Gulf of Mexico Science

Volume 29
Number 1 *Number 1*

Article 3

2011

Comparison of Ichthyoplankton Sampling Conducted by the State of Alabama and the National Marine Fisheries Service During Southeast Area Monitoring and Assessment Program Fall Plankton Surveys

Christina M. Schobernd
National Marine Fisheries Service

Mark Van Hoose
Alabama Department of Conservation and Natural Resources

Joanne Lyczkowski-Shultz
National Marine Fisheries Service

DOI: 10.18785/goms.2901.03

Gulf of Mexico Science, 2011(1), pp. 25–40

Comparison of Ichthyoplankton Sampling Conducted by the State of Alabama and the National Marine Fisheries Service During Southeast Area Monitoring and Assessment Program Fall Plankton Surveys

Christina M. Schobernd, Mark Van Hoose, and Joanne Lyczkowski-Shultz

Data on the abundance and distribution of the early life stages of fishes were collected by the Alabama Department of Conservation and Natural Resources (ADCNR) and the National Marine Fisheries Service (NMFS) between 1984 and 2007 during Southeast Area Monitoring and Assessment Program (SEAMAP) cooperative resource surveys in the northern Gulf of Mexico. The ADCNR collected samples from various locations inside and outside Mobile Bay, while the NMFS collected samples farther offshore at four standard SEAMAP grid stations near the Alabama coast. We compared catch data on larval and juvenile fishes, along with environmental information, from a total of 225 neuston samples between the two sampling areas. Larval assemblages and diversity parameters varied between ADCNR and NMFS sampling sites, reflecting differences in environmental conditions. A less diverse assemblage dominated by estuarine taxa, including engraulids, sciaenids, gerreids, and clupeids, was found at ADCNR sampling locations, whereas a more diverse marine assemblage, including lutjanids, carangids, labrids, monacanthids, and scombrids, was observed at NMFS sampling sites. Larvae of red drum, *Sciaenops ocellatus*, an important federally managed species, were more prevalent at the ADCNR sampled sites than at the standard SEAMAP stations sampled by the NMFS near Mobile Bay. However, over the entire SEAMAP survey area, catch rates of red drum larvae at shallow (<26 m) SEAMAP stations were comparable to, or even higher than, those observed at the ADCNR sites.

Introduction

The Alabama Department of Conservation and Natural Resources (ADCNR) along with marine resource agencies (or their designees) of the states of Texas, Louisiana, Mississippi, and Florida conduct fishery resource surveys cooperatively with the National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center, Mississippi Laboratories under the Southeast Area Monitoring and Assessment Program (SEAMAP) in the Gulf of Mexico (GOM). The goal of these annual surveys is to provide fishery-independent data on the abundance and distribution of economically important marine species (fish, shrimp, and crabs) and to collect data on select environmental and habitat parameters. Plankton sampling for fish eggs and larvae (ichthyoplankton) is a major component of SEAMAP resource surveys. The majority of SEAMAP plankton samples are collected by NMFS from National Oceanic and Atmospheric Administration (NOAA) vessels using standard SEAMAP methods and gear at predetermined (standard) SEAMAP stations arranged in a fixed, systematic grid pattern across the GOM (Lyczkowski-Shultz et al., 2004; Lyczkowski-Shultz and Hanisko, 2007). Historically, the states of Louisiana, Mississippi, Alabama, and Florida have collected plankton samples during one or more of the SEAMAP survey timeframes. However, the state of Alabama was not able to implement all standard SEAMAP plankton sampling protocols because of vessel limitations and restriction of vessel operations to state waters only. We present here a summary of ichthyoplankton data collected by Alabama during SEAMAP fall plankton surveys (mid-Aug. to mid-Oct.) with a comparison to comparable data collected by NMFS at standard SEAMAP plankton stations nearest to the Alabama sampling area. The objective of this comparison is to determine what effect Alabama's disparate sampling design has on estimates of taxonomic composition and abundance of fish larvae in this region of the SEAMAP survey area.

Methods

Field methods.—Plankton sample and data collection using standard SEAMAP plankton gear, bongo nets, and neuston nets were implemented on NOAA vessels in accordance with procedures outlined in the SEAMAP field operations manual (NMFS/GSMFC, 2001). Only the standard SEAMAP neuston net was used to collect plankton

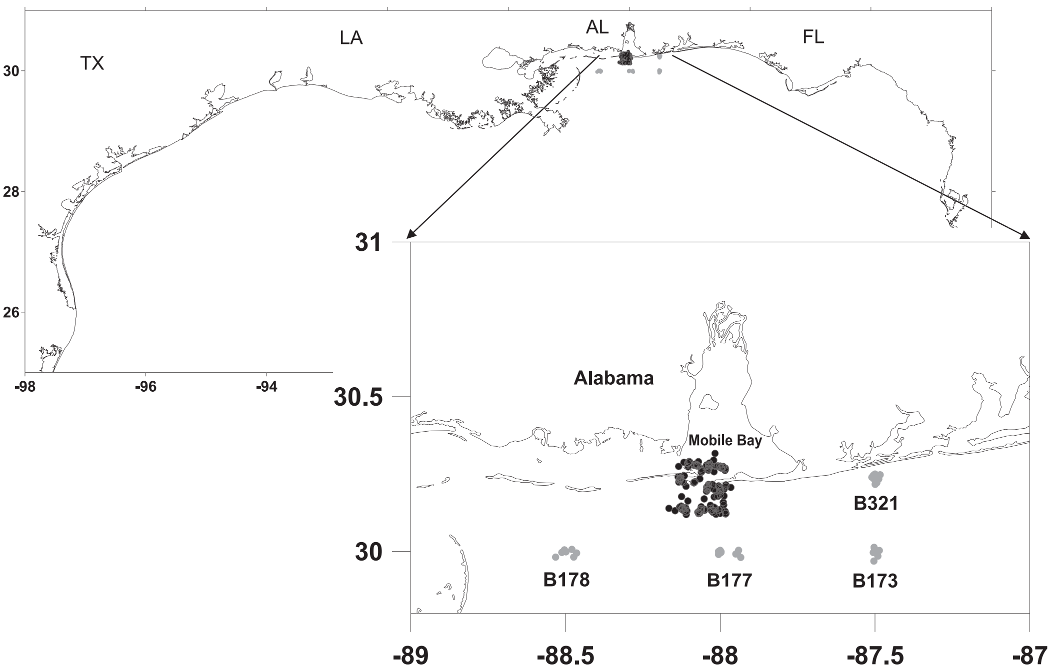

Fig. 1. Sampling sites for ADCNR (black dots) and NMFS (gray dots) during SEAMAP fall plankton surveys (Aug.–Sept., 1984–2007). NMFS SEAMAP samples were collected at stations on a standard grid, located ~ 30 nm apart (represented by ''B-number'' labels).

samples and data on the ADCNR vessel, and consequently only data from neuston samples were used in this analysis. The SEAMAP neuston gear consists of a 0.947-mm mesh net attached to a 1 × 2 m metal frame that is towed for a maximum duration of 10 min at a speed (~ 2 knots) sufficient to keep the net opening half submerged in the water and thus maintaining a sampling depth of 0.5 m. During four NMFS cruises, samples were collected using a double 1 × 2 m neuston frame with two 0.947-mm mesh nets, but only data from one net were used in this analysis. The ADCNR collected samples aboard the R/V *A.E. Verrill* during both daylight and night hours from 1986 to 1992. After 1992, ADCNR samples were only collected during daylight hours. The NMFS conducted 24-hr sampling aboard NOAA ships *Oregon II* (1984–90 and 2000), *Chapman* (1991–97), and *Gordon Gunter* (1998, 1999, and 2001–07). Environmental parameters (temperature, salinity, and dissolved oxygen) were measured at both ADCNR and NMFS sampling locations. Complete descriptions of survey methodologies, data collection, and sampling effort by year and survey type can be found in the SEAMAP Environmental and Biological Atlases of the Gulf of Mexico, 1982 to 2004 published by Gulf States Marine Fisheries Commission, Ocean Springs, MS (available at www.gsmfc.org).

The ADCNR collected 201 neuston samples over 21 surveys from 1986 to 2007 at locations both inside and outside Mobile Bay (not at standard SEAMAP stations) during the survey timeframe known as the SEAMAP fall plankton survey (Fig. 1). Despite its name, this survey is conducted during late summer months, late Aug. through Sept. The survey design consisted of sampling sites that were characterized as either inside Mobile Bay (north of 30.25°N), outside the Bay (in between 30.15°N and 30.25°N) or farther offshore (south of 30.15°N). The ADCNR sampled sites 139 times during daylight hours (sunrise to sunset) and 22 times during nighttime hours (sunset to sunrise; Table 1). For this analysis, we focused only on the samples collected after 1985, which made up the majority of Alabama's contribution to the SEAMAP fall plankton survey. The comparative NMFS data set used in this analysis consisted of 66 neuston samples (24 from daylight hours and 42 from nighttime hours; Table 1) collected at four standard SEAMAP stations (B178, B177, B173, and B321) located nearest to the Alabama coast during 20 fall plankton surveys (Fig. 1).

Laboratory methods.—Fish larvae from samples were removed and identified to the lowest level possible at the Sea Fisheries Institute, Plankton Sorting and Identification Center (ZSIOP) in

TABLE 1. Total number of samples (n) and mean CPUE (mean number of larvae collected per 10-min tow, ± SE) for daytime, nighttime, and day and night samples combined collected by the ADCNR (Alabama) and NMFS (B177, B178, B321, B173).

	Alabama	NMFS
Day (n)	139	24
Night (n)	22	42
Combined (n)	161	66
Day mean CPUE	147 (± 70)	152 (± 80)
Night mean CPUE	178 (± 59)	235 (± 55)
Combined mean CPUE	151 (± 61)	205 (± 45)

Gdynia and Szczecin, Poland. Body length (BL) in millimeters (either notochord or standard length) was measured for a varying number (two to all specimens) depending on the taxonomic level of identification. Only size range (i.e., size of the largest and smallest specimens) was measured for larvae identified to family and higher levels. In the early years of the SEAMAP sampling time series, only size range regardless of taxon was recorded. Length data were examined (mean and range) for select taxa where all or ≥ 10 captured specimens were measured. Among the samples used in this analysis 77% of the specimens were identified to the family level. Identification of fish larvae beyond the family level in the taxonomically rich Gulf of Mexico (McEachran and Fechhelm, 1998) remains problematic despite the recent publication of a guide to the early life stages of fishes in the central Western North Atlantic region (including the Gulf of Mexico; Richards, 2006). For a few groups of fishes, most notably the Clupeidae (herrings) and Engraulidae (anchovies), SEAMAP protocols permit identifications to order level (Clupeiformes). Herring and anchovy larvae can be distinguished from each other by the relative length of the gut or the total number of myomeres (Ditty et al., 2006; Farooqi et al., 2006). However, it is often the case that the long gut is torn loose from the body, making it impossible to use this character to distinguish herring from anchovy larvae. Furthermore, the high number of herring and/or anchovy larvae (> 200) typically found in SEAMAP inshore neuston samples makes it impractical to count myomeres of each specimen in a sample. When possible, the larger, more developed and intact specimens in samples are identified to family.

Data analysis.—Neuston catches were standardized by calculating the catch per unit effort (CPUE), or number of larvae caught per 10-min tow (CPUE = (n / tow time) × 10 min). Total and mean CPUE and percentage frequency of occurrence (%FO) were calculated for each taxon for daytime and nighttime samples at both ADCNR and NMFS sampling locations. Daytime and nighttime catches were treated separately to control for the reported confounding influence of time of day on neuston net catches (Morse, 1989; Lyczkowski-Shultz and Hanisko, 2007). Total number of taxa (S), Margalef's richness index (d), and H′ diversity were calculated for ADNCR and NMFS daytime and nighttime samples. Multivariate tests, Bray Curtis similarity, analysis of similarity (ANOSIM), and similarity percentages (SIMPER) were performed on daytime and nighttime CPUE data to compare taxonomic composition and taxon-specific larval abundances at the inshore ADCNR and standard SEAMAP-NMFS sampling locations. Data were square root transformed to down-weigh the contribution of dominant taxa; extremely rare taxa (< 5 larvae collected per 10-min tow) were removed (Clarke and Green, 1988) from the analyses.

RESULTS

Alabama samples contained a total of 24,418 fish larvae representing 84 taxa distributed among 42 families. Of these larvae, 19,133 were identified to family, 2,704 to genus, and 2,258 to species. The remaining specimens (323) could not be identified, were unidentifiable, or were identified to order or suborder level. Total mean CPUE was 151 [± 61 standard error (SE)] larvae per 10-min tow (Table 1). Owing to vessel limitations, ADCNR's sampling effort was considerably greater during the day (n = 139) than at night (n = 22). Daytime samples contained a mean CPUE of 147 (± 70 SE) larvae, whereas nighttime samples had a mean CPUE of 178 (± 59 SE) larvae. ADCNR collected 34 taxa exclusively in daytime samples, and 12 taxa in nighttime samples. It is likely these differences are due to lower nighttime than daytime sampling effort. The other 42 taxa were caught in both day and night samples (Table 2). In daytime samples, Engraulidae was the most abundant taxon, making up 81.6% of the total CPUE. Total catch of all other taxa was far lower than the engraulids; the next most numerous taxa included *Chloroscombrus chrysurus*, Gerreidae, *Monacanthus* spp., *Sciaenops ocellatus*, and *Opisthonema oglinum* (all combined = 14.7% of the total catch). Nighttime samples were dominated by *Cynoscion* spp., which made up 41.7% of the total catch. Engraulids and *C. chrysurus* were also common in nighttime samples, making up 23.4% and 8.3% of the total catch, respectively.

Gulf of Mexico Science, Vol. 29 [2011], No. 1, Art. 3

Table 2. Comparison of taxa caught in day and night neuston samples at ADCNR (AL) and NMFS sampling sites (1984–2007). Day and night frequency of occurrence (FO), day and night % frequency of occurrence (%FO), day and night total CPUE (total number of larvae collected per 10-min tow), and day and night mean CPUE are listed by taxa. n = number of samples.

Order, suborder, family, or subfamily	Tribe, genera, or species	AL day FO n = 139	AL night FO n = 22	NMFS day FO n = 24	NMFS night FO n = 42	AL day % FO	AL night % FO	NMFS day % FO	NMFS night % FO	AL day total CPUE	AL night total CPUE	NMFS day total CPUE	NMFS night total CPUE	AL day mean CPUE	AL night mean CPUE	NMFS day mean CPUE	NMFS night mean CPUE
Elopidae	Unidentified				1				2.38				1.00				0.02
Anguilliformes	Unidentified	1		1	8	0.72		4.17	19.05	1.00		0.98	18.85	0.01		0.04	0.45
Muraenidae	Unidentified			1	8			4.17	19.05			1.00	21.01			0.04	0.50
Ophichthidae	*Callechelys guineensis*				1				2.38				1.00				0.02
	Phaenomonas longissima				2				4.76				2.99				0.07
	Ophichthus gomesii				9				21.43				17.95				0.43
	Ophichthus rex				1				2.38				1.00				0.02
	Unidentified	1	1	1	9	0.72	4.55	4.17	21.43	2.00	1.00	1.98	19.84	0.01	0.05	0.08	0.47
Congridae	Unidentified				3				7.14				36.29				0.86
Clupeiformes	Unidentified	17	6	4	11	12.23	27.27	16.67	26.19	139.27	86.00	15.95	318.61	1.00	3.91	0.66	7.59
Clupeidae	*Brevoortia* spp.	1				0.72				1.00				0.01			
	Harengula jaguana	10	5	4	11	7.19	22.73	16.67	26.19	189.64	7.74	15.96	192.58	1.36	0.35	0.66	4.59
	Opisthonema oglinum	24	5	2	6	17.27	22.73	8.33	14.29	235.21	51.88	37.93	39.94	1.69	2.36	1.58	0.96
	Sardinella aurita	8	1	3	8	5.76	4.55	12.50	19.05	16.75	1.00	15.95	74.99	0.12	0.05	0.66	1.79
	Unidentified	5	1	1	4	3.60	4.55	4.17	9.52	8.92	1.00	0.95	19.85	0.06	0.05	0.04	0.47
Engraulidae	Unidentified	89	20	16	40	64.03	90.91	66.67	95.24	16628.22	916.15	2197.70	3818.48	119.63	41.64	91.58	90.92
Gonostomatidae	*Cyclothone* spp.				1				2.38				1.00				0.02
	Unidentified				1				2.38				2.00				0.05
Synodontidae	Unidentified	1	3	3	15	0.72	13.64	12.50	35.71	1.00	3.00	2.97	124.84	0.01	0.14	0.12	2.97
Paralepididae	Unidentified				1				2.38				1.00				0.02
Myctophidae	*Diaphus* spp.				1				2.38				1.00				0.02
	Myctophum spp.			1				4.17				1.00				0.04	
	Unidentified			1	2			4.17	4.76			1.00	2.00			0.04	0.05
Bregmaceratidae	*Bregmaceros* spp.		1	1	5		4.55	4.17	11.90		1.77	2.00	5.86		0.08	0.08	0.14
Ophidiidae	Unidentified	3	6	3	18	2.16	27.27	12.50	42.86	3.00	9.48	2.90	82.70	0.02	0.44	0.12	1.97
Lophiiformes	Unidentified				1				2.38				1.00				0.02
Antennariidae	*Histrio histrio*	3	1			2.16	4.55			3.01	0.95			0.02	0.04		
	Unidentified	1				0.72				0.96				0.01			
Ceratioidei	Unidentified				4				9.52				8.00				0.19
Gobiesocidae	Unidentified	1				0.72				1.00				0.01			

Table 2. Continued.

Order, suborder, family, or subfamily	Tribe, genera, or species	AL day FO n = 139	AL night FO n = 22	NMFS day FO n = 24	NMFS night FO n = 42	AL day % FO	AL night % FO	NMFS day % FO	NMFS night % FO	AL day total CPUE	AL night total CPUE	NMFS day total CPUE	NMFS night total CPUE	AL day mean CPUE	AL night mean CPUE	NMFS day mean CPUE	NMFS night mean CPUE
Atherinopsidae	Unidentified	31	5			22.30	22.73	4.17		118.94	53.76	12.00		0.86	2.44	0.50	
Hemiramphidae	*Hemiramphus* spp.	6	6	1		4.32	27.27	4.17		44.28	13.36	4.00		0.32	0.61	0.17	
	Unidentified	5		2	3	3.60		8.33	7.14	11.00		4.00	9.96	0.08		0.17	0.24
Exocoetidae	Unidentified	39	8	14	24	28.06	36.36	58.33	57.14	177.28	55.05	154.94	421.72	1.28	2.50	6.45	10.04
Fistulariidae	*Fistularia* spp.				1				2.38				1.00				0.02
Syngnathidae	*Syngnathus* spp.	3	7		5	2.16	31.82		11.90	2.91	8.94		10.55	0.02	0.41		0.25
	Hippocampus spp.	2	3	1	5	1.44	13.64	4.17	11.90	1.96	2.94	1.00	4.94	0.01	0.13	0.04	0.12
	Unidentified			1				4.17				1.00				0.04	
Scorpaenidae	Unidentified	2	1	1	12	1.44	4.55	4.17	28.57	1.96	0.88	3.96	20.94	0.01	0.04	0.17	0.50
Triglidae	Unidentified	4	10	4	18	2.88	45.45	16.67	42.86	14.00	28.69	9.75	142.82	0.10	1.30	0.41	3.40
Perciformes	Unidentified	2			1	1.44			2.38	2.00			1.00	0.01			0.02
Percoidei	Unidentified				1				2.38				0.96				0.02
Serraninae	*Centropristis* spp.				5				11.90				5.96				0.14
	Serraniculus pumilio				3				7.14				9.00				0.21
	Unidentified	1	1	1	4	0.72	4.55	4.17	9.52	1.00	0.88	1.98	6.97	0.01	0.04	0.08	0.17
Epinephelinae	Grammistini	1			9	0.72			21.43	1.00			16.91	0.01			0.40
	Unidentified				1				2.38				0.97				0.02
Priacanthidae	Unidentified			1	5			4.17	11.90			0.98	6.00			0.04	0.14
Apogonidae	Unidentified				2				4.76				2.00				0.05
Pomatomidae	*Pomatomus saltatrix*	1			2	0.72			4.76	0.96			2.82	0.01			0.07
Rachycentridae	*Rachycentron canadum*	1		1		0.72		4.17		0.99		0.97		0.01		0.04	
Echeneidae	Unidentified				3				7.14				2.91				0.07
Carangidae	*Caranx* spp.	1		7	6	0.72		29.17	14.29	1.00		10.81	36.46	0.01		0.45	0.87
	Chloroscombrus chrysurus	69	15	10	21	49.64	68.18	41.67	50.00	665.34	322.97	284.03	200.84	4.79	14.69	11.83	4.78
	Decapterus punctatus	7	4	10	25	5.04	18.18	41.67	59.52	13.80	10.76	177.76	279.32	0.10	0.49	7.41	6.65
	Oligoplites saurus	10	4			7.19	18.18			15.00	4.98			0.11	0.23		
	Selar crumenophthalmus				3				7.14				5.96				0.14
	Selene vomer				1				2.38				1.00				0.02
	Seriola spp.	1	1	2	2	0.72	4.55	8.33	4.76	23.76	0.95	4.97	2.00	0.17	0.04	0.21	0.05
	Trachinotus spp.	2		1		1.44		4.17		1.98		2.00		0.01		0.08	
	Unidentified	1		1	5	0.72		4.17	11.90	1.00		2.00	14.00	0.01		0.08	0.33
Coryphaenidae	*Coryphaena* spp.	1	1	1	3	0.72	4.55	4.17	7.14	4.75	0.98	1.00	11.00	0.03	0.04	0.04	0.26

TABLE 2. Continued.

Order, suborder, family, or subfamily	Tribe, genera, or species	AL day FO n = 139	AL night FO n = 22	NMFS day FO n = 24	NMFS night FO n = 42	AL day % FO	AL night % FO	NMFS day % FO	NMFS night % FO	AL day total CPUE	AL night total CPUE	NMFS day total CPUE	NMFS night total CPUE	AL day mean CPUE	AL night mean CPUE	NMFS day mean CPUE	NMFS night mean CPUE
Lutjanidae	*Lutjanus* spp.				7				16.67				14.00				0.33
	Lutjanus campechanus			2	9			8.33	21.43			2.92	41.56			0.12	0.99
	Lutjanus griseus	1			2	0.72			4.76	1.00			3.90	0.01			0.09
	Pristipomoides aquilonaris				1				2.38				1.00				0.02
	Rhomboplites aurorubens		1		17		4.55		40.48		0.88		125.89		0.04		3.00
	Unidentified			1	6			4.17	14.29			0.98	9.00			0.04	0.21
Lobotidae	*Lobotes surinamensis*	5	1	2	1	3.60	4.55	8.33	2.38	6.05	0.98	2.00	1.00	0.04	0.04	0.08	0.02
Gerreidae	Unidentified	65	13	10	25	46.76	59.09	41.67	59.52	570.30	74.86	248.79	1548.61	4.10	3.40	10.37	36.87
Haemulidae	Unidentified				1				2.38				0.97				0.02
Sparidae	*Lagodon rhomboides*				1				2.38				1.00				0.02
	Unidentified			1	4			4.17	9.52			2.00	6.00			0.08	0.14
Sciaenidae	*Cynoscion* spp.	5	11	1	10	3.60	50.00	4.17	23.81	8.00	1633.65	0.95	47.07	0.06	74.26	0.04	1.13
	Larimus fasciatus	1			1	0.72			2.38	1.00			1.00	0.01			0.02
	Leiostomus xanthurus	1				0.72				1.00				0.01			
	Menticirrhus spp.	12	7	3	5	8.63	31.82	12.50	11.90	15.77	34.88	12.75	13.81	0.11	1.59	0.53	0.33
	Micropogonias undulatus	7	6		3	5.04	27.27		7.14	25.89	61.88		6.95	0.19	2.81		0.17
	Sciaenops ocellatus	39	5	3	6	28.06	22.73	12.50	14.29	413.59	106.69	18.43	19.50	2.98	4.85	0.77	0.46
	Stellifer lanceolatus				1				2.38				1.00				0.02
	Unidentified		4		3		18.18		7.14		20.00		8.00		0.91		0.19
Mullidae	Unidentified			2	2			8.33	4.76			4.99	3.00			0.21	0.07
Kyphosidae	*Kyphosus* spp.	1		1	1	0.72		4.17	2.38	1.00		1.00	0.96	0.01		0.04	0.02
Mugilidae	*Mugil* spp.				2				4.76				2.00				0.05
Pomacentridae	Unidentified			1	5			4.17	11.90			0.98	5.99			0.04	0.14
Labridae	Unidentified				12				28.57				92.09				2.19
Scaridae	*Sparisoma* spp.		1		2		4.55		4.76		1.00		11.00		0.05		0.26
	Unidentified				3				7.14				3.00				0.07
Uranoscopidae	Unidentified				2				4.76				2.00				0.05
Blennioidei	Unidentified	12				8.63				54.58				0.39			
Blenniidae	Unidentified	27	13	5	12	19.42	59.09	20.83	28.57	111.65	23.53	6.88	162.53	0.80	1.07	0.29	3.87
Callionymidae	*Callionymus* spp.		1		1		4.55		2.38		1.00		2.00		0.05		0.05
	Unidentified				5				11.90				11.96				0.28

TABLE 2. Continued.

Order, suborder, family, or subfamily	Tribe, genera, or species	AL day FO n = 139	AL night FO n = 22	NMFS day FO n = 24	NMFS night FO n = 42	AL day % FO	AL night % FO	NMFS day % FO	NMFS night % FO	AL day total CPUE	AL night total CPUE	NMFS day total CPUE	NMFS night total CPUE	AL day mean CPUE	AL night mean CPUE	NMFS day mean CPUE	NMFS night mean CPUE
Gobiidae	Unidentified	9	13	2	29	6.47	59.09	8.33	69.05	17.92	43.84	1.98	609.47	0.13	1.99	0.08	14.51
Microdesmidae	Unidentified	1			1	0.72			2.38	1.00			1.00	0.01			0.02
Ephippidae	*Chaetodipterus faber*	3	4		1	2.16	18.18		2.38	3.00	6.00		7.00	0.02	0.27		0.17
Sphyraenidae	*Sphyraena* spp.	3		2	6	2.16		8.33	14.29	4.00		2.98	12.74	0.03		0.12	0.30
Trichiuridae	*Trichiurus lepturus*	1			4	0.72			9.52	1.00			9.95	0.01			0.24
Istiophoridae	Unidentified			1	1			4.17	2.38			0.98	1.00			0.04	0.02
Scombridae	*Scomberomorus cavalla*	1			5	0.72			11.90	1.00			15.00	0.01			0.36
	Scomberomorus maculatus	6	2	1	2	4.32	9.09	4.17	4.76	11.00	1.95	2.86	2.00	0.08	0.09	0.12	0.05
	Auxis spp.			2	8			8.33	19.05			2.00	53.07			0.08	1.26
	Euthynnus alletteratus		1	1	7		4.55	4.17	16.67		1.00	1.00	21.66		0.05	0.04	0.52
	Katsuwonus pelamis				1				2.38				1.00				0.02
	Thunnus spp.				3				7.14				7.01				0.17
Nomeidae	*Cubiceps* spp.				1				2.38				2.00				0.05
Ariommatidae	*Ariomma* spp.	1		1		0.72		4.17		0.96		2.93		0.01		0.12	
Stromateidae	*Peprilus* spp.	3			2	2.16			4.76	12.95			2.00	0.09			0.05
	Peprilus burti				4				9.52				4.64				0.11
	Peprilus alepidotus	5	1	1	2	3.60	4.55	4.17	4.76	7.00	2.00	1.98	1.96	0.05	0.09	0.08	0.05
Paralichthyidae	*Citharichthys* spp.	1	2	1	5	0.72	9.09	4.17	11.90	1.00	2.00	1.00	58.00	0.01	0.09	0.04	1.39
	Citharichthys spilopterus	4	8		6	2.88	36.36		14.29	4.00	26.58		68.57	0.03	1.21		1.63
	Cyclopsetta spp.				2				4.76				2.00				0.05
	Etropus spp.	1	9	1	23	0.72	40.91	4.17	54.76	1.00	53.92	1.96	221.97	0.01	2.45	0.08	5.29
	Syacium spp.	2			18	1.44			42.86	2.00			249.60	0.01			5.94
Bothidae	*Engyophrys senta*				1				2.38				3.00				0.07
	Bothus spp.			1	6			4.17	14.29			0.97	6.00			0.04	0.14
	Unidentified		3	1	5		13.64	4.17	11.90		7.95	3.96	17.00		0.36	0.17	0.40
Soleidae	Unidentified		8		1		36.36		2.38		37.98		0.96		1.73		0.02
Cynoglossidae	*Symphurus* spp.	6	7	8	17	4.32	31.82	33.34	40.48	8.00	108.82	125.78	128.48	0.06	4.95	5.25	3.06
Balistidae	*Balistes capriscus*	2	1		4	1.44	4.55		9.52	3.96	0.98		5.00	0.03	0.04		0.12
	Canthidermis maculatus	1			1	0.72			2.38	0.96			1.00	0.01			0.02
	Unidentified	3		1	2	2.16		4.17	4.76	116.00		0.98	12.00	0.83		0.04	0.29
Monacanthidae	*Aluterus* spp.	2	1	3	4	1.44	4.55	12.50	9.52	61.84	1.96	5.00	9.00	0.44	0.09	0.21	0.21

TABLE 2. Continued.

Order, suborder, family, or subfamily	Tribe, genera, or species	AL day FO n = 139	AL night FO n = 22	NMFS day FO n = 24	NMFS night FO n = 42	AL day % FO	AL night % FO	NMFS day % FO	NMFS night % FO	AL day total CPUE	AL night total CPUE	NMFS day total CPUE	NMFS night total CPUE	AL day mean CPUE	AL night mean CPUE	NMFS day mean CPUE	NMFS night mean CPUE
	Aluterus heudelotii			1				4.17				0.97				0.04	
	Aluterus schoepfii	3		1		2.16		4.17		4.86		1.94		0.03		0.08	
	Monacanthus spp.	3	3	3	1	2.16	13.64	12.50	2.38	471.78	15.10	20.00	6.00	3.39	0.69	0.83	0.14
	Stephanolepis spp.		1	3	3		4.55	12.50	7.14		0.98	113.79	12.00		0.04	4.74	0.29
	Stephanolepis hispidus	11	3	3	8	7.91	13.64	12.50	19.05	28.91	20.66	12.00	22.55	0.21	0.94	0.50	0.54
	Stephanolepis setifer	3	1	1		2.16	4.55	4.17		2.96	0.98	0.98		0.02	0.04	0.04	
	Unidentified		1	3	5		4.55	12.50	11.90		0.98	14.65	20.97		0.04	0.61	0.50
Tetraodontidae	*Sphoeroides* spp.	10	4	5	7	7.19	18.18	20.83	16.67	39.50	11.81	13.00	24.45	0.28	0.54	0.54	0.58
	Unidentified	7		6	6	5.04		25.00	14.29	11.96		14.96	33.85	0.09		0.62	0.81
Unidentified fish	Unidentified	12	7	6	11	8.63	31.82	25.00	26.19	13.99	23.94	33.56	49.00	0.10	1.09	1.40	1.17

NMFS samples contained a total of 13,482 fish larvae representing 126 taxa distributed among 60 families. Of these larvae, 9,995 were identified to family, 1,715 to genus, and 1,309 to species. The remaining specimens (463) could not be identified, were unidentifiable, or were identified to order or suborder level. Total mean CPUE was 205 (± 45 SE) larvae per 10-min tow (Table 1). Unlike ADCNR samples, NMFS collected samples more frequently at night (n = 42) than during the day (n = 24). Daytime samples contained a mean CPUE of 152 (± 80 SE) larvae, whereas nighttime samples had a mean CPUE of 235 (± 55 SE) larvae. NMFS collected 12 taxa exclusively in daytime samples, and 59 taxa in nighttime samples. Again, these differences are likely due to the wide disparity between daytime and nighttime sampling effort. The other 58 taxa were caught in both day and night samples (Table 2). Similar to the catches of daytime ADCNR samples, Engraulidae was the most numerous taxon caught in NMFS daytime samples, making up 60.0% of the total catch. All other taxa in daytime samples were far less abundant; the most numerous included *C. chrysurus*, Gerridae, *Decapterus punctatus*, Exocoetidae, *Stephanolepis* spp., and *Symphurus* spp. (all combined = 29.5% of the total catch). Engraulids also dominated nighttime catches, making up 38.6% of the total catch. Among the next most numerous taxa collected in nighttime samples were Gerreidae, Gobiidae, and Exocoetidae, which made up 15.7%, 6.2%, and 4.3% of the total catch, respectively.

Taxa captured in 25% or more of ADCNR daytime samples included Engraulidae, *C. chrysurus*, Gerreidae, Exocoetidae, and *S. ocellatus* (Table 3). NMFS also captured the first four of these taxa in more than 25% of day samples, whereas *S. ocellatus* only occurred in 12.5% of day NMFS samples. Species with a greater than 25% FO in daytime samples for NMFS sampling locations, but not at day ADCNR stations, included unidentified fish, *D. punctatus*, Tetraodontidae, *Symphurus* spp., and *Caranx* spp. ADCNR and NMFS captured many of the same taxa in 30% or more of the nighttime samples (Table 4). Taxa that were caught in at least 30% of nighttime samples at ADCNR locations but not night NMFS locations included *Cynoscion* spp., *Citharichthys spilopterus*, Soleidae, *Menticirrhus* spp., *Syngnathus* spp., and unidentified fish. Taxa caught in at least 30% of nighttime samples at NMFS locations but not ADCNR locations included Ophidiidae, *D. punctatus*, *Etropus* spp., Synodontidae, *Rhomboplites aurorubens*, and *Syacium* spp. Despite difficulties in comparing the size distributions of specimens captured in

TABLE 3. Taxa with 25% or higher frequency of occurrence in daytime samples at either ADCNR or NMFS SEAMAP sampling sites in and near Mobile Bay (1984–2007). Taxa are listed by decreasing %FO for Alabama sites. AL n = 139, NMFS n = 24.

		%FO		Total CPUE		Mean CPUE	
Family	Taxon	AL	NMFS	AL	NMFS	AL	NMFS
Engraulidae	Unidentified	64.03	66.67	16,628.22	2,197.70	119.63	91.57
Carangidae	*Chloroscombrus chrysurus*	49.64	41.67	665.34	284.03	4.79	11.83
Gerreidae	Unidentified	46.76	41.67	570.30	248.79	4.10	10.37
Exocoetidae	Unidentified	28.06	58.33	177.28	154.90	1.28	6.45
Sciaenidae	*Sciaenops ocellatus*	28.06	12.50	413.59	18.43	2.98	0.77
Unidentified Fish	Unidentified	8.63	25.00	13.99	33.56	0.10	1.40
Carangidae	*Decapterus punctatus*	5.04	41.67	13.80	177.75	0.10	7.41
Tetraodontidae	Unidentified	5.04	25.00	11.95	14.96	0.09	0.62
Cynoglossidae	*Symphurus* spp.	2.88	29.17	5.00	98.06	0.04	4.09
Carangidae	*Caranx* spp.	0.72	29.17	1.00	10.81	0.01	0.45

ADCNR and NMFS samples (caused by limitations in historical and taxon-related SEAMAP measurement protocols) is was apparent that for most taxa there was little to no difference in mean and range in body length of larvae captured at the two sampling locations (Table 5).

ADCNR collected red drum, *S. ocellatus*, in greater numbers (daytime and nighttime mean CPUE = 2.98 and 4.85) and more frequently (daytime and nighttime %FO = 28.06% and 22.73%) than did the NMFS at the four SEAMAP stations nearest Mobile Bay (daytime and nighttime mean CPUE = 0.77 and 0.46, and %FO = 12.50% and 14.29%). Size composition of red drum larvae in the ADCNR and SEAMAP samples was comparable: mean BL = 4.7 (n = 205) and 3.5 (n = 37); and size range = 2.4–7.0 and 2.7–5.1 mm, respectively. This species was collected over the entire ADCNR sampling area, including inside Mobile Bay (north of 30.25°N, Fig. 2A), just outside the Bay (between 30.15°N and 30.25°N; Fig. 2B), and farther offshore along the 15-m depth contour (south of

TABLE 4. Taxa with 30% or higher frequency of occurrence in nighttime samples at either ADCNR or NMFS SEAMAP sampling sites in and near Mobile Bay (1984–2007). Taxa are listed by decreasing %FO for Alabama sites. AL n = 22, NMFS n = 42.

		%FO		Total CPUE		Mean CPUE	
Family	Taxon	AL	NMFS	AL	NMFS	AL	NMFS
Engraulidae	Unidentified	90.91	95.24	916.05	3,818.48	41.64	90.92
Carangidae	*Chloroscombrus chrysurus*	68.18	50.00	322.97	200.84	14.68	4.78
Blenniidae	Unidentified	59.09	28.57	23.53	162.53	1.07	3.87
Gerreidae	Unidentified	59.09	59.52	74.86	1,548.61	3.40	36.87
Gobiidae	Unidentified	59.09	69.05	43.84	609.47	1.99	14.51
Sciaenidae	*Cynoscion* spp.	50.00	23.81	1,633.65	47.07	74.26	1.12
Triglidae	Unidentified	45.45	42.86	28.69	142.82	1.30	3.40
Paralichthyidae	*Citharichthys spilopterus*	36.36	14.29	26.58	68.57	1.21	1.63
Exocoetidae	Unidentified	36.36	57.14	55.05	421.70	2.50	10.04
Soleidae	Unidentified	36.36	2.38	37.98	0.96	1.73	0.02
Sciaenidae	*Menticirrhus* spp.	31.82	11.90	34.88	13.81	1.59	0.33
Cynoglossidae	*Symphurus* spp.	31.82	40.48	108.82	128.48	4.95	3.06
Sygnathidae	*Syngnathus* spp.	31.82	11.90	8.94	10.55	0.41	0.25
Unidentified Fish	Unidentified	31.82	26.19	23.94	49.00	1.09	1.17
Ophidiidae	Unidentified	27.27	42.86	9.48	82.70	0.43	1.97
Carangidae	*Decapterus punctatus*	18.18	59.52	10.76	279.32	0.49	6.65
Paralichthyidae	*Etropus* spp.	13.64	33.33	40.00	164.96	1.82	3.93
Synodontidae	Unidentified	13.64	35.71	3.00	124.80	0.14	2.97
Lutjanidae	*Rhomboplites aurorubens*	4.55	40.48	0.88	125.89	0.04	3.00
Paralichthyidae	*Syacium* spp.	0.00	42.86	0.00	249.60	0.00	5.94

TABLE 5. Length measurements for taxa where all or ≥ 10 specimens were measured. Number of specimens measured, mean length, min length, and max length are listed for each taxa. Taxa in bold type were found and measured in both Alabama and NMFS samples.

		Alabama				NMFS			
Order, suborder, family, or subfamily	Tribe, genera, or species	No. measured	Mean length (mm)	Min length (mm)	Max length (mm)	No. measured	Mean length (mm)	Min length (mm)	Max length (mm)
Anguilliformes	Unidentified					10	5.0	3.5	7.2
Muraenidae	Unidentified					13	52.6	9.0	78.0
Ophichthidae	Unidentified					18	20.2	5.3	90.2
	Ophichthus gomesii					17	61.3	12.8	91.0
Clupeiformes	**Unidentified**	**13**	**7.9**	**4.0**	**16.0**	**10**	**11.5**	**4.0**	**19.0**
Clupeidae	Unidentified					14	14.2	4.0	23.5
	Harengula jaguana	**53**	**10.9**	**3.7**	**63.5**	**53**	**11.5**	**4.7**	**24.0**
	Opisthonema oglinum	**134**	**11.7**	**4.2**	**43.0**	**40**	**7.8**	**3.0**	**15.0**
	Sardinella aurita	**18**	**8.7**	**3.8**	**23.0**	**47**	**12.3**	**4.1**	**18.1**
Engraulidae	**Unidentified**	**205**	**12.0**	**2.2**	**43.0**	**115**	**12.0**	**1.9**	**31.5**
Synodontidae	Unidentified					30	12.1	4.0	33.0
Ophidiidae	**Unidentified**	**11**	**11.6**	**5.2**	**21.0**	**32**	**8.7**	**3.6**	**19.2**
Atherinopsidae	Unidentified	57	27.2	5.0	90.0				
Hemiramphidae	*Hemiramphus* spp.	23	22.3	6.7	71.0				
Exocoetidae	**Unidentified**	**89**	**12.4**	**3.1**	**55.0**	**71**	**13.4**	**2.7**	**52.0**
Syngnathidae	*Syngnathus* spp.	12	36.2	8.1	67.5				
Scorpaenidae	Unidentified					18	5.1	2.3	9.2
Triglidae	**Unidentified**	**23**	**6.1**	**3.3**	**10.0**	**37**	**4.9**	**2.8**	**11.2**
Epinephelinae	Grammistini					15	5.4	4.1	7.0
Carangidae	Unidentified					13	8.4	3.1	15.0
	Caranx spp.					27	15.6	1.0	70.0
	Chloroscombrus chrysurus	**406**	**7.6**	**2.1**	**44.5**	**140**	**6.0**	**1.8**	**31.0**
	Decapterus punctatus	**21**	**8.7**	**2.8**	**22.3**	**178**	**6.4**	**2.5**	**36.2**
	Oligoplites saurus	20	7.8	3.3	13.0				
	Seriola spp.	21	40.9	26.0	55.0				
	Coryphaena spp.					10	15.3	9.0	37.0
Lutjanidae	*Lutjanus* spp.					14	3.3	3.0	4.3
	Lutjanus campechanus					45	4.1	3.2	6.0
	Rhomboplites aurorubens					96	3.8	2.5	5.9
Gerreidae	**Unidentified**	**155**	**10.0**	**4.0**	**13.5**	**67**	**7.5**	**3.0**	**11.7**
Sciaenidae	Unidentified	17	4.3	3.2	5.4				
	***Cynoscion* spp.**	**81**	**4.7**	**2.8**	**6.9**	**34**	**4.1**	**1.8**	**6.6**
	***Menticirrhus* spp.**	**51**	**5.7**	**2.9**	**8.5**	**25**	**4.2**	**2.6**	**7.1**
	Micropogonias undulatus	65	5.3	3.0	37.0				
	Sciaenops ocellatus	**205**	**4.7**	**2.4**	**7.0**	**37**	**3.5**	**2.7**	**5.1**
Labridae	Unidentified					19	8.5	2.1	12.6
Blennioidei	Unidentified	20	7.4	5.0	10.8				
Blenniidae	**Unidentified**	**63**	**7.5**	**3.6**	**12.6**	**22**	**6.8**	**3.2**	**14.2**
Gobiidae	**Unidentified**	**31**	**8.4**	**6.2**	**15.0**	**52**	**7.0**	**3.6**	**10.0**
Sphyraenidae	*Sphyraena* spp.					11	5.9	4.3	7.0
Trichiuridae	*Trichiurus lepturus*					10	6.6	4.3	9.3
Scombridae	*Scomberomorus cavalla*					15	4.4	3.0	6.8
	Scomberomorus maculatus	13	9.4	3.2	22.0				
	Auxis spp.					54	6.1	4.0	20.6
	Euthynnus alletteratus					22	4.7	3.1	6.1
Stromateidae	*Peprilus* spp.	13	12.6	9.0	26.0				
Paralichthyidae	*Citharichthys* spp.					11	7.2	5.3	8.1
	Citharichthys spilopterus	**17**	**7.2**	**2.8**	**9.0**	**28**	**6.7**	**5.6**	**7.7**
	Etropus spp.					45	5.7	1.9	12.0
	Syacium spp.					53	5.0	2.8	9.0
Soleidae	Unidentified	14	4.1	2.8	15.1				
	***Symphurus* spp.**	**16**	**6.4**	**3.0**	**8.7**	**39**	**7.7**	**3.5**	**12.8**

DOI: 10.18785/goms.2901.03

Table 5. Continued.

Order, suborder, family, or subfamily	Tribe, genera, or species	Alabama No. measured	Alabama Mean length (mm)	Alabama Min length (mm)	Alabama Max length (mm)	NMFS No. measured	NMFS Mean length (mm)	NMFS Min length (mm)	NMFS Max length (mm)
Monacanthidae	Unidentified					17	11.1	3.1	23.5
	Aluterus spp.					12	15.2	3.5	38.1
	Monacanthus spp.	11	16.3	3.7	33.0				
	Stephanolepis spp.					44	19.5	5.5	53.0
	Stephanolepis hispidus	**30**	**14.5**	**4.0**	**28.5**	**20**	**13.5**	**2.5**	**42.0**
Tetraodontidae	**Unidentified**	**10**	**8.2**	**5.6**	**11.5**	**19**	**5.8**	**2.2**	**10.5**

30.14°N; Fig. 2C). Red drum larvae were captured more frequently in samples inside than outside the bay, but they were more numerous (caught in greater numbers) at stations outside the bay (Table 6).

Surface water properties varied significantly between ADCNR and NMFS stations (Table 7; Fig. 3). Significantly cooler sea surface temperatures (mean = 27.5°C) and less saline surface waters (mean = 27.0) prevailed at ADCNR sampling locations when compared with all four NMFS locations ($F_{(4,222)} = 21.6416$, $P < 0.0001$, and $F_{(4,222)} = 40.7617$, $P < 0.0001$, respectively). Mean surface dissolved oxygen (6.5 mg/L) was significantly higher at ADCNR stations than at two (B177, B178) of the four NMFS SEAMAP stations ($F_{(4,214)} = 4.4213$, $P < 0.0019$).

Taxa number (S), richness (d), and diversity (H′) differed among daytime and nighttime ADCNR and NMFS samples, with lower values always found in ADCNR samples when compared with NMFS samples (Table 8). In daytime samples, mean taxa number and H′ diversity were significantly lower in ADCNR than in NMFS samples ($T_{crit} = 3.16$, $P < 0.0019$ and $T_{crit} = 2.42$, $P < 0.0168$, respectively; Fig. 4). Daytime mean taxa richness, although lower for ADCNR samples, was not significantly different than for

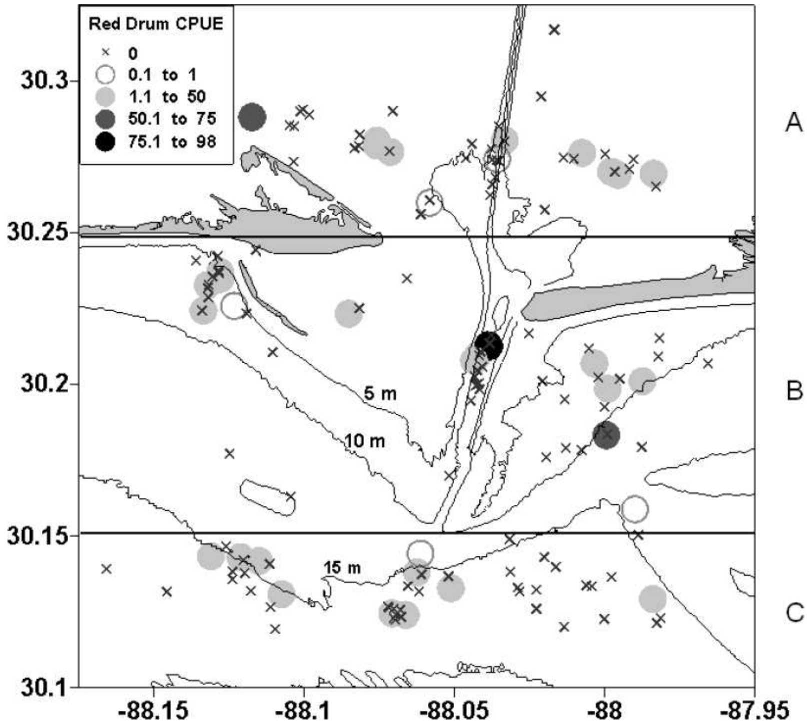

Fig. 2. Location of capture and catch per unit effort (number of larvae collected per 10-min tow) for red drum (*Sciaenops ocellatus*) in ADCNR neuston samples (1986–2006). A = samples taken inside Mobile Bay (north of 30.25° N), B = outside the Bay (in between 30.15° N and 30.25° N), and C = farther offshore along the 15-m depth contour (south of 30.15° N).

TABLE 6. Mean CPUE (mean number of larvae per 10-min tow), total CPUE, and %FO (percentage frequency of occurrence) for red drum (*S. ocellatus*) caught in ADCNR neuston samples (A) in the Mobile Bay, (B) outside the Bay, (C) and farther from the Bay along the 15-m depth contour. Mean station depth, and mean surface temperature (°C), salinity, and dissolved oxygen (DO; mg/L) at the three sampling subregions (A, B, and C).

Subregion (No. of samples)	Mean CPUE (± SE)	Total CPUE	%FO	Mean depth (m)	Mean surface temp (°C)	Mean surface salinity	Mean surface DO (mg/L)
A (n = 52)	2.1 (± 1.4)	108	34.6	5.7	27.3	22.2	6.9
B (n = 61)	5.6 (± 2.3)	340	26.2	9.3	27.3	28.4	6.2
C (n = 48)	1.5 (± 0.6)	72	20.8	16.6	27.7	30.0	6.4

NMFS samples. In nighttime samples, mean taxa number and richness were significantly lower in ADCNR than in NMFS samples ($T_{crit} = 2.16$, $P < 0.035$ and $T_{crit} = 2.36$, $P < 0.0217$, respectively; Fig. 5). Nighttime mean H′ diversity was also lower in ADCNR samples, but was not significantly different than in NMFS samples.

Multivariate ANOSIM tests on adjusted Bray Curtis similarity indices (Clarke et al., 2006) revealed that larval assemblage structure did vary significantly between ADCNR and NMFS sampling locations for both daytime ($R = 0.23$, $P \leq 0.001$) and nighttime ($R = 0.14$, $P \leq 0.001$) samples. A SIMPER test indicated that over 50% of the overall dissimilarity between ADCNR and NMFS SEAMAP daytime samples was due to the following taxa: Engraulidae, Gerreidae, Exocoetidae, *C. chrysurus*, *D. punctatus*, whereas 50% of the overall dissimilarity between nighttime samples was due to these same five taxa, as well as *Cynoscion* spp., Gobiidae, Clupeiformes, Triglidae, *Symphurus* spp., and *Syacium* spp.

DISCUSSION

Despite differences in overall sample size and relative proportion of daytime and nighttime samples, useful comparisons could be made between the Alabama and NMFS components of the SEAMAP fall plankton survey. Species assemblages and diversity parameters varied between ADCNR and NMFS sampling sites, reflecting differences in environmental conditions. ADCNR sampling locations were directly influenced by the Mobile Bay and were shallower, less saline, more oxygenated, and cooler than at NMFS standard SEAMAP sampling sites during the fall SEAMAP survey timeframe. It was not surprising to find a less diverse species assemblage dominated by estuarine species at ADCNR sampling locations (including engraulids, sciaenids, gerreids, and clupeids) and a more diverse marine assemblage (including lutjanids, carangids, labrids, monacanthids, and scombrids) at NMFS sampling sites. Although the larvae and juveniles of many taxa were common in both ADCNR and NMFS samples, e.g., engraulids, gerreids, exocoetids, blenniids, and gobiids; larvae of only two-thirds as many families were present in the ADCNR samples as were present in the NMFS samples. Larvae of one family, Gobiosocidae, were found only in the ADCNR samples. Although direct comparisons cannot be made between our study and the results from a more extensive survey of ichthyoplankton off Alabama because of differing diversity indices, Hernandez et al. (2010) also documented high diversity in larval fish assemblages collected in Alabama offshore waters. They identified taxa from 58 families in plankton samples collected monthly from Oct. 2004 to Oct. 2006; taxa were collected from a similar number of families, 60, in our offshore NMFS samples. Hernandez et al. (2010) found diversity to be significantly related to temperature and explained that the inner shelf environment off Alabama is a highly productive region because of its unique geographic boundaries (it is bordered to the west by the Mississippi River Delta, the

TABLE 7. Mean station depth (m), and mean surface temperature (°C), salinity, and dissolved oxygen (DO; mg/L) at ADCNR and NMFS SEAMAP sampling sites. Parameter ranges (min–max) are included in parentheses next to mean values.

Location	Depth (m)	Surface temperature (°C)	Surface salinity	Surface oxygen (mg/L)
Alabama	10.3 (1.3–25.1)	27.5 (26.0–29.9)	27.0 (20.5–33.8)	6.5 (5.2–7.4)
B178	25.4 (20.1–28.0)	28.8 (27.3–29.8)	32.3 (30.3–34.6)	6.0 (4.6–7.2)
B177	23.6 (17.9–28.0)	28.7 (27.4–30.2)	32.2 (28.4–34.4)	6.1 (4.5–7.0)
B173	26.2 (22.0–33.8)	28.5 (26.6–30.6)	33.3 (30.3–35.1)	6.3 (5.4–7.7)
B321	11.7 (8.1–15.2)	28.3 (25.3–29.5)	32.8 (28.3–34.2)	6.2 (5.4–7.1)

DOI: 10.18785/goms.2901.03

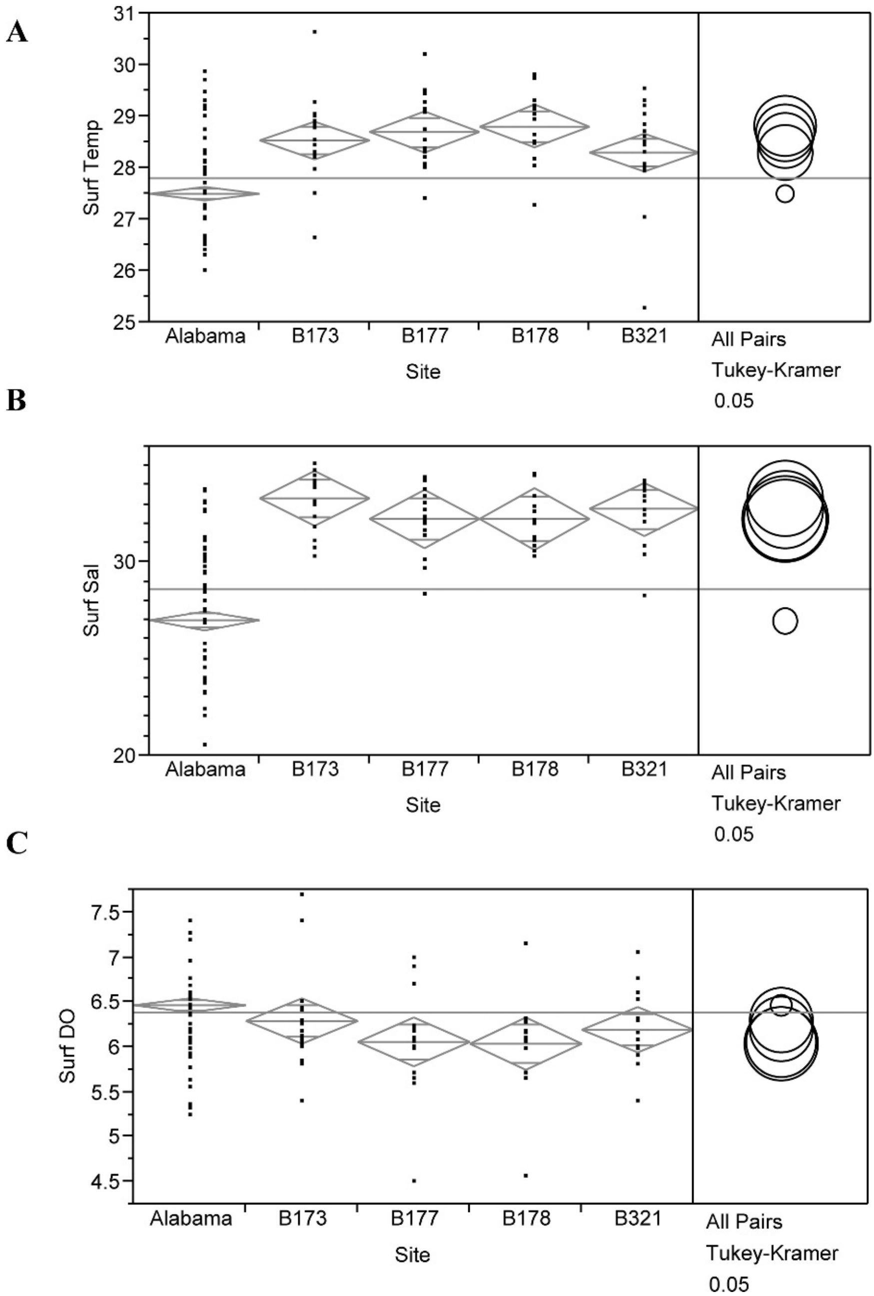

Fig. 3. Comparison of mean (A) sea surface temperature (°C), (B) salinity, and (C) dissolved oxygen (mg/L) at ADCNR and NMFS SEAMAP sampling sites. Horizontal line through chart represents overall sample mean. Middle lines in diamonds represent site means. Upper and lower diamond points span the 95% confidence interval (CI) computed from sample values at each site. Small lines at tops and bottoms of diamonds represent ± $(\sqrt{(2CI / 2)})$. Circles are a graphic representation of the Tukey-Kramer HSD means comparison test. The diameter of each circle spans the 95% confidence interval for each group.

north by the Mobile River system, and the east by the DeSoto Canyon).

The primary objective of plankton sampling conducted during the annual SEAMAP fall plankton survey is to provide fishery-independent data on the abundance, distribution, and habitat of the early life stages of federally managed [Fishery Management Plan (FMP)]

TABLE 8. Mean diversity parameters: taxa number (S), richness (d), and H′ diversity (H′) for day and nighttime samples collected at ADCNR and NMFS sampling sites. Bold type denotes significant differences between ADCNR and NMFS samples.

Location	S	d	H′
ADCNR day	**4.33**	1.57	**1.10**
NMFS day	**6.58**	1.93	**1.44**
ADCNR night	**11.22**	**3.16**	0.89
NMFS night	**15.26**	**4.00**	0.92

species. The larvae of a number of Fishery Management Plan (FMP) species were captured at both the ADCNR stations and nearby standard SEAMAP stations. The larvae of one species in particular; red drum (*S. ocellatus*) were more prevalent at the ADCNR stations than at the standard stations. This is not altogether surprising, since red drum spawn in waters at the inshore boundary of the SEAMAP survey grid. The more nearshore ADCNR samples might be expected, therefore, to provide a more accurate indicator (index) of larval abundance than the offshore SEAMAP samples. However, a comparison of captures of red drum larvae in neuston samples (both day and night combined) at the shallowest (< 26 m) and most inshore SEAMAP stations Gulfwide indicated comparable percentage frequency of occurrence, 25.2% and 27.3%, and mean CPUE, 5.0 ± 1.0 and 3.2 ± 1.0 at the standard SEAMAP and Alabama stations, respectively.

Occurrence and abundance data from SEAMAP fall plankton surveys are currently used to generate annual larval indices for NMFS's stock assessments of king mackerel (Gledhill and Lyczkowski-Shultz, 2000) and red snapper (Hanisko et al., 2007). However, only data taken at standard SEAMAP stations are used to develop those indices because they are based on the SEAMAP statistical survey design, which is comprised of a fixed grid of stations Gulfwide. Furthermore, only data from bongo net samples are used to generate SEAMAP larval indices because bongo net tows, unlike neuston tows, encompass most, if not all, of the pelagic habitat occupied by fish larvae. Bongo net samples thus provide estimates of abundance (number of larvae over a given area) and not just CPUE. Although the ADCNR neuston net samples are not currently used in SEAMAP larval index formulation and Gulfwide stock assessments, they do provide a valuable set of observations on nearshore occurrence and relative abundance of fish larvae in the easternmost region of the most productive fishing grounds in the northern Gulf of Mexico. This growing time series of nearshore plankton sampling can be used to follow trends in local spawning populations of species such as red drum, whose spawning grounds are underrepresented during SEAMAP plankton surveys. Although red drum larvae are distributed throughout the water column, they have been shown to be consistently concentrated in the upper 1 m of the water column during daylight hours in coastal waters of the northern Gulf (Lyczkowski-Shultz and Steen, 1991). The CPUE of red drum larvae in SEAMAP neuston samples from the upper 0.5 m of the water column can, therefore, be considered a valid measure of their abundance. The ADCNR time series of spatially intensive sampling can be used to evaluate the potential influence of coastal development and changes in water and habitat quality on the planktonic life stages of local fish populations.

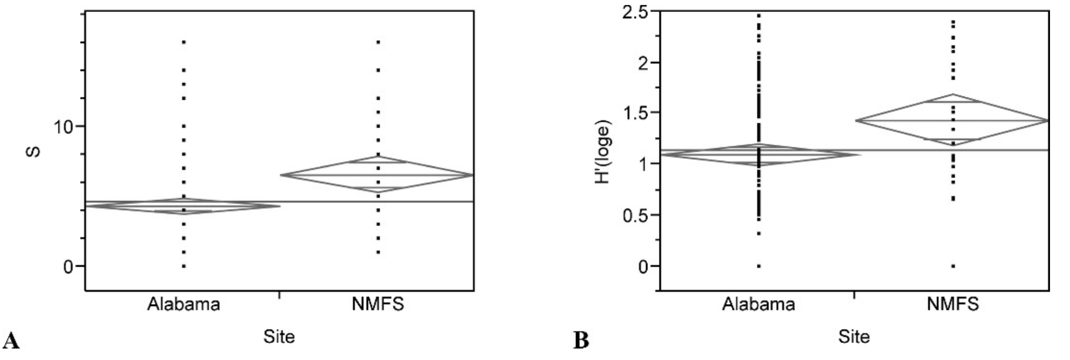

Fig. 4. Comparison of (A) mean taxa number and (B) H′ diversity for daytime samples collected at ADCNR and NMFS sampling sites. Horizontal line through chart represents overall sample mean. Middle lines in diamonds represent site means. Upper and lower diamond points span the 95% confidence interval (CI) computed from sample values at each site. Small lines at tops and bottoms of diamonds represent ± ($\sqrt{(2CI / 2)}$).

DOI: 10.18785/goms.2901.03

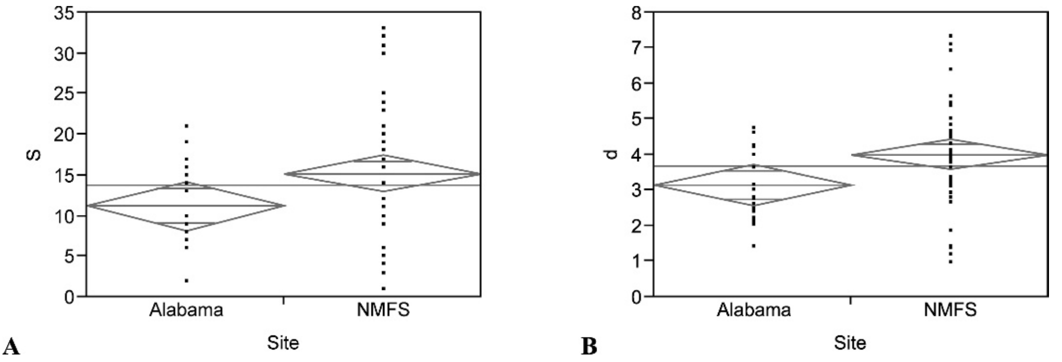

Fig. 5. Comparison of (A) mean taxa number and (B) richness for nighttime samples collected at ADCNR and NMFS sampling sites. Horizontal line through chart represents overall sample mean. Middle lines in diamonds represent site means. Upper and lower diamond points span the 95% confidence interval (CI) computed from sample values at each site. Small lines at tops and bottoms of diamonds represent ± ($\sqrt{}$(2CI / 2)).

ACKNOWLEDGMENTS

We wish to thank the following individuals for their significant contributions to this work: the staff of the Sea Fisheries Institute, Plankton Sorting and Identification Center, Gdynia and Szczecin, Poland; Kim Williams at the SEAMAP Archiving Center, Fish and Wildlife Research Institute, St. Petersburg, FL; Pam Bond, Connie Cowan, Denice Drass, Glenn Zapfe, David Hanisko, NOAA/NMFS Mississippi Laboratories, Pascagoula, MS; crews of the NOAA Ships *Chapman*, *Oregon* II, and *Gordon Gunter*; crew of the R/V *A.E. Verrill*; and IAP World Services.

LITERATURE CITED

CLARKE, K. R., AND R. H. GREEN. 1988. Statistical design and analysis for a ''biological effects'' study. Mar. Ecol. Prog. Ser. 46:213–226.

———, P. J. SOMERFIELD, AND M. G. CHAPMAN. 2006. On resemblance measures for ecological studies, including taxonomic dissimilarities and a zero-adjusted Bray-Curtis coefficient for denuded assemblages. J. Exp. Mar. Bio. Ecol. 330:55–80.

DITTY, J. G., T. FAROOQI, AND R. F. SHAW. 2006. Clupeidae: Sardines and herrings, p. 73–99. *In:* Early stages of Atlantic fishes: an identification guide for the western Central North Atlantic. W. J. Richards (ed.). Taylor and Francis Group, Boca Raton, FL.

FAROOQI, T. W., J. G. DITTY, AND R. F. SHAW. 2006. Engraulidae: Anchovies, p. 101–127. *In:* Early stages of Atlantic fishes: an identification guide for the western Central North Atlantic. W. J. Richards (ed.). Taylor and Francis Group, Boca Raton, FL.

GLEDHILL, C. T., AND J. LYCZKOWSKI-SHULTZ. 2000. Indices of larval king mackerel, *Scomberomorus cavalla*, for use in population assessment in the Gulf of Mexico. Fish. Bull. 98:684–691.

HANISKO, D. S., J. LYCZKOWSKI-SHULTZ, AND G. W. INGRAM. 2007. Indices of larval red snapper occurrence and abundance for use in stock assessment, p. 285–300. *In:* Red snapper ecology and fisheries in the U.S. Gulf of Mexico. W. F. Patterson III, J. H. Cowan Jr., G. R. Fitzhugh, and D. L. Nieland (eds.). American Fisheries Society, Symposium 60, Bethesda, MD.

HERNANDEZ, F. J., JR., S. P. POWERS, AND W. M. GRAHAM. 2010. Seasonal variability in ichthyoplankton abundance and assemblage composition in the northern Gulf of Mexico off Alabama. Fish. Bull. 108:193–207.

LYCZKOWSKI-SHULTZ, J., AND D. S. HANISKO. 2007. A time series of observations of red snapper larvae from SEAMAP surveys, 1982–2003: seasonal occurrence, distribution, abundance, and size. Am. Fish. Soc. Symp. 60:2–23.

———, ———, K. J. SULAK, AND G. D. DENNIS III. 2004. Characterization of ichthyoplankton within the U.S. Geological Survey's Northeastern Gulf of Mexico study area based on analysis of Southeast Area Monitoring and Assessment Program (SEAMAP) sampling surveys, 1982–99. NEGOM Ichthyoplankton Synopsis Final Report U.S. Dept. Interior, U.S. Geological Survey, USGS SIR-2004-5059. 136.

———, AND J. P. STEEN JR. 1991. Diel vertical distribution of red drum *Sciaenops ocellatus* in the north-central Gulf of Mexico. Fish. Bull. 89:631–641.

MCEACHRAN, J. D., AND J. D. FECHHELM. 1998. Fishes of the Gulf of Mexico, vol. 1. University of Texas Press, Austin, TX.

MORSE, W. W. 1989. Catchability, growth, and mortality of larval fishes. Fish. Bull. 87:417–446.

[NMFS/GSMFC] NATIONAL MARINE FISHERIES SERVICE/ GULF STATES MARINE FISHERIES COMMISSION. 2001. SEAMAP field operations manual for data collection. Prepared by the National Marine Fisheries Service and the Gulf States Marine Fisheries Commission. Oct. 2001. Revision No. 4.

W. J. RICHARDS (ED.). 2006. Early stages of Atlantic fishes: an identification guide for the western central north Atlantic, vols. 1, 2. CRC Press, Boca Raton, FL.

(CMS, JLS) National Marine Fisheries Service, Southeast Fisheries Science Center, Mississippi Laboratories, 3209 Frederic Street, Pascagoula, Mississippi 39567; and (MVH) Alabama Department of Conservation and Natural Resources, 2 North Iberville Street, Dauphin Island, Alabama 36528 (Retired). Date accepted: February 24, 2011

DOI: 10.18785/goms.2901.03