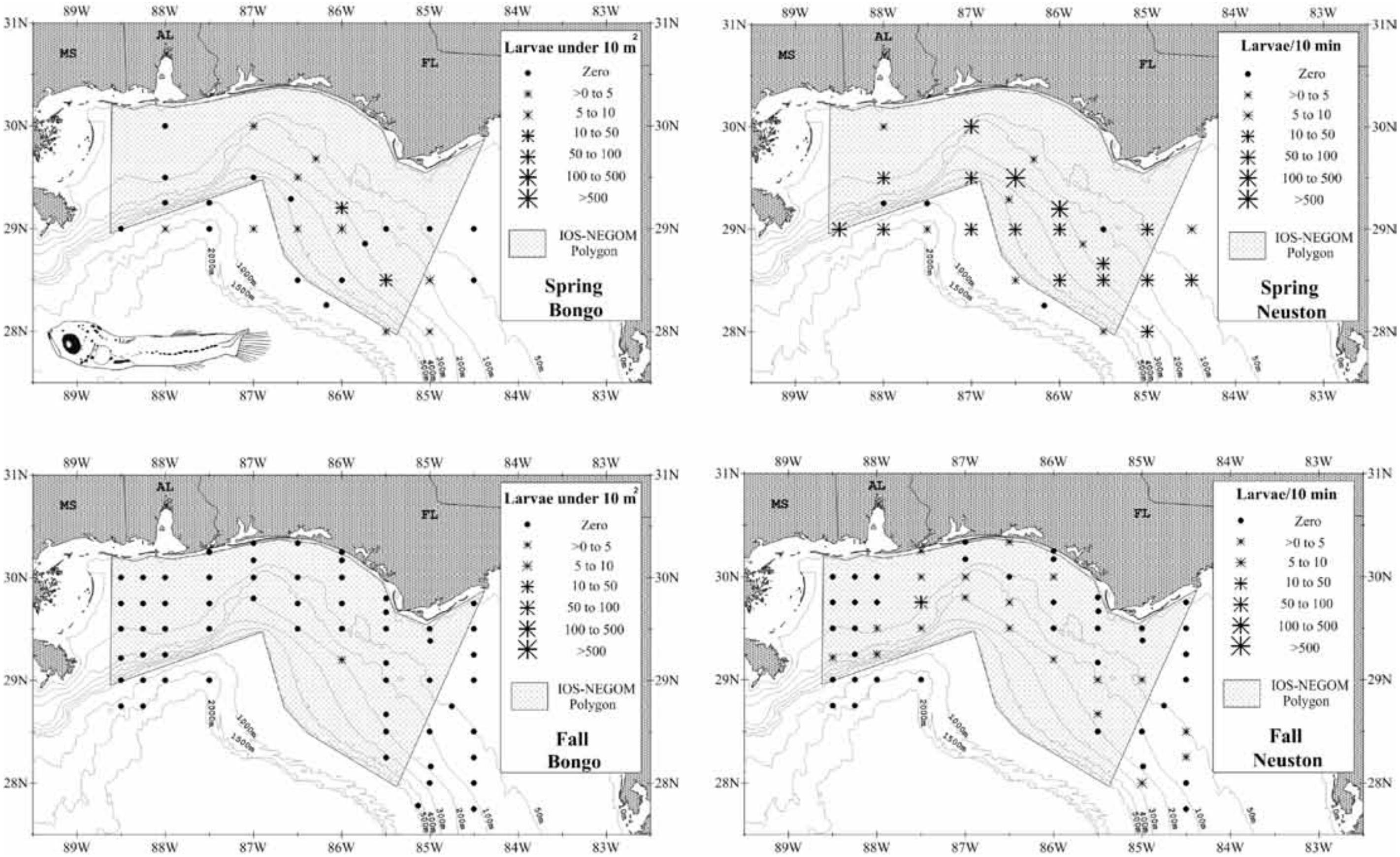

Figure 46. *Mean abundance and mean CPUE of goatfish (Mullidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

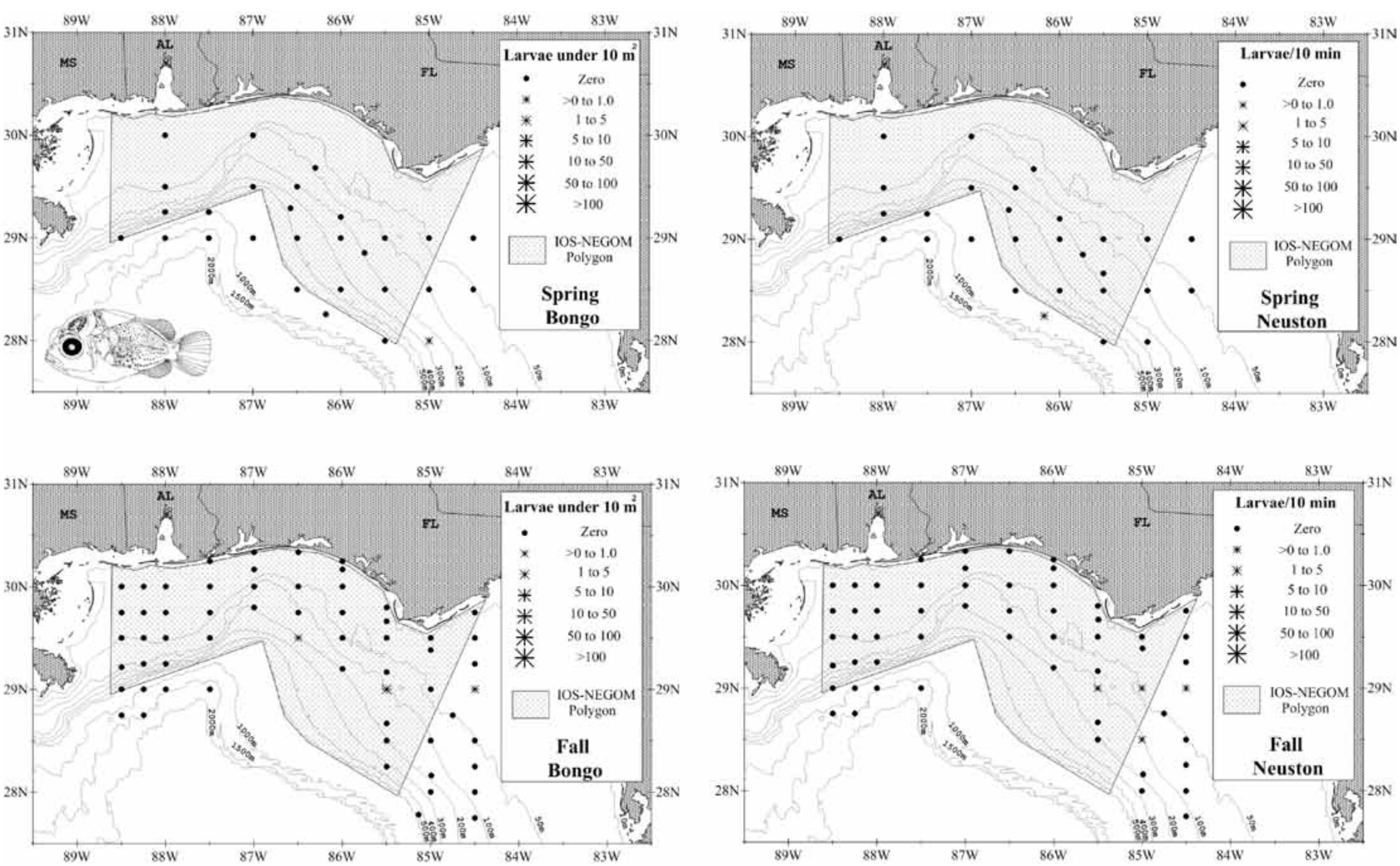

Figure 47. *Mean abundance and mean CPUE of butterflyfish (Chaetodontidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

However, despite the few captures overall, occurrence in fall neuston samples was significantly higher in the study than Gulfwide. Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

POMACANTHIDAE (6 occurrences; 7 larvae; Figure 48)

Angelfishes are also characteristic members of reef communities. Their larvae, like those of the previous family, are distinctive and rare in plankton collections but the angelfishes do not have a specialized pelagic stage. Pomacanthid larvae were taken in both neuston and bongo samples, and during spring and fall surveys (Table 1). There were too few occurrences overall to suggest spatial or seasonal differentiation within the UNIS study area. Mean size in neuston collections was 10.1 mm BL (n = 4; range = 3.1—14.0 mm) and mean size in bongo samples was 6.1 mm BL (n = 3; range = 3.8—7.2 mm). Distribution of angelfish (Figure 48) was similar to that of butterflyfish larvae (Figure 47). Angelfish larvae were taken only at localities along or east of longitude 86.5°W and were found over water depths ranging from 50—400 m. The frequency of occurrence of larvae was not significantly different between the study area and Gulfwide (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

POMACENTRIDAE (63 occurrences; 166 larvae; Figure 49)

The damselfishes are among the most studied reef fishes, yet the larval development of few species has been described. The eggs of these fishes are demersal but the larvae of most species are planktonic (Leis and Rennis 1983, Watson 1996b). Identification even to the family level remains problematic for the Pomacentridae (Kavanagh et al. 2000). This is especially true in the GOM where the poorly known larvae of mullids, gerreids and sparids are abundant. Larvae of these perciform families closely resemble pomacentrid larvae. For example, juvenile *Abudefduf saxatilis* were found during a recent re—examination of specimens identified as Sparidae (porgies) in SEAMAP collections. Despite uncertainties, SEAMAP data on larval pomacentids are summarized here under the caveat that misidentifications have led to an underestimation of occurrence and abundance of at least one pomacentrid (as noted above). Damselfish larvae were taken as often in neuston as in bongo nets and, although the total number of specimens was equally divided between spring and fall surveys, larvae occurred 3 times more frequently in fall survey samples than in spring survey samples (Table 1). Mean size in neuston collections was 4.9 mm BL (n = 30; range = 2.5—17.8 mm) and mean size in bongo samples was 2.9 mm BL (n = 37; range = 1.6—5.0 mm). Larvae were distributed throughout the UNIS study area especially during fall surveys when highest mean abundances were found along or east of longitude 86.5°W (Figure 49). Damselfish

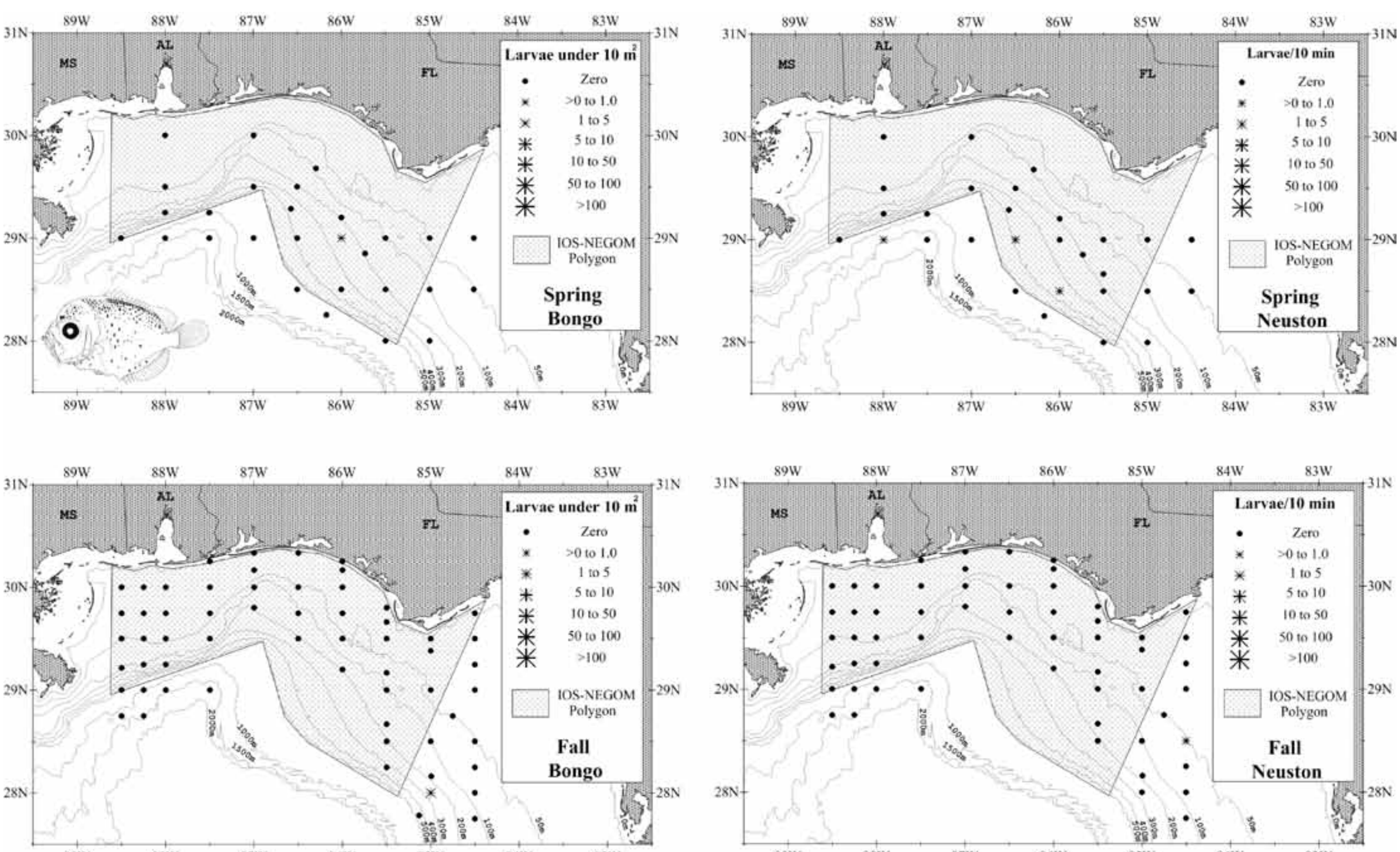

Figure 48. *Mean abundance and mean CPUE of angelfish (Pomacanthidae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

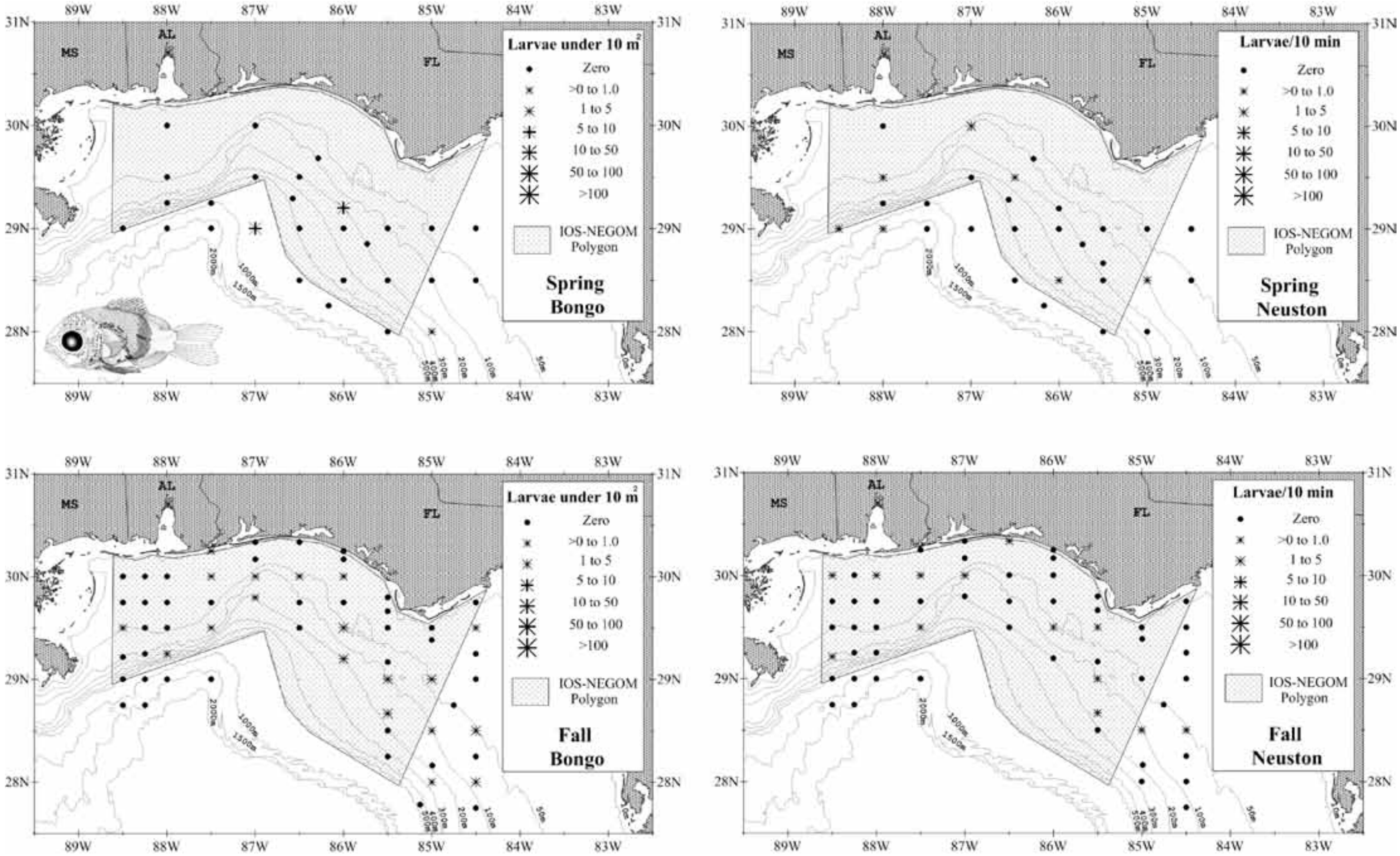

Figure 49. *Mean abundance and mean CPUE of damselfish (Pomacentridae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

larvae occurred significantly less frequently in spring bongo and fall neuston samples in the study area than Gulfwide but as frequently as Gulfwide in spring neuston and fall bongo samples (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Labridae (358 occurrences; 3,420 larvae; Figure 50)

Among specimens that could be reliably identified at least to family, larvae of the wrasses were the most numerous among obligate reef fishes in UNIS study area collections. Over 80% of occurrences and 93% of specimens were captured in bongo samples and 86% of occurrences and 95% of specimens were taken during fall surveys (Table 1). Mean size in neuston collections was 7.1 mm BL (n = 54; range = 2.0—12.6 mm) and mean size in bongo samples was 5.0 mm BL (n = 140; range = 1.2—12.0 mm). Wrasse larvae were homogeneously distributed throughout the study area, being taken at nearly every station during fall surveys (aside from one site within the IOS—NEGOM research polygon and 4 sites in the extreme southwestern corner of the UNIS study area; Figure 50). Frequency of occurrence of wrasse larvae in study area samples (72%) far exceeded their occurrence Gulfwide (41%) during fall surveys when larvae were statistically far more common in the study area than Gulfwide in both bongo and neuston samples (Table 3). Frequency of occurrence in the study area was either significantly less (bongo samples) than Gulfwide or comparable (neuston samples) to Gulfwide occurrence during spring surveys. Relative abundance and CPUE in the 2 areas differed by < 0.2% except in fall bongo samples, when the relative abundance was 2.5% higher than expected in the study area than Gulfwide (Table 4).

Scaridae (113 occurrences; 369 larvae; Figure 51)

Although not as abundant as wrasse larvae, parrotfish larvae were also taken primarily in bongo net samples during fall surveys (Table 1). Mean size in neuston collections was 7.8 mm BL (n = 27; range = 2.1—11.7 mm) and mean size in bongo samples was 5.4 mm BL (n = 72; range = 1.8—11.0 mm). Parrotfish larvae were not as widely distributed throughout the UNIS study area as labrid larvae and were more frequently taken and more numerous at localities east of longitude 87°W during fall surveys (Figure 51). There was no statistical difference between the UNIS and Gulfwide survey areas in frequency of occurrence of scarid larvae in spring neuston samples or fall survey samples (Table 3). Scarid larvae were taken significantly less frequently in the study area than Gulfwide in spring bongo samples. Relative abundance and CPUE in the 2 areas differed by < 0.1% (Table 4).

Acanthuridae (4 occurrences; 5 larvae; Figure 52)

As in a number of other reef fish families, the duration of the pelagic phase of the surgeonfishes may be long and includes a specialized, pre—settlement stage called the 'acronurus' stage (Thresher 1984). These larvae were rare in the UNIS study area, occurring in both bongo and neuston sam-

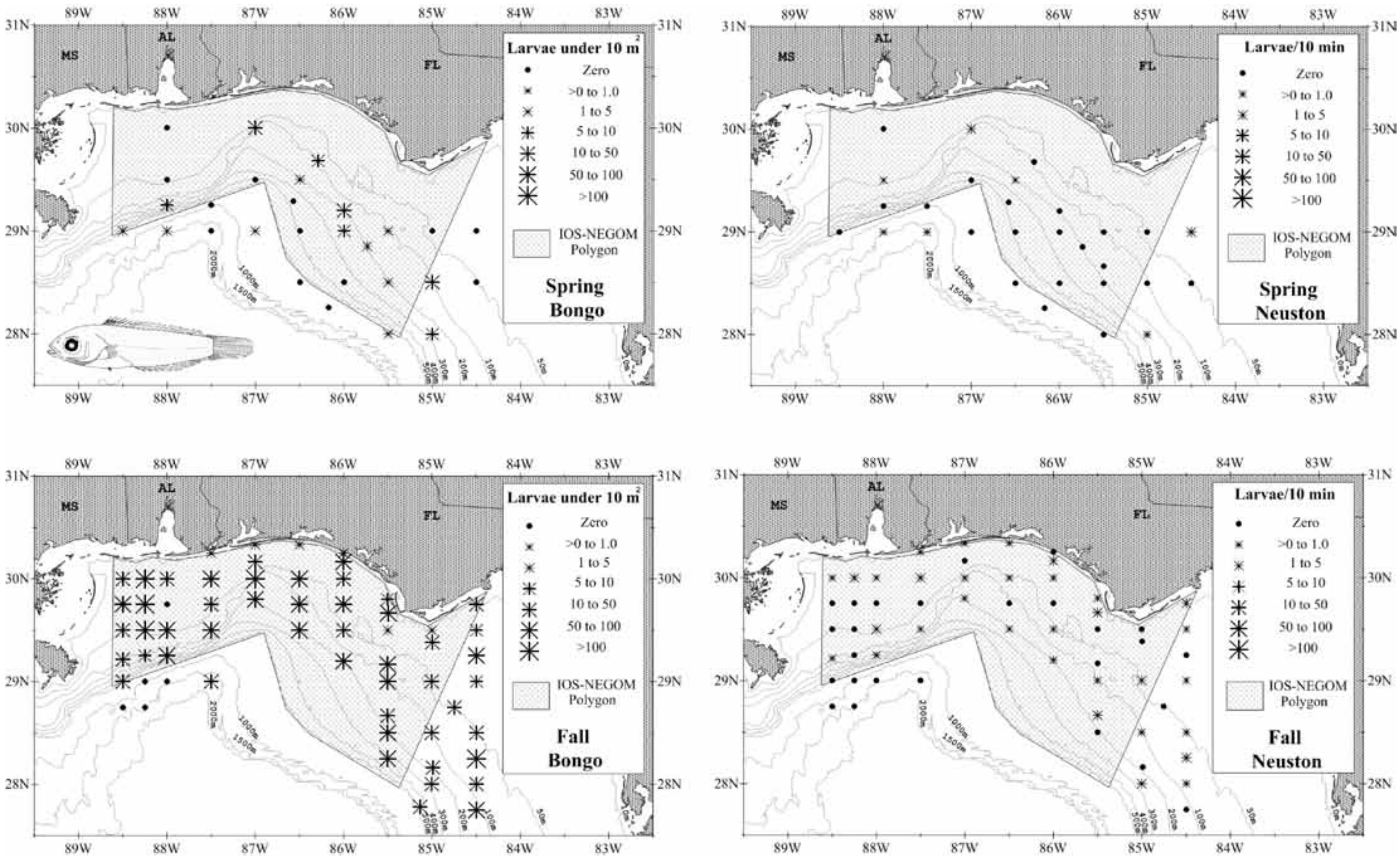

Figure 50. *Mean abundance and mean CPUE of wrasse (Labridae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

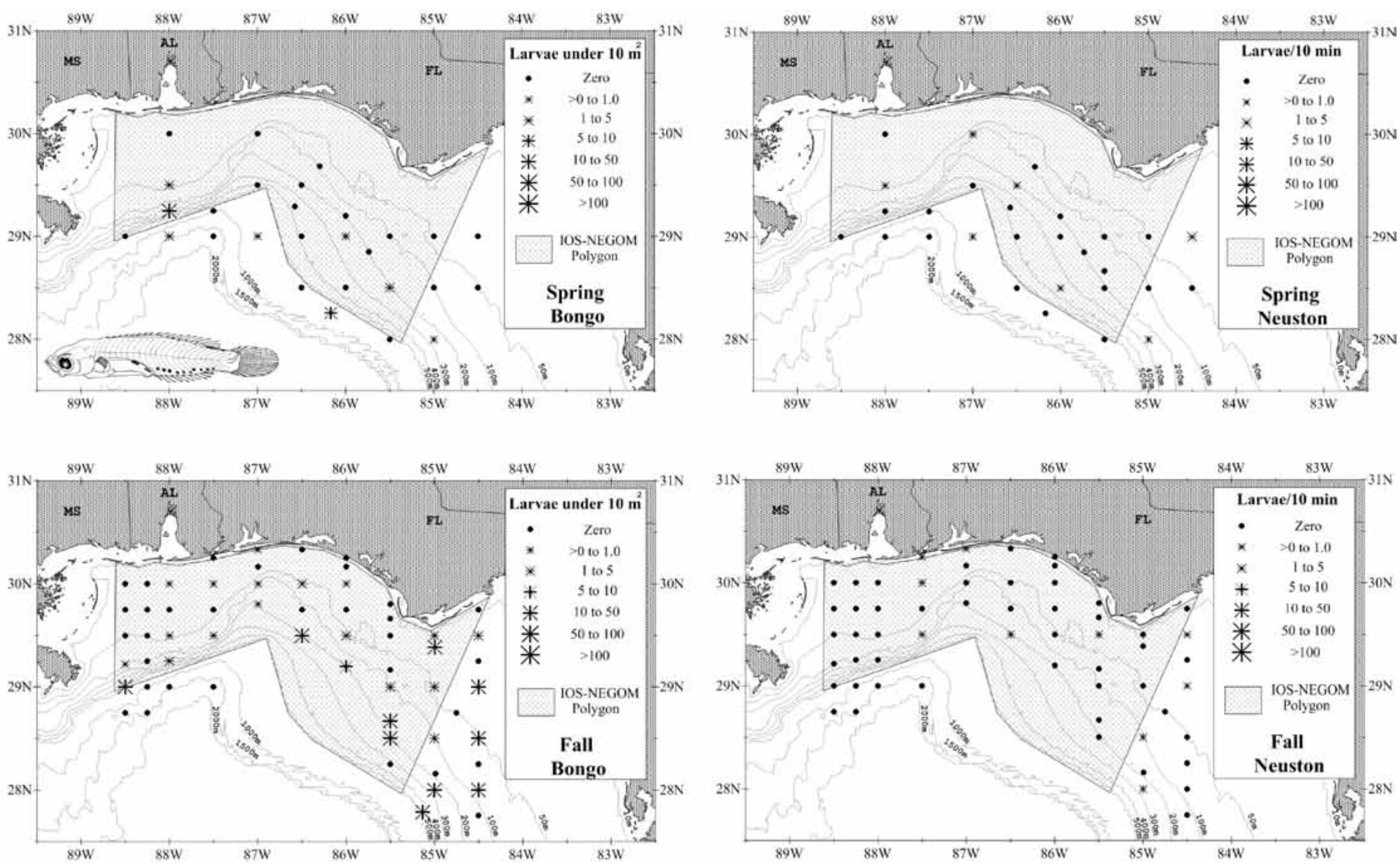

Figure 51. *Mean abundance and mean CPUE of parrotfish (Scaridae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

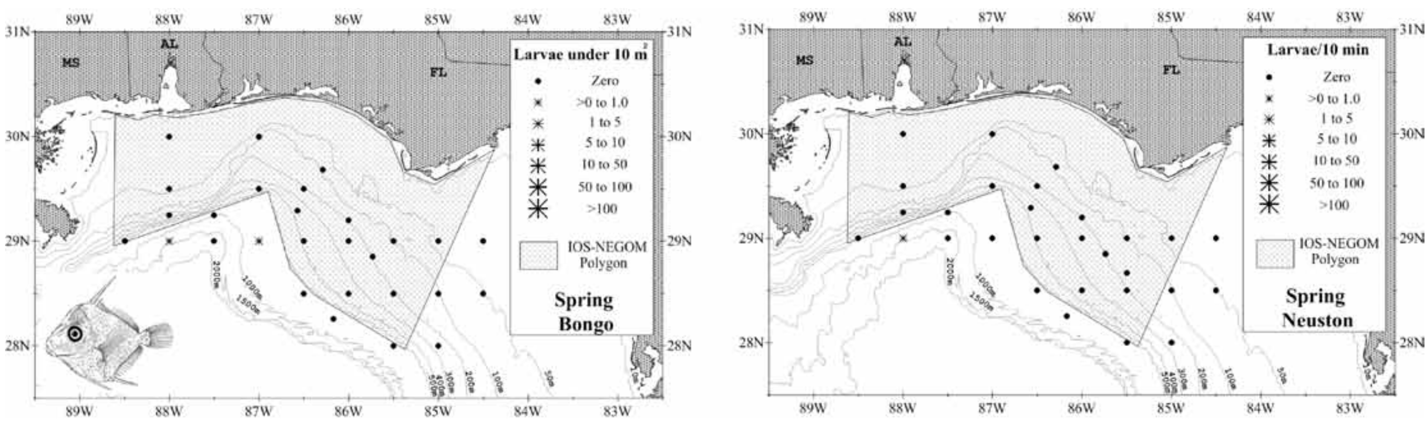

Figure 52. *Mean abundance and mean CPUE of surgeonfish, (Acanthuridae) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of one occurrence in fall survey neuston samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

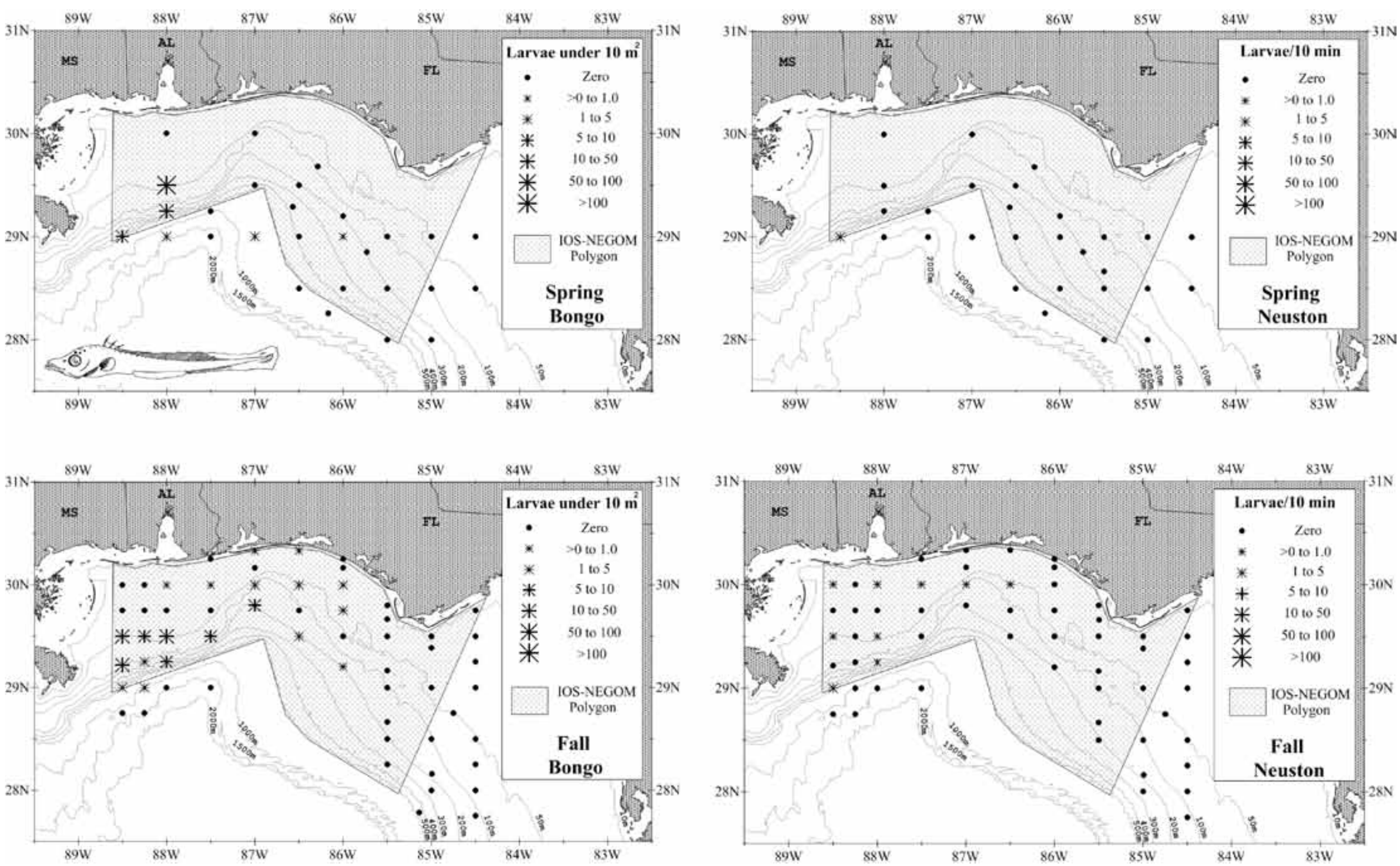

Figure 53. *Mean abundance and mean CPUE of Atlantic cutlassfish,* Trichiurus lepturus, *larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

ples with all but one occurrence during spring surveys (Table 1). The single fall occurrence (not shown in Figure 52) was in a neuston net sample taken at station B153 between the 200 and 300 m contours southwest of the Florida Middle Grounds. Mean size in neuston collections was 3.6 mm BL (n = 3; range = 3.5–3.7 mm) and mean size in bongo samples was 9.2 mm BL (n = 2; range = 4.0–14.3 mm). All captures were made outside the IOS–NEGOM research polygon, at or beyond the continental slope (Figure 52). Frequency of occurrence in the study area was significantly less than Gulfwide during spring surveys, but during fall surveys surgeonfish larvae were as common in neuston samples in the study area as they were in Gulfwide samples (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

TRICHIURIDAE

Trichiurus lepturus (82 occurrences; 260 larvae; Figure 53)

The Atlantic cutlassfish is the most common member of this family in the GOM. Young *T. lepturus* were most frequently captured in bongo samples during fall surveys (Table 1). Mean size in bongo samples was 6.4 mm BL (n = 125; range = 2.4–26 mm) and mean size in neuston collections was 6.3 mm BL (n = 27; range = 4.3–9.3 mm). Larvae occurred more often and in greater numbers in the central and western regions of the UNIS study area (Figure 53). Atlantic cutlassfish young were never taken east of longitude 86°W. Cutlassfish larvae were significantly more common in spring bongo samples in the UNIS study area than Gulfwide but were as common in both areas in spring neuston samples and during fall surveys (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Scombridae

Acanthocybium solandri (2 occurrences; 2 larvae; Figure 54)

The larvae of another highly prized sport fish, the wahoo, were rare in the UNIS study area and were taken exclusively in bongo net samples during fall surveys (Table 1). These 2 specimens measured 2.8 and 5.0 mm in length. Both stations where larvae were taken lie outside the IOS–NEGOM research polygon (Figure 54). The westernmost capture station was located over water depths >1500 m, whereas the easternmost capture station was located between the 50–100 m isobaths. There was no statistical difference between the UNIS and Gulfwide survey areas in frequency of occurrence of wahoo larvae (Table 3). Relative abundances in the 2 areas differed by <0.1% (Table 4).

Katsuwonus pelamis (63 occurrences; 136 larvae; Figure 55)

Larvae of skipjack tuna, an oceanic schooling scombrid,

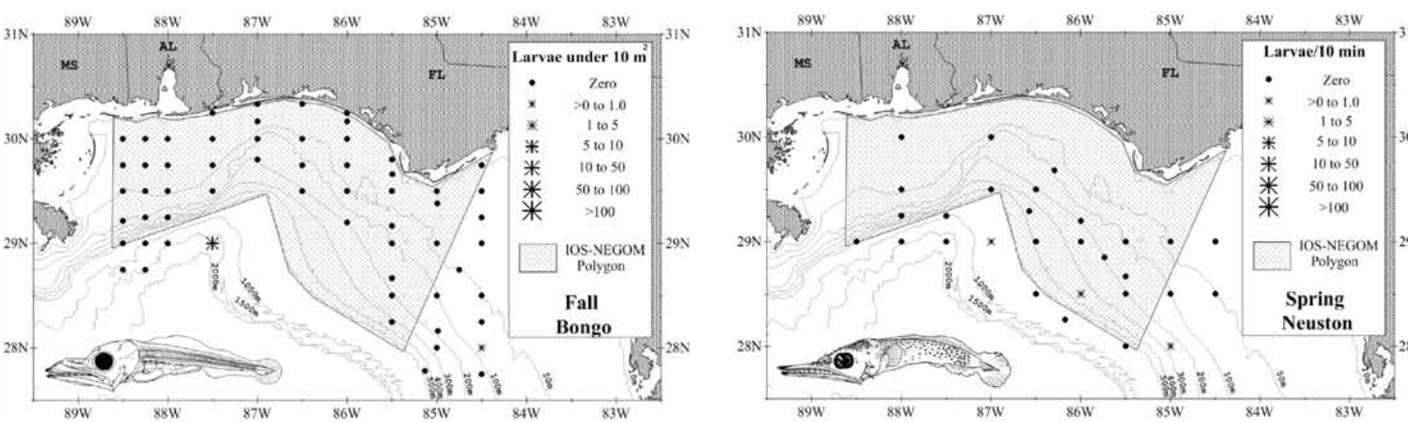

Figure 54. Mean abundance of wahoo, Acanthocybium solandri, *larvae (left); and mean CPUE of swordfish,* Xiphias gladius *(right), larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

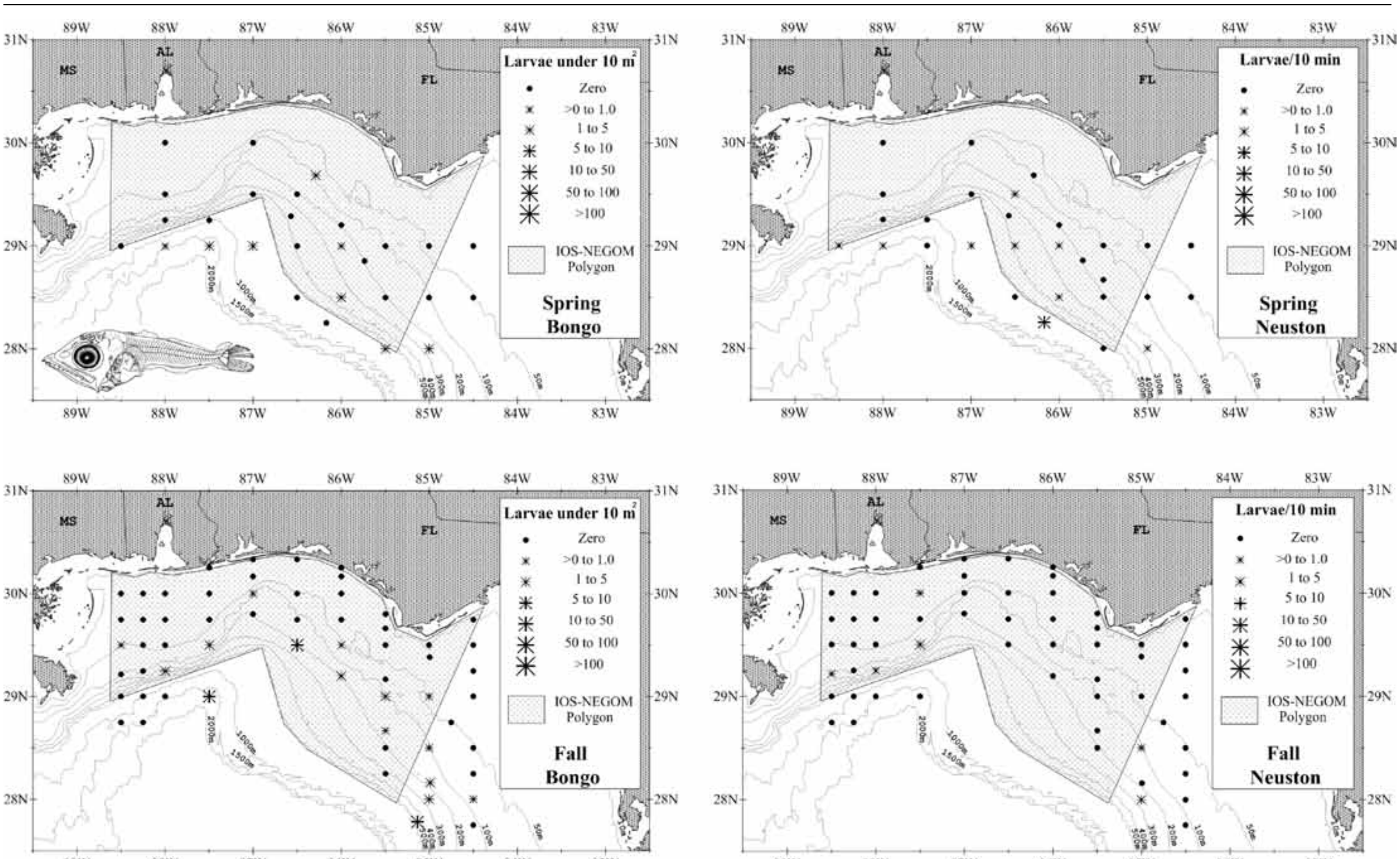

Figure 55. Mean abundance and mean CPUE of skipjack tuna, Katsuwonus pelamis, *larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

were as common in bongo as in neuston samples during spring and fall surveys (Table 1). Mean size in bongo samples was 3.9 mm BL (n = 29; range = 2.3—7.0 mm) and mean size in neuston collections was 5.1 mm BL (n = 46; range = 3.1—9.8 mm). Skipjack tuna larvae were taken most frequently and at the highest mean abundances at localities beyond the 100 m isobath (Figure 55). Skipjack tuna larvae were significantly less common in the study area during spring surveys than Gulfwide (Table 3). During fall surveys there was no statistical difference between the UNIS and Gulfwide survey areas in their occurrence. Relative abundances in the 2 areas differed by < 0.1% (Table 4).

Scomberomorus cavalla (87 occurrences; 143 larvae; Figure 56)

King mackerel larvae occurred across the UNIS study area inshore of the 200 m isobath during fall surveys, but were taken in other regions of the GOM during spring surveys (Table 3). Larvae were captured as often in bongo as in neuston samples (Figure 56); however, neuston collections accounted for 62% of specimens captured (Table 1). Mean size in bongo samples was 3.8 mm BL (n = 50; range = 1.9—7.2 mm) and mean size in neuston collections was 4.8 mm BL (n = 66; range = 2.7—7.5 mm). King mackerel larvae were significantly less common in fall bongo samples in the study area than Gulfwide but occurred at comparable frequencies in fall neuston samples in the 2 areas (Table 3). Relative abundances in the 2 areas differed by < 0.1% (Table 4).

Scomberomorus maculates (39 occurrences; 144 larvae; Figure 57)

Spanish mackerel larvae were also taken as often in bongo as in neuston samples, with the latter gear capturing the majority of specimens. Howver, unlike king mackerel, Spanish mackerel larvae were found in the UNIS study area during spring surveys (Table 1). Mean size in bongo samples was 2.9 mm BL (n = 25; range = 1.7—6.1 mm) and mean size in neuston collections was 7.7 mm BL (n = 74; range = 3.0—15.6 mm). Spanish mackerel larvae were not as evenly distributed over the study area as king mackerel larvae were during fall surveys (Figure 57). Larvae were significantly more common in the UNIS than Gulfwide survey area during spring surveys but were significantly less common in the UNIS study area during fall surveys (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Thunnus spp. (165 occurrences; 712 larvae; Figure 58)

Larvae of this genus are difficult to identify. Due to the economic importance of Atlantic bluefin tuna, *Thunnus thynnus*, all tuna larvae captured during SEAMAP spring surveys and initially identified in Poland are re—examined and their identification verified (W. J. Richards, NMFS, pers. comm.). No attempt was made to identify *Thunnus* larvae captured in fall surveys to species. Although far more numerous in neuston samples, *Thunnus* spp. larvae were taken as often in neuston as in bongo samples (Table 1). Mean size in bongo samples was 3.3 mm BL (n = 127; range = 1.8—7.6 mm) and mean size in neuston collections was 5.0 mm BL (n = 312; range = 2.8—10.3 mm). Occurrence and abundance were higher during fall than spring surveys. Tuna larvae were only taken beyond the 200 m isobath during spring surveys but were found from the 200 to within the 50 m isobaths during fall surveys (Figure 58). Frequency of occurrence and relative abundance of tuna larvae within the Gulfwide and UNIS survey areas varied with survey timeframe (Table 3). *Thunnus* spp. larvae were significantly less common in the UNIS study area than Gulfwide survey area during spring surveys and in fall neuston samples but occurred at comparable frequencies in fall bongo samples in the two areas (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

Thunnus thynnus (26 occurrences; 136 larvae; Figure 59)

Larvae of the Atlantic bluefin tuna were the most common of the tuna larvae identified to species in the UNIS study area. This species is managed through international treaties governing its conservation and annual estimates of larval abundance from SEAMAP spring plankton surveys are used in Atlantic bluefin tuna stock assessment (Scott et al. 1993). Atlantic bluefin tuna larvae were more frequently taken in neuston than in bongo net samples and were only captured during spring surveys (Table 1). Mean size in bongo samples was 3.9 mm BL (n = 10; range = 2.2—5.5 mm); mean size in

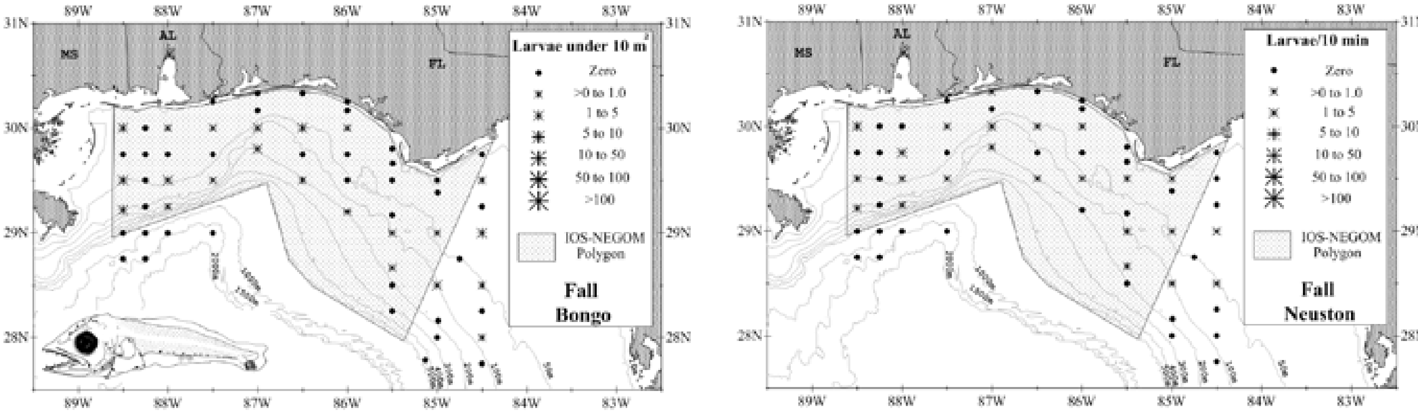

Figure 56. *Mean abundance and mean CPUE of king mackerel,* Scomberomorus cavalla, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

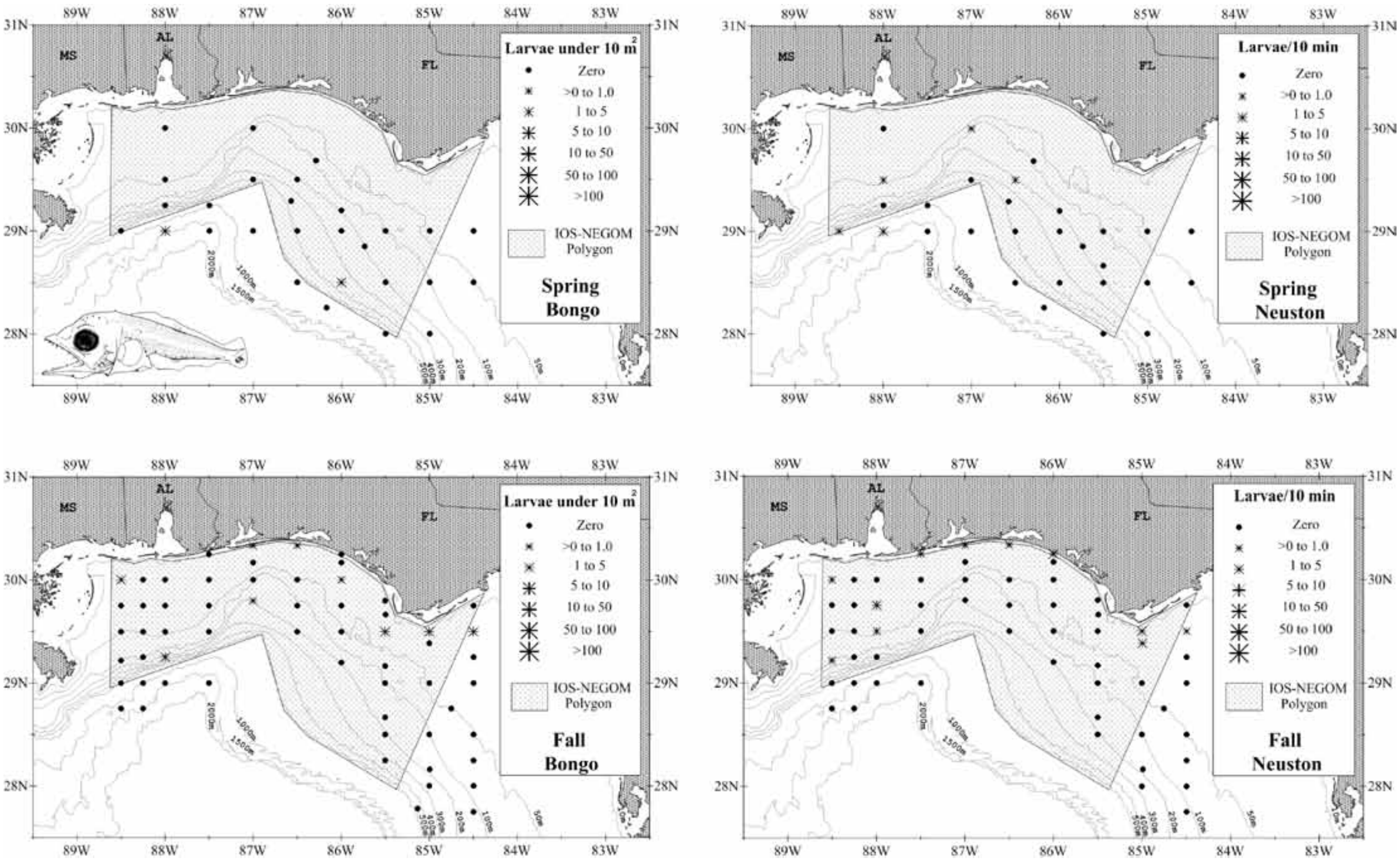

Figure 57. *Mean abundance and mean CPUE of Spanish mackerel,* Scomberomorus maculatus, *larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

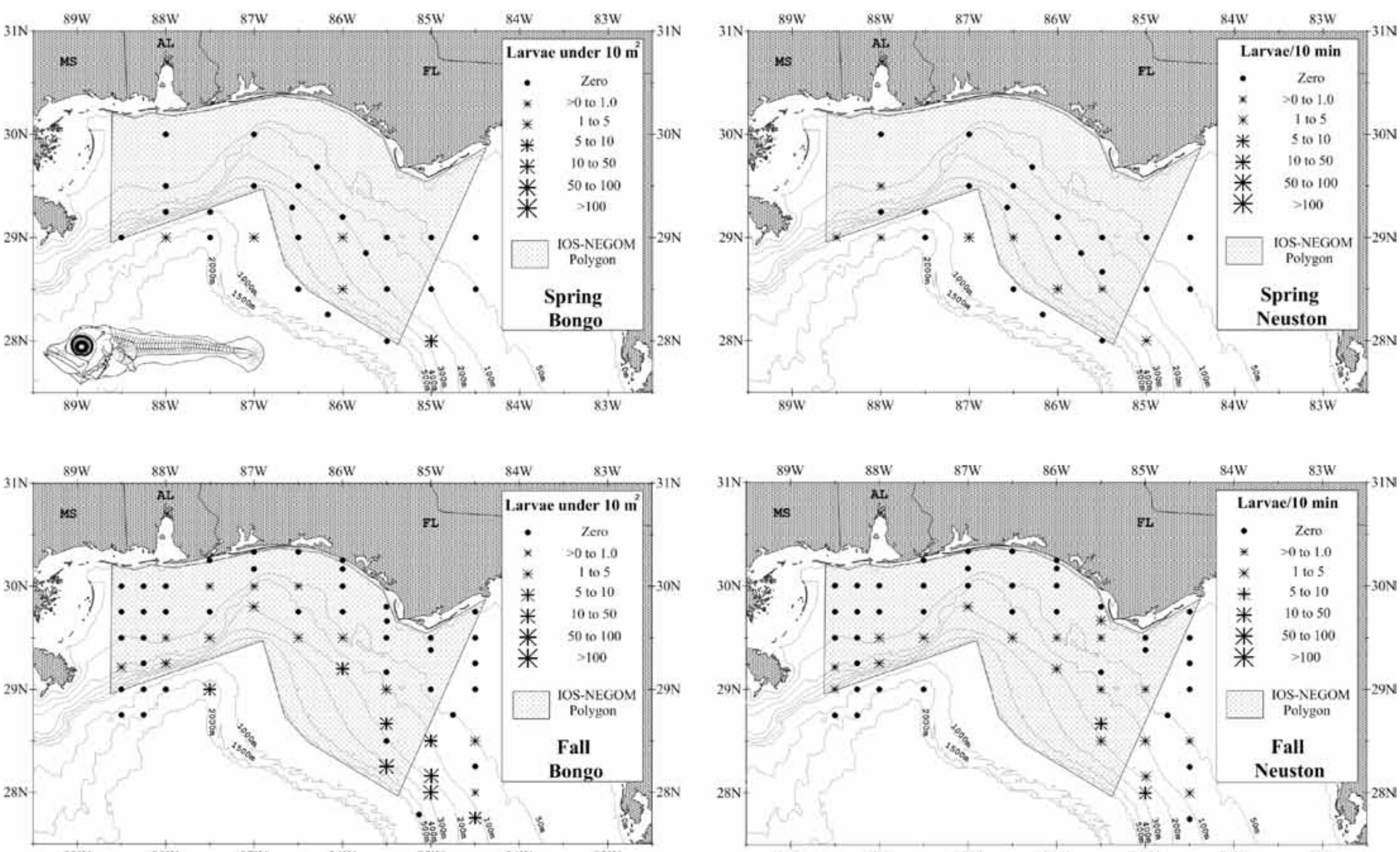

Figure 58. *Mean abundance and mean CPUE of tuna (*Thunnus spp.*) larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

neuston collections was 4.9 mm BL (n = 88; range = 3.1–6.0 mm). Larvae were found across the study area but mean abundances were highest at localities in the southeastern corner of the study area (Figure 59). Atlantic bluefin tuna larvae were significantly less common in the UNIS study area than Gulfwide survey area (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

XIPHIIDAE

Xiphias gladius (3 occurrences; 4 larvae; Figure 54)

Swordfish larvae were rare in the UNIS study area. All 4 specimens captured were taken in neuston samples during spring surveys at or beyond the continental shelf–slope break, i.e., beyond the 200 m isobath (Table 1; Figure 54). Overall size range of larvae was 19–46 mm BL. Larvae were relatively more common in Gulfwide collections. They were captured in both bongo and neuston samples during spring surveys and in neuston samples during fall surveys (Table 3). Swordfish larvae were significantly less common in the UNIS study area than Gulfwide survey area (Table 3). Relative abundances and CPUEs in the 2 areas differed by < 0.1% (Table 4).

ISTIOPHORIDAE (38 occurrences; 78 larvae; Figure 60)

Billfish larvae are exceedingly difficult to identify even to

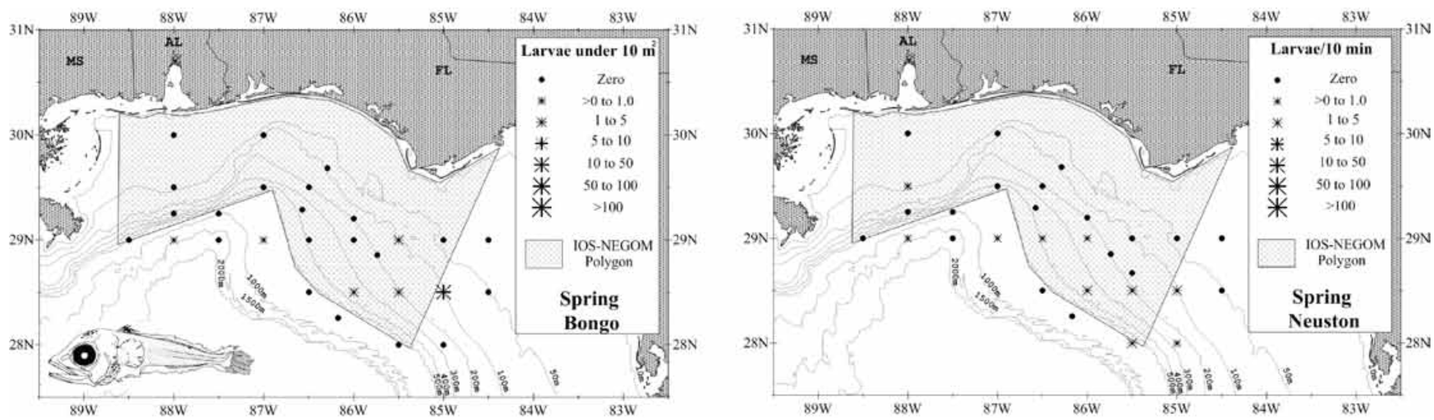

Figure 59. *Mean abundance and mean CPUE of bluefin tuna,* Thunnus thynnus, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

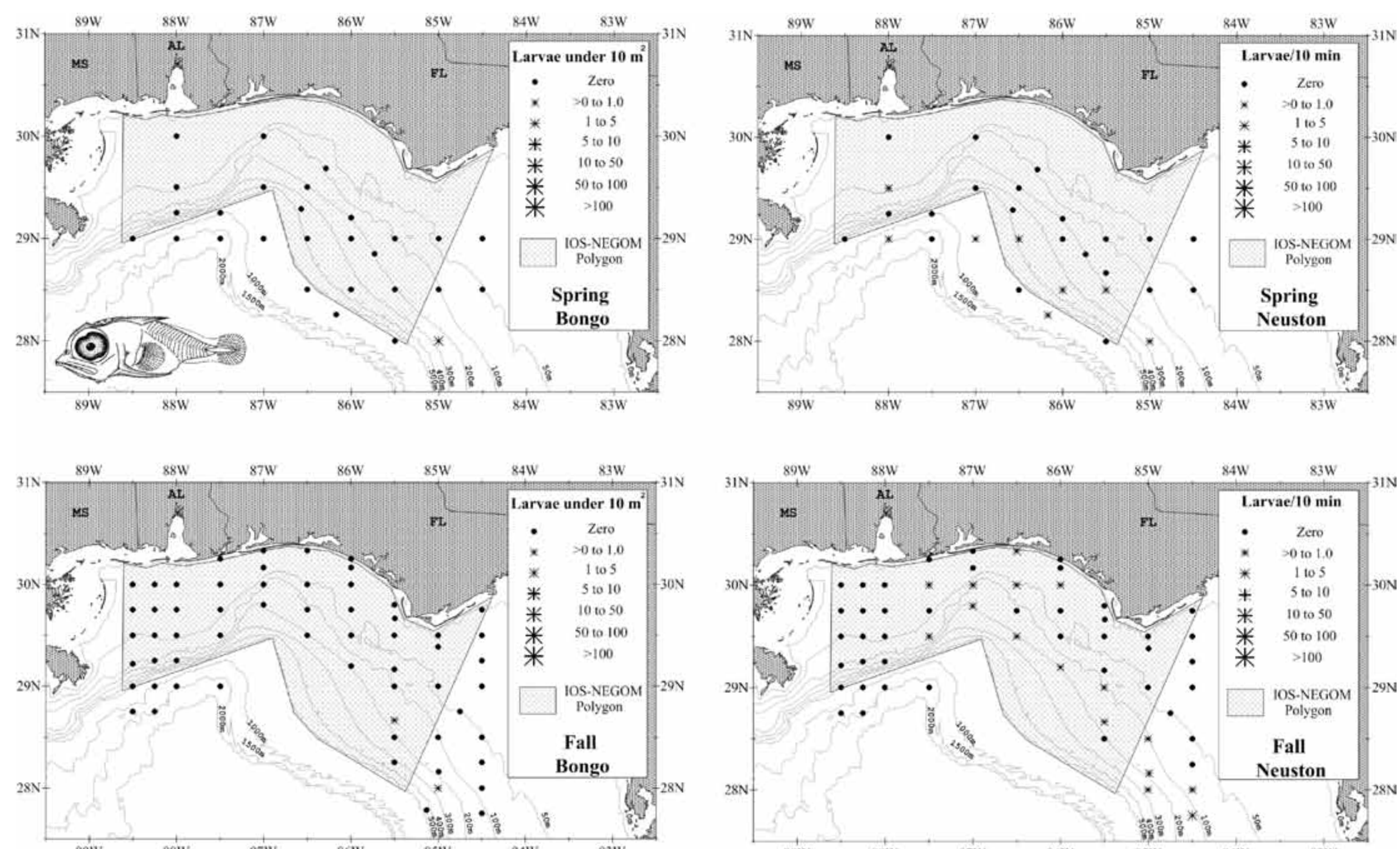

Figure 60. *Mean abundance and mean CPUE of billfish (Istiophoridae) larvae at sampling sites in the UNIS study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

the genus level; however, their identity as billfish is indisputable. Recent advances in the application of molecular genetics techniques has made species identifications of billfish larvae more feasible (Luthy et. al. 2005). Most billfish young caught in the UNIS study area were taken in neuston samples with 67% of the specimens being taken during fall surveys (Table 1). Mean size in bongo samples was 3.2 mm BL (n = 5; range = 2.6—4.4 mm) and mean size in neuston collections was 6.2 mm BL (n = 35; range = 3.1—32.8 mm). There was a clear shift in the distribution of billfish larvae from offshore in the spring to more inshore during the fall survey (Figure 60). Larvae were taken most consistently during fall surveys over the 'head' and the eastern slope of the DeSoto Canyon. No billfish larvae were captured west of longitude 87.5°W during fall surveys. There was no statistical difference between the UNIS and Gulfwide survey areas in frequency of occurrence of billfish larvae in spring and fall bongo samples but larvae were taken significantly less frequently in the study area than Gulfwide in spring and fall neuston samples (Table 3). Relative abundance and CPUE in the 2 areas differed by < .01% (Table 4).

STROMATEIDAE

Peprilus alepidotus (51 occurrences; 181 larvae; Figure 61)

Harvestfish young, like most other members of the family Stromateidae, are often found concentrated around and associated with floating debris and/or pelagic coelenterates. Larvae were taken primarily in bongo samples and almost exclusively taken during fall surveys (Table 1). Mean size in bongo samples was 2.3 mm BL (n = 129; range = 1.2—11.0 mm) and mean size in neuston collections was 8.9 mm BL (n = 55; range = 2.8—39 mm). Larvae were found throughout the UNIS study area generally within the 100 m isobath with highest mean abundances in bongo samples observed off Cape San Blas inshore of the 50 m isobath off northern Florida (Figure 61). There was a single, spring occurrence in a bongo sample (not shown on Figure 61) at station B153 between the 200 and 300 m contours southwest of the Florida Middle Grounds. There was no statistical difference between the UNIS and Gulfwide survey areas in frequency of occurrence of young harvestfish larvae in spring bongo samples and fall neuston samples, but larvae were taken significantly less often in the study area than Gulfwide in fall bongo samples (Table 3). Relative abundance and CPUE in the 2 areas differed by < 0.1% (Table 4).

Peprilus burti (115 occurrences; 813 larvae; Figure 62)

The Gulf butterfish is a demersal, vertically migrating middle to outer continental shelf species (Vecchione 1987, Herron et al. 1989). Their larvae were more abundant in the UNIS study area than harvestfish larvae. Like its congener, Gulf butterfish larvae were more common in bongo than neuston samples, and were taken almost exclusively during fall surveys (Table 1). Mean size in bongo samples was 2.4 mm BL (n = 338; range = 1.2—11 mm) and mean size in neuston collections was 8.7 mm BL (n = 47; range = 2.5—22.5 mm). Although larvae occurred throughout the study area, highest mean abundances were observed at localities between the 50 and 200 m isobaths along the contours outlining the DeSoto Canyon (Figure 62). Frequency of occurrence of Gulf butterfish larvae in bongo samples was higher in the UNIS study area (26%) than Gulfwide (11%; Table 3). There was no statistical difference between the UNIS and Gulfwide survey areas in frequency of occurrence of young Gulf butterfish larvae in spring bongo samples but larvae were taken significantly more often in the study area than Gulfwide in spring neuston and fall survey samples (Table 3). Relative abundance and CPUE in the 2 areas differed by < 0.5% (Table 4).

Summary of Distributional Observations

A complete representation of the seasonality of ichthyoplankton occurrence and abundance in the NEGOM cannot be produced from these SEAMAP data since only 2 survey time frames yielded data for this synopsis. However, these

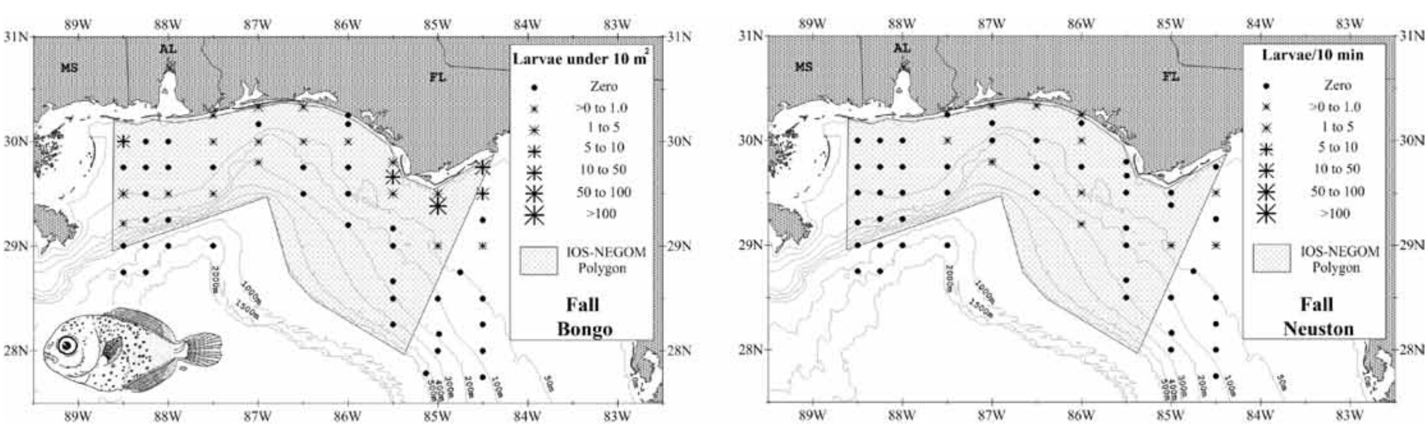

Figure 61. *Mean abundance and mean CPUE of harvestfish,* Peprilus alepidotus, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. (Map of one occurrence in spring survey bongo samples is not shown.) UNIS and SEAMAP defined in Figure 1.*

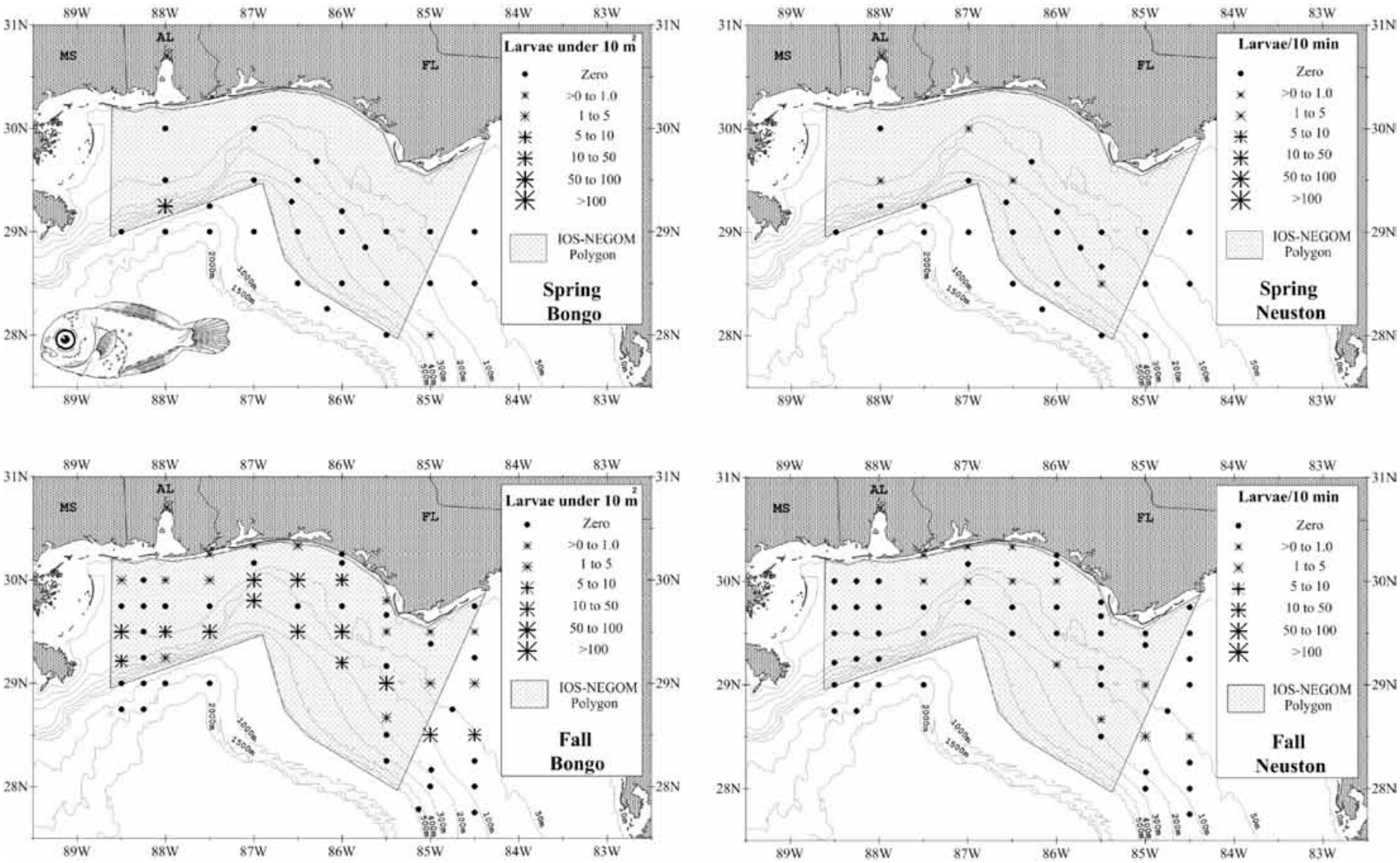

Figure 62. *Mean abundance and mean CPUE of Gulf butterfish,* Peprilus burti, *larvae at sampling sites in the UNIS Study area captured during SEAMAP surveys, 1982-1999. UNIS and SEAMAP defined in Figure 1.*

2 periods, principally mid—April through May and September to mid—October, encompass the spawning seasons and peak occurrence of the majority of shelf dwelling species in the GOM (Ditty 1986; Ditty et al. 1988). Houde and Chitty (1976) found ichthyoplankton abundance to be highest on the west Florida shelf during May through September. Of course, depending on specific taxa of interest there are notable exceptions to this, namely, late fall to winter spawning species such as most of the groupers, tilefishes, porgies, menhaden and striped mullet.

Three coarse measures of fish spawning, ichthyoplankton abundance, and zooplankton abundance indicated that the UNIS study area contributed more fish eggs, total larvae and zooplankton to Gulfwide survey totals than would be expected from the number of samples taken in that region. This was more evident during spring than fall surveys, and is probably related to the close proximity of UNIS survey stations to the Mississippi River and the inshore penetration of the DeSoto Canyon. The vast majority of spring survey stations outside the study area are located in open GOM waters beyond the influence of nutrient enriched, continental shelf waters.

During spring surveys, total ichthyoplankton abundance both in the water column and at the surface was disproportionately higher (5—9%) in the study area than Gulfwide, while during fall surveys the reverse was true (2—6% lower than expected). This latter finding is probably related to the reduced amount of shelf area in the UNIS study area compared to the remainder of the SEAMAP fall survey area especially in the western GOM. Zooplankton biomass was also greater in the study area relative to the entire survey area during both survey time frames but the difference was greater (8% above expectation) during fall surveys.

Statistical comparison of the frequency of occurrence of the 61 ichthyoplankton taxa selected for this study revealed that the larvae of many were taken significantly more often in the UNIS area than expected based on their occurrence Gulfwide. In contrast, gross measures of relative ichthyoplankton abundance and CPUE, with a few notable exceptions, indicated little difference between the study areas. Thirteen of these taxa were taken significantly more often in the study area during the season and collecting gear combination that accounted for the highest catches. These taxa were: Muraenidae, *E. teres*, Engraulidae, Sternoptychidae, Synodontidae, *C. bermudensis*, Serranidae, *Decapterus* spp., *Seriola* spp., *R. aurorubens*, Mullidae, Labridae, and *P. burti*. The relative abundance and CPUE in the UNIS study area of only the Engraulidae and Mullidae accounted for a disproportionately higher than expected value of the percent of abundance of total fish larvae captured Gulfwide.

The 13 taxa includes fishes from mesopelagic, coastal and shelf demersal and pelagic, and reef assemblages indicating that the NEGOM is an important spawning and/or nursery area for a diverse group of fishes. This diversity reflects the wide variety of available habitats in this region of the GOM that range from shallow mud to sand to deep hard/live bottoms all adjoining deep oceanic waters. The occurrence and relative abundance of numerous other taxa in the study area were similar to Gulfwide values. Therefore, as the larvae of more species are identified in SEAMAP collections using updated descriptive information, the number of taxa for which the NEGOM proves to be an important spawning and/or nursery area will undoubtedly increase.

The importance of the NEGOM to production of many economically valuable fishes including coastal pelagic, reef and highly migratory taxa is supported by the consistent occurrence of their young in the UNIS study area. Amberjack (*Seriola* spp.) and vermilion snapper (*R. aurorubens*) larvae were relatively more common in the study area than Gulfwide during the season of their highest abundance. At other times, some larvae were found to be more common in the study area than Gulfwide at a time outside of the documented spawning season, such as Spanish mackerel (*S. maculatus*) during spring surveys. This latter finding may indicate that Spanish mackerel spawning begins earlier in the NEGOM than in other areas of the northern GOM. Red snapper (*L. campechanus*) larvae were in general less common in the study area than Gulfwide, but their relative abundance in study area neuston samples was similar to the Gulfwide value. Young dolphins (Coryphaenidae) were less common in the study area during spring (offshore) surveys when they were most abundant but were as common in the UNIS area as Gulfwide during fall surveys over the continental shelf. Occurrences of billfish (Istiophoridae), wahoo (*A. solandri*), and cobia (*R. canadum*) larvae in plankton collections are rare events anywhere. Thus, the consistent occurrence of these species in SEAMAP collections in the UNIS study area is noteworthy, indicating that these highly migratory fishes spawn in the NEGOM region.

Several general distribution patterns emerged from an examination of the occurrences of larvae within the UNIS study area. Of the 61 selected taxa, the larvae of 4 taxa occurred predominately west of 87°W longitude; *R. canadum, Caranx* spp., *L. campechanus*, and *T. lepturus*. The larvae of 14 taxa occurred mostly at localities east of the 87th meridian; *S. aurita, E. teres, C. bermudensis,* Epinephelinae, Grammistinae, Priacanthidae, *Seriola* spp., *L. griseus,* Scaridae, Istiophoridae, Apogonidae, Haemulidae, Chaetodontidae, and Pomacanthidae. A number of taxa in this latter group were found predominately east of longitude 86.5°W, including L. griseus, Haemulidae, Chaetodontidae, and Pomacanthidae.

These patterns coincide with distinct changes in topography, bottom type and hydrography of the region and, in turn, available habitats and associated biological communities. The northern rim of DeSoto Canyon cuts into the inner continental shelf to a minimum depth of 50–60 m dividing the NEGOM shelf into distinct western and eastern sectors subject to different physical and biological influences. Oceanographically, cold deep water, driven by the GOM Loop Current (Maul 1977), rides up the canyon impinging upon the inner shelf (Müller–Karger et al. 2001). The area west of 87°W consists of a broad predominately mud and clay (terrigenous sediments) covered shelf that adjoins several extensive estuarine systems and can be influenced directly by the Mississippi River. East of that meridian the shelf narrows, sand and carbonate sediments are dominant and riverine influence is minimal.

The influence of the DeSoto Canyon on the fish fauna of the NEGOM is also profound, differentiating both the demersal (Weaver et al. 2002) and pelagic fish faunas, including current–borne ichthyoplankton. The SEAMAP distribution patterns for larvae of 6 taxa clearly coincide with the 50–500 isobaths outlining the submarine canyon: *C. bermudensis*, Sternoptychidae, Paralepididae, Anthiine, and *P. aquilonaris.* The distribution of larval *P. burti* was also linked to the canyon, but deviated somewhat from this pattern. Highest mean abundances were consistently located over the canyon, although Gulf butterfish larvae also occurred inshore of the canyon.

Although discrete depth sampling was not conducted during SEAMAP surveys, the 2 types of plankton nets employed provided samples from distinct and separate segments of the water column. The neuston net sampled the upper half–meter of the ocean surface layer. The bongo net sampled the entire water column from sub–surface to near bottom (or to a maximum depth of 200 m when bottom depth was greater). Contrasting the catches of the 2 gear types provided some insights into utilization of 2 different oceanic regimes by fish larvae in the study area. The young of 11 taxa, including highly migratory, pelagic, and reef fishes, were found predominantly in the surface layer of the ocean: *X. gladius*, Istiophoridae, *T. thynnus, R. canadum, Caranx* spp., *Seriola* spp., Coryphaenidae, *L. surinamensis*, Muraenidae, Holocentridae, and Mullidae. For these taxa, over 85% of specimens were taken in surface waters, and over 70% of captures occurred in surface waters. The young of *X. gladius, R. canadum*, and *L. surinamensis* were never captured below the surface layer (i.e., never in bongo nets). All remaining taxa considered in this study were as numerous, or more numerous, below the surface layer (i.e., in bongo net collections) as at the surface (i.e., in neuston net collections). Among the young of hard–bottom and deep–reef fishes analyzed from study area collections, 6 were found principally below the surface layer, occurring in over 70% of bongo samples: *C. bermudensis*, Anthiinae, Epinephelinae, Haemulidae, Labridae and Scaridae. Except for the Anthiinae, over 90% of specimens in these taxa were taken in the water column. In the Anthiinae, 69% of specimens were taken in the water column. The young of 3 additional hard/live bottom taxa; Priacanthidae, Pomacentridae and Acanthuridae, occurred with equal frequency in both surface and water column collections.

Limited size data were summarized for the young of taxa representing fishes living in or near hard/live bottom habitats, namely the 4 subfamilies of sea basses (Serranidae) and 10 families of obligate reef fishes. Due to the difficulties inherent in these data (i.e., not all larvae in collections were measured), only the incidence of the largest and smallest specimens relative to position in the water column were examined. There seemed to be a difference in the size of larvae captured in the surface layer and throughout the water for some reef taxa. The largest individuals of 3 taxa were consistently taken in neuston samples. This was most evident among young Holocentridae but was also true for the Priacanthidae and Pomacentridae. The early life histories of the first 2 families are known to include a pelagic juvenile stage of long duration prior to settlement (Thresher 1984). Early life stages of representatives of all 3 families, especially the pomacentrid, *Abudefduf saxatilis*, are consistently taken in floating *Sargassum* in the western Atlantic Ocean and NEGOM (Dooley 1972, Bortone et al. 1977, Moser et al. 1998, Franks et al. 2002). The size distributions of the most ubiquitous and numerous reef fishes in UNIS study area plankton collections, the Labridae and Scaridae, were essentially the same in both surface and water column collections. Among sea bass larvae, larger anthiines were taken in water column samples while individuals in the largest size classes of the Serranine and Grammistinae were equally represented in the 2 sampled segments of the water column.

The consistent presence of fish eggs throughout the study area at mean abundances > 100 under 10 m² sea surface indicates that the NEGOM is an important spawning area. Additional evidence of high spawning activity in the region comes from a survey of the entire west Florida shelf (Houde and Chitty 1976). These workers found that the most intense spawning of fishes occurred north of latitude 27°15´N, i.e., the area adjoining the UNIS study area to the east. The presence of larvae in the 1.5 and 2.0 mm size classes is further evidence of local spawning. Small sea bass larvae in those size classes were collected in the UNIS study area indicating, unambiguously, that these fishes spawn in the NEGOM region. Small (≤ 2.0 mm) larvae of 7 of the 10 selected reef fish families were also present in study area samples. The smallest larvae of the Chaetodontidae, Pomacanthidae, and Acanthuridae taken in UNIS study area samples were 2.5, 3.1, and 3.5 mm BL, respectively. Despite the small number of specimens captured, it is more than likely based on the known areas of hard bottom habitat in the NEGOM that these taxa also spawn in this area.

Local spawning, however, may not be the only source of reef fish larvae in NEGOM waters. The Loop Current and its associated eddies and rings are known to exert the dominant dynamic influence not only in the open GOM but also on the continental shelf and slope and facilitate exchanges of water mass between them (Maul 1977, Vukovich and Crissman 1986, Kelly 1991, Hamilton 1992, Berger et al. 1996, Nowlin et al. 1998). The UNIS study area is consistently in the direct path of the Loop Current; it has been shown that the shelf edge region off Mississippi and Alabama is influenced by the Loop Current 40% of the time (Kelly 1991). Additionally, pools of Loop Current water formed by short—lived rings can intrude into the UNIS study area at least as often as every 2 years (Muller—Karger et al. 2001). It is probable, therefore, that the early life stages of hard/live bottom fishes are periodically transported into the study area via Loop Current intrusions, providing an extrinsic source of recruitment. However, larvae produced in the NEGOM may likewise be either retained there or exported to other GOM reefs via the same mechanisms. Hanisko and Lyczkowski—Shultz (2003) examined the distribution of labrid and scarid larvae from SEAMAP collections Gulfwide in light of the Loop Current and its associated eddies and rings. These authors suggested that, depending on species—specific, planktonic stage durations, larvae produced on reefs throughout the northern GOM could be entrained in currents produced by Loop Current eddies and could return in time to settle on their natal reefs or, alternatively, could be exported to settle on distant GOM reefs.

This synopsis represents an examination of the most extensive set of ichthyoplankton data available for the northern GOM, namely data generated from SEAMAP plankton surveys ongoing since 1982. The specific purpose of this analysis of historical SEAMAP ichthyoplankton data was to characterize occurrence and relative abundance of young fishes in the northeastern region of the GOM and to examine the region's relative contribution to the early life histories of fishes as compared to the entire GOM within the U.S. EEZ. This summary has revealed that the NEGOM should be considered an important if not critical habitat for the young of a diverse, perhaps even unique, assemblage of fish larvae. The varied and juxtaposed essential fish habitats of the NEGOM result in an area that is used as spawning and nursery grounds for estuarine and coastal, hard/live bottom, soft bottom, and oceanic fishes.

Future Directions

Since this data summary was first produced as USGS Project report USGS SIR—2004—5059 (http://cars.er.usgs.gov/coastaleco/), a significant contribution to larval fish identifications in the region has been published and plankton sampling during SEAMAP surveys has been expanded; both of which address shortcomings of historical SEAMAP ichthyoplankton surveys and data as revealed here. The recently published guide to the early life stages of marine fishes of the western central Atlantic Ocean (Richards 2006) brings together in a single work all previously published, as well as new larval descriptions. This compilation will facilitate the re—examination and more precise identification (i.e., to lower taxonomic levels) of archived SEAMAP specimens. Improved taxonomic resolution will allow SEAMAP ichthyoplankton data to be used to describe critical spawning and nursery habitats, relationships between oceanographic processes and pre—settlement stage larvae, or to reveal recruitment dynamics and the effects of perturbations to the environment for more species than was previously possible.

Additional shortcomings of the earlier SEAMAP ichthyoplankton surveys lie in the realm of seasonal coverage, discrete depth, and directed sampling. The original plan to sample throughout the GOM in all seasons has never been realized. As a result, there are major gaps in data and information for species that spawn in areas and at times that remain un—surveyed. The most egregious deficiency is the lack of information on winter spawning species. In order to fill this data gap, NMFS began a biannual, SEAMAP winter plankton survey in 2007 which over time will result in a more comprehensive set of ichthyoplankton data for all marine fishes in the GOM. Also starting with the 2007 winter survey, NMFS began taking discrete depth ichthyoplankton collections with a 1 m multiple opening and closing net and environmental sensing system (MOCNESS) during SEAMAP plankton surveys. Position in the water column can have a direct influence on dispersal of fish larvae (Lyczkowski—Shultz and Steen 1991) and the pre—settlement and pelagic juvenile stages of many reef fishes are capable of adjusting their vertical position in the water column; some have been shown to maintain a preferred depth (Leis et al. 1996, Cowan and Sponaugle 1997). Subsurface currents may be an important mechanism for either the retention of larvae near or their transport to the habitats and communities where they will eventually settle and take up demersal existence.

Implementation of plankton sampling targeting oceanographic features of interest began in 2008 during the spring SEAMAP survey. Satellite imagery was used to direct additional, 'off the grid' sampling in the vicinity of Loop Current eddies and convergence zones where it is believed that Atlantic bluefin tuna spawn and where their larvae may be concentrated (Muhling et al. 2010). Ichthyoplankton sampling in the GOM relative to Loop Current fronts and associated convergence zones has shown that the larvae of tunas, wrasses and parrotfishes are more abundant in areas dominated by these oceanographic features (Richards et al. 1989, Hanisko and Lyczkowski—Shultz 2003).

Ultimately the data from more specialized sampling of this kind will reveal in more detail the coupling between oceanographic processes and recruitment of not only reef species but also the young of fishes such as mullet and menhaden that are spawned in open GOM waters and must return to nearshore habitats (Richards and Lindeman 1987). This new, ever evolving SEAMAP ichthyoplankton database will allow future researchers to conduct more sophisticated analyses of larval fish assemblages and provide more detailed insights into the early life histories of marine fishes in the GOM ecosystem.

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