

The Across-shelf Larval, Postlarval, and Juvenile Fish Communities Associated with Offshore Oil and Gas Platforms West of the Mississippi River Delta

FRANK J. HERNANDEZ, JR.¹ and RICHARD F. SHAW^{1,2}

¹*Department of Oceanography and Coastal Sciences
Center for Coastal Energy and Environmental Resources*

*Louisiana State University
Baton Rouge, Louisiana 70803-7503 USA*

²*Coastal Fisheries Institute
Louisiana State University
Baton Rouge, Louisiana 70803-7503 USA*

ABSTRACT

The fisheries aggregation value of oil and gas platforms in the continental shelf waters of the northern Gulf of Mexico is well recognized, but the assessment of early life stages associated with these structures has not been adequately addressed. Ichthyoplankton assemblages were sampled at three offshore platforms: Green Canyon 18 (GC 18; 230 m depth, shelf slope); Grand Isle 94 (GI 94; 60 m depth, mid-shelf); and South Timbalier 54 (ST 54; 20 m depth, inner shelf) with passive plankton nets and light-traps. Family richness was highest at GC 18 (52), followed by GI 94 (43), and ST 54 (42). At the genus level, richness was highest at GI 94 (114), followed by ST 54 (86) and GC 18 (82). Clupeiforms dominated samples at all sites, comprising 59-97% of the total catch. Carangids and scombrids dominated the reef-associated fish assemblages at all sites, with blenniids becoming prominent in inshore collections. Other relatively common reef-associated fish were serranids and lutjanids (GC 18), pomacentrids and opisthognathids (GI 94), and *Rhomboplites aurorubens* (ST 54). The ichthyoplankton assemblages sampled at each site were relatively dissimilar, based on Schoener's Index of Similarity, with the highest index value for any two sites being 0.45 for GI 94 and ST 54 (0-1 scale). No significant difference was observed between mean Shannon-Weiner diversity indices calculated for plankton net samples at each site. For light-trap samples diversity was lowest at GC 18, significantly higher at GI 94, and then decreased inshore at ST 54. The presence of early preflexion larvae and presettlement postlarvae and juveniles in our collections indicate that both local spawning and settlement/recruitment may be occurring at these platforms.

KEY WORDS: Gulf of Mexico, oil and gas platforms, ichthyoplankton

INTRODUCTION

The introduction and proliferation of offshore oil and gas structures in the northern Gulf of Mexico has undoubtedly affected the marine ecosystem. The central and western Gulf is dominated by a mud/silt/sand bottom with little relief or hard bottom habitat, and there are approximately 4,000 oil and gas structures in

these federal waters. Parker et al. (1983) reported only 2,780 km² of natural available reef in the central and western Gulf. Although Gallaway (1998) calculated that oil and gas platforms in the northern Gulf provided 11.7 km² (or 4.0%) of the total "reef" habitat, the fact that platforms represent vertical artificial substrate that extends from the bottom to the surface (photic zone), regardless of location and depth, increases their significance. Since fish populations are usually limited by available energy, recruitment, or habitat, it is important to determine if platforms:

- i) Provide critical habitat for early life history stages;
- ii) Serve as new or additional spawning habitat; and
- iii) Influence energy flow through the ecosystem by aggregating prey.

Oil and gas platforms can enhance fisheries by providing attachment substrate for habitat-limited sessile invertebrates, thereby creating food and habitat for reef-dependent species that are trophically-dependent on sessile and motile invertebrates associated with reefs (Gallaway 1981, Bohnsak and Sutherland 1985, Stephan et al. 1990, Bohnsak 1991). Since reef fish assemblages are among the most diverse and taxonomically rich in the aquatic biosphere (Sale 1991), platform communities may significantly enhance biodiversity. In addition, oil and gas structures may offer refugia for species which are trophically-independent of the biofouling community (i.e., reef-associated species; Choat and Bellwood 1991), but are ecologically-important resident, seasonal, or transient members of the hard substrate fish community (Gallaway et al. 1980). The extensive range (latitudinally and longitudinally) of this artificial substrate may also serve as migratory routes for tropical and subtropical species.

The objective of this study was to characterize and compare the larval, postlarval, and juvenile fish assemblages, particularly reef-oriented taxa, associated with three offshore oil and gas platforms off Louisiana representing different depth zones across the continental shelf. This objective was accomplished by collecting a wide variety of taxa and sizes utilizing two sampling techniques, light-traps and passive plankton nets. These methodologies complemented each other, since nets effectively sample yolk-sac, larval, and some postlarval fishes, whereas light-traps sample photopositive species at overlapping and larger sizes to give us more complete estimates of sizes (cohorts or inferred ages) and developmental/early life history stages present (Choat et al. 1993).

MATERIALS AND METHODS

Sampling occurred along a transect west of the Mississippi River Delta with site selection for platforms based upon the work of Gallaway et al. (1980) and Gallaway (1981) who reported that nekton communities around platforms could be categorized by water depth in the northern Gulf. Three communities were characterized: a coastal assemblage (water depths < 27m), an offshore assemblage (water depths 27 to 64 m), and a bluewater/tropical assemblage (water depths > 64m). The platforms selected encompass all three zones. Mobil's Green Canyon (GC) 18, which lies in about 230 m of water on the shelf slope (27°56'37"N,

91°01'45"W), was sampled monthly during new moon phases over a 2-3 night period during July 1995 - June 1996. Mobil's Grand Isle (GI) 94B, which lies in approximately 60 m of water at mid-shelf (28°30'57"N, 90°07'23"W), was sampled twice monthly during new and full moon phases over a three night period during April - August 1996. In addition, during May extra samples during the first quarter and third quarter moon phases were collected. Exxon's South Timbalier (ST) 54G, which lies in approximately 20 meters of water on the inner shelf (28°50'01"N, 90°25'00"W), was sampled twice monthly during new and full moon periods in during April - September 1997.

Sampling protocols for GC 18, GI 94, and ST 54 were similar. At GC 18, all sampling began one hour after sunset and was completed one hour before sunrise. The major sampling station for each platform was located in the internal central region along a stainless steel, small diameter guidewire (monorail) tethered to the first set of the platform's underwater, cross-member, support structures. At this central station, replicate trap collections ($N = 2$) were taken three times each night at near-surface (1 - 2 m depth) and at a depth between 15 and 23 m, depending upon the individual platform's underwater configuration of the first set of cross-member supports. Subsurface samples were collected by lowering a trap without floatation. Light-traps were deployed for 10 minute periods. Passive, horizontal plankton net collections were taken three times at both depths during each night at the central station using a metered, 60 cm diameter, 333 μ m mesh net. The nets had a vane (to help orient into the current) which was fixed to a gimbal attachment on the net ring, which allowed the net to be set and retrieved closed for the at depth deployment. In addition, three collections each night were made with a floating light-trap which was tethered and free drifted away (off-platform) from the platform (approximately 20 m) on the down current side of the platform. Sampling effort was modified at GI 94 and ST 54 to obtain one (rather than two) replicate subsurface and surface collection per gear, and one off-platform light-trap collection per set, with still three sets taken per night.

Community similarity between sites was measured using Schoener's Index of Niche Overlap (Schoener 1970) which was calculated by combining fish collected by all gears within each site. Only fish identified to at least the genus level were used in the similarity analyses. Since this type of analysis can be heavily influenced by large abundances of a single species, it was done without the most dominant taxa at each site included. At times, the sampling efforts differed temporally between sites, so the samples used for comparisons were limited to only those months where samples were collected for both sites in a pairing. Only April-August samples were used to compare GC 18 to GI 94 and ST 54. Full data sets were used in comparisons between GI 94 and ST 54. Shannon-Weiner diversity indices (Magurran, 1988) were calculated for each sample collected at GC 18, GI 94, and ST 54. Differences in mean diversity between sites were analyzed with ANOVA models using gear as a main effect. Post-ANOVA tests (Tukey's Studentized Range, $\alpha=0.05$) were used to determine which sites were significantly different. Only fish identified at least to the level of genus were included in the diversity analyses.

RESULTS

A total of 67 families were represented in our plankton net and light-trap collections from the three platform sites. The number of families represented in passive plankton net collections decreased from 45 at GC 18 (shelf slope) to 40 at GI 94 (mid-shelf) and 34 at ST 54 (inner shelf). In contrast, the number of families represented in light-trap collections was fairly consistent, from 37 at GC 18 and GI 94 to 34 at ST 54. The number of taxa collected, however, peaked at GI 94 for both plankton nets (83) and light-traps (90). The number of taxa collected in plankton nets and light-traps at GC 18 (64 and 59) and ST 54 (59 and 65) were similar. At GC 18, plankton nets collected fish from more unique families (15) and taxa (25) than the light-traps (7 and 18, respectively). At GI 94, plankton nets collected twice as many unique families as the light-traps (6 vs. 3), but light-traps collected more unique taxa (31) than plankton nets (26). At ST 54, plankton nets and light-traps collected equal numbers of unique families (8), while the light-traps collected more unique taxa than the plankton nets (27 vs. 19).

Reef-dependent and reef-associated fish (Choat and Bellwood 1991) made up a relatively small percentage of the total plankton net and light-trap collections (with clupeiforms removed from the total catch) at the three platforms (Table 1). At GC 18, these groups of fish comprised 18% and 32% of the plankton net and light-trap collections, respectively. Dominant groups included scombrids and carangids, as well as *Holocentrus* spp., *Pomacentrus* spp., and *Pristipomoides aquilonaris*. At GI 94, reef-dependent and reef-associated fishes comprised 10% of the plankton net catch and 17% of the light-trap catch. Blenniids were prominent in light-trap collections, while carangids were dominant in plankton nets. At ST 54, these fishes comprised less than 1% of the plankton net collections and only 8% of the light-trap collections. Carangids, blenniids, and scombrids were the dominant reef-associated taxa.

At GC 18, light-traps (n = 319) and plankton nets (n = 125) collected 1,114 and 3,943 fish, respectively, over the course of the year (Table 1). Clupeiform fishes, primarily unidentified engraulids, *Opisthonema oglinum*, *Anchoa nasuta/hepsetus*, and *Engraulis eurystole* dominated the samples, comprising 59% of the total catch for both gear types combined. Dominant non-clupeiform fishes included the reef-associated *Auxis* spp., *Caranx crysos*, and *Caranx hippos/latus*, and the sciaenid *Sciaenops ocellatus*.

At GI 94, light-traps (n = 474) collected 31,353 fish and plankton nets (n = 329) collected 14,401 fish. Clupeiforms dominated the total catch (66%). The most common taxa collected included *Anchoa* spp., *A. nasuta*, *Engraulis eurystole*, and *Opisthonema oglinum*. Among the most common non-clupeiform fishes were demersal taxa such as synodontids (primarily *Synodus foetens* and *S. poeyi*), and *Symphurus* spp., as well as the reef-associated blenniids (*Hypsoblennius invemar* and *Parablennius marmoreus*) and scombrids (*Auxis* spp. and *Euthynnus alletteratus*).

Table 1. Size ranges (SL in mm) and percent of the total catch by gear for dominant taxa (>1%) collected by at least one gear type. Percentages are calculated after the exclusion of clupeiform fishes. Asterisks (*) indicate taxa from reef-associated or reef-dependent families.

Taxon	Light-trap		Plankton net	
	Size Range	%	Size Range	%
Green Canyon 18 (July 1995-June 1996)				
<i>Cyclothone braueri</i>	3.2-7.2	5.8	4.0-13.0	1.8
<i>Saurida brasiliensis</i>	3.2-9.8	5.8		
<i>Trachinocephalus myops</i>	16.2-35.0	1.8		
<i>Bregmaceros cantori</i>	1.5-6.7	2.0	1.3-6.8	4.5
<i>Gobiosox stromosus</i>	2.6-3.2	2.0		
<i>Holocentrus</i> spp.*	6.0-37.5	4.0		
<i>Caranx crysos</i> *	5.0-65.0	12.0	2.5-16.5	3.3
<i>Caranx hipposelatus</i> *	3.0-54.0	6.4	2.0-32.0	10.9
<i>Chloroscombrus chrysurus</i> *			1.9-7.0	1.6
<i>Elagatis bipinnulata</i> *			2.0-3.5	1.3
<i>Pristipomoides aquilonaris</i> *			2.3-40.0	3.9
<i>Eucinostomus</i> spp.	6.5-11.2	3.3		
<i>Cynoscion arenarius</i>	2.5-4.5	1.1	2.0-4.4	6.9
<i>Micropogonias undulatus</i>	3.2-4.5	1.1		
<i>Sciaenops ocellatus</i>			1.8-3.9	12.3
<i>Pomacentrus</i> spp.*	9.0-19.3	4.7		
<i>Mugil cephalus</i>	2.4-21.5	3.8	2.2-5.0	9.0
<i>Microdesmus lanceolatus</i>			2.0-11.0	1.5
<i>Microdesmus longipinnis</i>	2.4-4.9	1.8		
<i>Auxis</i> spp.*	3.3-59.0	13.3	2.2-10.5	7.6
<i>Euthynnus alletteratus</i> *	6.2-87.0	5.1	3.0-12.0	2.5
<i>Scomberomorus cavalla</i> *	3.0-4.5	1.3		
<i>Scomberomorus maculatus</i> *			2.0-10.1	2.1
<i>Ariomma</i> spp.			2.1-2.5	7.8
<i>Peprius burti</i>	1.7-4.2	2.0	1.4-3.3	1.2
<i>Citharichthys spilopterus</i>			3.0-8.0	2.1
<i>Syacium</i> spp.	3.5-6.5	2.7		
<i>Symphurus</i> spp.	2.2-8.0	5.3	2.8-9.0	6.9
Grand Isle 94 (April-August 1996)				
<i>Saurida brasiliensis</i>	4.5-55.0	7.9	2.7-22.5	6.2
<i>Synodus foetens</i>	6.0-43.0	30.6	4.2-22.5	1.8
<i>Synodus poeyi</i>	5.3-45.0	15.6	2.0-16.5	1.2
<i>Bregmaceros cantori</i>	2.0-29.0	3.0	2.0-15.5	16.6
<i>Caranx crysos</i> *			2.5-15.0	2.1
<i>Chloroscombrus chrysurus</i> *			2.1-16.5	1.5
<i>Lutjanus</i> spp.*			3.0-5.5	1.0
<i>Cynoscion arenarius</i>			1.9-5.2	2.2
<i>Sphyræna guachancho</i> *			2.6-7.3	2.7

Table 1 continued.

Taxon	Light-trap		Plankton net	
	Size Range	%	Size Range	%
<i>Hypsoblennius hentz/ionthas</i> *	4.3-12.0	2.5		
<i>Hypsoblennius invemar</i> *	3.5-14.5	13.8		
<i>Parablennius marmoreus</i> *	4.4-23.7	12.3		
<i>Scartella/Hypleurochilus</i> *	3.6-12.5	1.7		
<i>Microdesmus lanceolatus</i>			2.4-25.0	2.2
<i>Auxis</i> spp.*	4.0-36.0	1.4	2.5-10.3	10.3
<i>Euthynnus alletteratus</i> *	3.1-60.0	5.3	2.7-8.7	10.7
<i>Etropus crossotus</i>			2.5-9.0	2.6
<i>Syacium</i> spp.			2.1-8.5	3.0
<i>Symphurus</i> spp.			2.0-12.8	22.5
South Timbalier 54 (April-September 1997)				
<i>Saurida brasiliensis</i>	26.4-43.0	1.2		
<i>Synodus foetens</i>	9.0-44.5	38.9		
<i>Bregmaceros cantori</i>			2.2-11.7	2.1
<i>Caranx crysos</i> *	6.5-24.5	2.0		
<i>Caranx hipposfatus</i> *	5.5-35.0	3.8		
<i>Chloroscombrus chrysurus</i> *	2.5-25.0	1.5	2.0-18.4	17.4
<i>Cynoscion arenarius</i>	2.0-7.0	7.0	1.9-7.8	53.3
<i>Menticirrhus</i> spp.			2.4-5.0	1.9
<i>Hypsoblennius hentz/ionthas</i> *	3.4-12.5	4.4		
<i>Hypsoblennius invemar</i> *	5.7-13.8	3.6		
<i>Scartella/Hypleurochilus</i> *	2.0-14.3	5.0		
<i>Microdesmus lanceolatus</i>			3.2-20.8	1.3
<i>Microdesmus</i> spp.			2.0-3.3	1.3
<i>Auxis</i> spp.*	4.9-25.0	1.7		
<i>Euthynnus alletteratus</i> *	7.0-22.5	9.1		
<i>Scomberomorus cavalla</i> *	3.5-20.0	1.1	2.4-4.2	2.9
<i>Scomberomorus maculatus</i> *	2.5-40.5	6.0	1.9-10.2	4.4
<i>Peprilus burti</i>	3.5-22.0	1.9	2.1-12.0	1.0
<i>Peprilus alepidotus</i>	2.5-24.7	1.3	1.8-5.0	1.6
<i>Etropus crossotus</i>	2.8-12.7	1.1	3.0-13.1	2.1
<i>Symphurus</i> spp.			2.0-14.5	2.3
<i>Sphoeroides</i> spp.	6.7-16.0	1.6		

At ST 54, light-traps ($n = 194$) and plankton nets ($n = 89$) collected 6,116 and 91,583 fish, respectively. Overall, clupeiforms, primarily clupeids, dominated the collections at ST 54, comprising 97% of the total catch for both gear types combined. Of the non-clupeiform fishes collected, sciaenids (*Cynoscion arenarius*), synodontids (*Synodus foetens*), and the reef-associated carangids (*Chloroscombrus chrysurus*) were dominant.

Schoener's Index of Similarity values range from 0 (no similarity) to 1 (identical taxonomic compositions). Similarity values between the sites were relatively low, with the highest similarity occurring between the mid-shelf site, GI 94, and the inner shelf site, ST 54 (0.45). The next highest value was between GC 18 and ST 54 (0.35), followed by GI 94 and GC 18 (0.29). Shannon-Weiner Diversity Index

values for plankton net collections were not significantly different between the sites (Tukey's Studentized Range test, $\alpha = 0.05$; Figure 1). Diversity peaked for light-trap samples at GI 94, where index values were significantly higher than the other sites. Light-trap collections at GC 18 had a significantly lower mean diversity index than the other sites, while diversity at ST 54 was intermediate.

DISCUSSION

Overall, reef-dependent taxa (chaetodontids, pomacentrids, labrids, and scarids) were relatively rare and never comprised over one percent of the total catch for either gear at any site. Pomacentrids and chaetodontids were collected only at the shelf slope and mid-shelf sites, while labrids and scarids were also collected at the inshore site. Our total of 67 families collected at oil and gas platforms throughout the course of this study is comparable with previously published surveys from the Gulf of Mexico (61 families, Ditty et al. 1988; 74 families, Richards et al. 1984), but is generally less than surveys that included more tropical waters (85 families, McGowan, 1985; 91 families, Limouzy-Paris et al. 1994; 96 families, Richards 1984; 100 families, Richards et al. 1993). While reef-dependent fish were uncommon, reef-associated fish (e.g., carangids, scombrids, blenniids) were much more common and many times represented a significant component of the community assemblage at each site.

In general, the dominant reef-associated fish at all sites were carangids and scombrids, although the relative abundances of taxa within these families changed across the shelf. *Caranx crysos*, *C. hippos/latus*, and *Auxis* spp. were dominant taxa at GC 18. *Euthynnus alletteratus* were more prominent at GI 94, while *Chloroscombrus chrysurus* and *E. alletteratus* were dominant at ST 54. While these taxa are pelagic predators as adults, they attain high numbers near reefs and serve as an energetic link that returns nutrients from off-reef feeding to the reef environment via defecation (Choat and Bellwood 1991). A wide size range was represented by these fish as well, from small preflexion sizes to larger juveniles, suggesting that both local spawning and juvenile recruitment and settlement may be occurring at these sites.

Reef-associated and reef-dependent taxa, though rare, were present at the platform sites, and differed in some respects across the shelf. At GC 18, serranids were present, most of which were from the poorly known subfamily Anthiinae. Anthiine adults are residents of rocky reefs on the outer shelf and are not usually found on shallow, inshore reefs (Thresher 1984). Other serranids included *Epinephelus* spp. and *Mycteroperca* spp. Lutjanids were also present, primarily *Pristipomoides aquilonaris*, one of the most common residents of mid- and outer shelf reefs (Hoese and Moore 1977). Other noteworthy taxa included unidentified blennies, *Holocentrus* spp., (reef-associated) and *Pomacentrus* spp. (reef-dependent). Based on the adult community description of offshore artificial and natural reefs (Galloway 1981), we expected this site to have the most speciose and diverse reef fish assemblage, but that was not the case with our larval and juvenile

collections. This may be because reef fish communities are limited, in part, by the supply of pelagic larvae, usually from upstream sources rather than the resident populations (Sponaugle and Cowen 1996, Victor 1986). Reefs and platforms located on the shelf slope would theoretically have significantly fewer upstream sources of potential recruits than those on the mid-shelf, where other natural hard-bottom or reef habitats may be more abundant, or where the density of platforms is orders of magnitude greater. Therefore, the extremely remote location of GC 18 (shelf slope) is probably the limiting factor with regards to the pool of available larvae to be sampled.

At GI 94 there was greater taxonomic richness among reef fish than at GC 18. By far the most dominant reef-associated fish taxa at GI 94 were blenniids, particularly *Parablennius marmoratus* and *Hypsoblennius invemar*. These fishes are perhaps one of the most common taxa affiliated with oil and gas platforms, but are probably underestimated in visual surveys due to their small size, cryptic coloration, and tendency to hide in attached barnacle shells. At GI 94, unidentified gobiids and pomacentrids, primarily *Chromis* spp. and *Pomacentrus* spp. were also present. Unique to this site was the collection of opisthognathids in surface waters (plankton nets as well as surface and off-platform light-traps) during the spring-early summer. Adult *Opisthognathus aurifrons* are reported to be tropical (south Florida, Bahamas, northern South America) and rarely collected on the mid-to-outer shelf (Hoese and Moore 1977, Robins et al. 1986). Adult *O. lonchurus* are also reported to inhabit the northeast Gulf as well as tropical waters (Robins et al. 1986). The presence of these larvae reinforces the notion that oil and gas platforms may play a role in extending the ranges of more tropical forms that would otherwise be habitat limited in the northcentral Gulf.

Other taxonomic differences in reef-associated fish composition were observed between GI 94 (mid-shelf) and GC 18 (outer shelf). At GI 94, lutjanids were also relatively common, with *Rhomboplites aurorubens* the dominant species, followed by *Lutjanus* spp. While *Pristipomoides aquilonaris* was the primary lutjanid at GC 18, none were collected at this mid-shelf site. With regards to serranids, the dominant group was serranines (e.g., *Diplectrum* spp., *Centropristis* spp., and *Serranus* spp.), while relatively few anthiines were collected. Also noteworthy was the relatively high abundance of mullids collected at GI 94, particularly *Upeneus parvus*, a common species on the mid-to-inner shelf (Hoese and Moore 1977).

At ST 54, the most abundant reef/structure-associated fishes were blenniids and gobiids. Unlike GI 94, *Parablennius marmoratus* was relatively uncommon. The dominant species at ST 54 were *Scartella/Hypoleurochilus* spp., *Hypsoblennius hertz/ionthas*, and *H. invemar*. Difficulties in identification prevent us from confidently separating *H. hertz* from *H. ionthas* and *Scartella* spp. from *Hypoleurochilus* spp. but all of these taxa are common in nearshore areas and hard-bottomed habitats, such as oyster reefs and pilings (Hoese and Moore 1977). In general at ST 54, reef fish, although not abundant, were relatively well represented in terms of number of taxa, rivaling that of GI 94. However, other than blenniids and gobiids, abundances of other reef fish were very low (less than a total of 10

individuals collected per taxa) but included *Rhomboplites aurorubens* and unidentified pomacentrids, serranids, and ephippids.

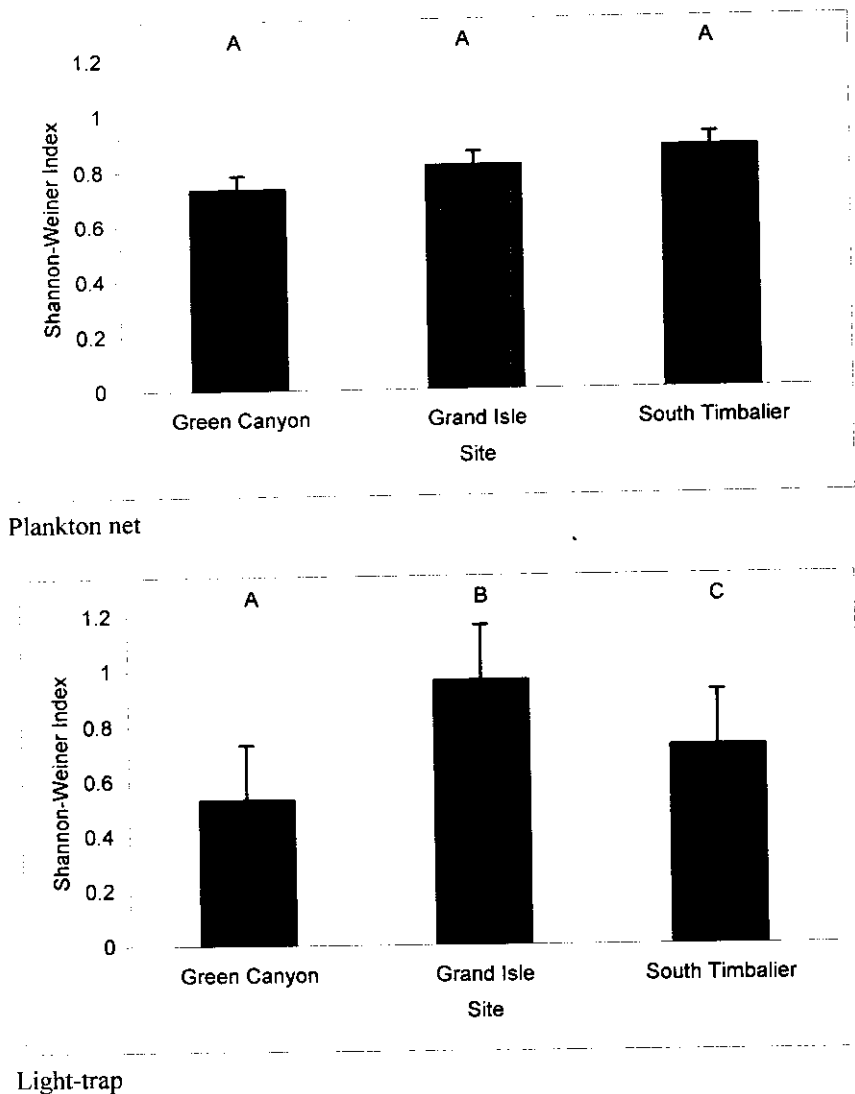


Figure 1. Mean Shannon-Weiner diversity index values (with standard error bars) for plankton net and light-trap collections from each sampling site. The same letter above each bar indicates no significant difference between sites based on Tukey's Studentized Range tests ($\alpha = 0.05$). Different letters indicated significant differences.

The low reef fish abundances are not surprising, particularly for the more tropical taxa such as haemulids, labrids, and scarids. The adults of these taxa are more typical of the outer shelf assemblages (Gallaway 1981). Similarly with regards to reef fish larvae and juveniles, this trend of decreasing taxonomic richness towards the more inshore environments is supported somewhat by our study, particularly with regards to scarids. Even though an inner shelf platform would be downstream from potentially more offshore sources of larvae and recruits, perhaps the relatively greater distances involved necessitate extended pelagic larval durations and the potentially less favorable inshore environmental conditions may result in increased mortality (Leis 1991).

In an effort to examine the relative similarity in taxonomic assemblages between the different sites we computed Schoener's Index of Similarity for each site. In general, the index values indicate that the sites were not very similar, with the highest similarity value between any two sites being 0.45 for GI 94 and ST 54 (mid- and inner shelf). This is not unexpected since we purposely chose sampling sites in different depth zones across the shelf where there should be some faunal transitions (Gallaway et al., 1980; Gallaway, 1981). The highest similarity index for GC 18, however, was with ST 54, the inner shelf platform, whereas we might have expected GC 18 to most similar to GI 94. This somewhat unexpected result is probably due to the previously mentioned, large number of reef taxa collected at GI 94 that were unique to that site. Reef fish taxa such as *Chromis* spp., *Abudefduf taurus*, *Mullus auratus*, *Ophioblennius atlantica*, *Pseudopeneus maculatus*, *Opisthognathus aurifrons*, and *Opisthognathus lonchurus* were collected only at the GI 94 platform. Other taxa (ephippids and scarids) were collected at GC 18 and ST 54, but not at GI 94.

The mean diversity indices for the plankton net collections taken at the platform sites were not significantly different from each other, ranging from 0.73-0.83 (Figure 1). In general, observed statistical differences in Shannon-Weiner diversity indices between sites were limited to light-trap collections. Light-trap collections were significantly more diverse at GI 94, a result of being less dominated by clupeiform fishes than ST 54, and of collecting more taxa, particularly reef fish taxa, than GC 18. In general, taxonomic richness in light-traps was highest at GI 94, with 90 taxa identified to genus as compared to 65 taxa at ST 54, the platform with the second highest number of taxa. Inshore (particularly estuarine) areas are generally characterized as having lower diversity than adjacent shelf waters and are dominated by a few highly abundant taxa (Nybakken 1988). This pattern is generally attributed to the fluctuating nature of the nearshore environment, particularly with regards to salinity and temperature, and the lack of physiological specializations needed to deal with this estuarine environmental variability (Nybakken 1988). This, in part, may explain the relatively low diversity indices for ST 54 the inshore site. In contrast, species richness and abundance is generally relatively low on the outer shelf, due to the homogeneity of the bottom substrate (Bond 1996). As previously discussed, topographical relief is disjunct throughout the northcentral Gulf (especially west of the Delta) and the sea floor is basically dominated by expanses of mud and silt.

Again, this homogeneity and the previously discussed lack of a large amount of upstream supply of larvae may in part explain the low taxonomic diversity observed in the light-trap collections at GC 18.

This study represents the first comprehensive look at the ichthyoplankton assemblages associated with oil and gas platforms in the northern Gulf of Mexico and is also a first (yet preliminary) attempt at comparing such assemblages across different depth zones and geographical regions. It is apparent that a diverse recently spawned larval, postlarval, and juvenile fish community can be captured in the waters within and near platforms, and these structures may therefore be important to reef-associated and reef-dependent fish. Though many taxa were represented in our collections, it is difficult to discern the reasons why some fish were present at these artificial structures. Some, like the clupeiforms, are extremely abundant, very photopositive, and may be behaviorally attracted to such structures with a large, consistent light-field. Other taxa like blennies may be attracted to the numerous habitats created by the biofouling community (e.g., barnacles) on the platform legs and cross-members, as well as the associated zooplankton food resources. Pelagic species, like carangids and scombrids, have more generalized habitat requirements, but may also be attracted to the structure (reef-associated) or to concentrations of zooplankton and forage fish that are inhabiting the platform and immediately surrounding waters. For whatever reason, based on the results from this study the oil and gas platforms serve a potentially important function as a hard-substrate habitat and could, therefore, lead to increased production.

LITERATURE CITED

- Bohnsak, J.A. 1991. Habitat structure and the design of artificial reefs. Pages 412-426 in S.S. Bell, E.D. McCoy, and H.R. Mushinsky, (eds.) *Habitat Structure: The Physical Structure of Objects in Space*. Chapman and Hall, London.
- Bohnsak, J.A. and D.L. Sutherland. 1985. Artificial reef research: a review with recommendations for future priorities. *Bulletin of Marine Science* 37:11-19.
- Bond, C E. 1996. *Biology of Fishes*. Saunders College Publishing, Orlando, Florida USA.
- Choat, J.H. and D.R. Bellwood. 1991. Reef fishes: their history and evolution. Pages 39-66 in: P. F. Sale, (ed.) *The Ecology of Fishes on Coral Reefs*. Academic Press, San Diego, California USA.
- Choat, J.H., P.J. Doherty, B.A. Kerrigan, and J.M. Leis. 1993. A comparison of towed nets, purse seine, and light-aggregation devices for sampling larvae and pelagic juveniles of coral reef fishes. *Fishery Bulletin* 91:195-209.
- Ditty, J.G., G.G. Zieske, and R.F. Shaw. 1988. Seasonality and depth distribution of larval fishes in the northern Gulf of Mexico above latitude 26°00'N. *Fishery Bulletin* 86:811-823.
- Gallaway, B.J., L.R. Martin, R.L. Howard, G.S. Boland and G.D. Dennis. 1980. A case study of the effects of gas and oil production on artificial reef and demersal

- fish and macrocrustacean communities in the northwestern Gulf of Mexico. *Expo Chem 1980*, Houston, Texas USA.
- Galloway, B.J. 1981. An ecosystem analysis of oil and gas development on the Texas-Louisiana continental shelf. U.S. Fish & Wildlife Service, Office of Biological Services, FWS/OBS-81/27, Washington, D.C. USA.
- Galloway, B. J. 1998. Cumulative ecological significance of oil and gas structures in the Gulf of Mexico: Information search, synthesis, and ecological modeling: Phase I, Final Report. U. S. Geological Survey, Biological Research Division, Washington, D.C. USGS/BRD/CR-1997-0006.
- Hoese, H.D. and R.H. Moore. 1977. *Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters*. Texas A&M University Press, College Station., Texas USA.
- Leis, J.M. 1991. The pelagic stage of reef fishes: the larval biology of coral reef fishes. Pages 183-230 in: P.F. Sale, (ed.) *The Ecology of Fishes on Coral Reefs*. Academic Press, San Diego, California USA.
- Limouzy-Paris, C., M.F. McGowan, W.J. Richards, J.P. Umaran and S S. Cha. 1994. Diversity of fish larvae in the Florida Keys: results from SEFCAR. *Bulletin of Marine Science* 54(3):857-870.
- Magurran, A.E. 1988. *Ecological Diversity and Its Measurement*. Princeton University Press, Princeton, New Jersey USA.
- McGowan, M.F. 1985. *Ichthyoplankton of the Flower Garden Banks, northwest Gulf of Mexico*. Doctoral Dissertation. University of Miami, Miami, Florida USA.
- Nybakken, J.W. 1988. *Marine Biology: An Ecological Approach*. Harper and Row, New York, New York USA.
- Parker, R.O., Jr., D.R. Colby T.P. Willis. 1983. Estimated amount of reef habitat on a portion of the U.S. South Atlantic and Gulf of Mexico continental shelf. *Bulletin of Marine Science* 33:935-940.
- Richards, W. J. 1984. Kinds and abundances of fish larvae in the Caribbean Sea and adjacent areas. NOAA Technical Report NMFS-SSRF-776.
- Richards, W. J., T. Potthoff, S. Kelley, M. F. McGowan, L. Ejsymont, J. H. Rower and R. M. Olvera. 1984. SEAMAP 1982-Ichthyoplankton. NOAA Technical Memorandum NMFS-SEFC-144.
- Richards, W. J., M. F. McGowan, T. Leming, J. T. Lampkin and S. Kelley. 1993. Larval assemblages at the Loop Current boundary in the Gulf of Mexico. *Bulletin of Marine Science* 53(2):475-537.
- Robins, C. R., G.C. Ray, and J. Douglass. 1986. *A Field Guide to the Atlantic Coast Fishes of North America*. Houghton Mifflin Company, Boston.
- Sale, P. F. 1991. *The Ecology of Fishes on Coral Reefs*. Academic Press, New York, New York USA.
- Schoener, T. W. 1970. Non-synchronous spatial overlap of lizards in patchy habitats. *Ecology* 51:408-418.
- Sponaugle, S. and R.K. Cowen. 1996. Nearshore patterns of coral reef fish larval supply to Barbados, West Indies. *Marine Ecology Progress Series* 133:13-28.

- Stephan, C. D., B.G. Dansby, G.C. Matlock, R.K. Rieckers, and R. Rayburn. 1990. Texas artificial reef fishery management plan. Texas Parks and Wildlife Department of Fisheries Management Plan Serial 3.
- Thresher, R. E. 1984. *Reproduction in Reef Fishes*. T.F.H. Publications, Inc.
- Victor, B. C. 1986. Larval settlement and juvenile mortality in a recruitment-limited coral reef fish population. *Ecological Monographs* 56:145-160.