2001

The Across-Shelf Distribution of Larval, Postlarval and Juvenile Fishes Collected at Oil and Gas Platforms and a Coastal Jetty Off Louisiana West of the Mississippi River Delta.

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THE ACROSS-SHELF DISTRIBUTION OF LARVAL, POSTLARVAL AND JUVENILE FISHES COLLECTED AT OIL AND GAS PLATFORMS AND A COASTAL JETTY OFF LOUISIANA WEST OF THE MISSISSIPPI RIVER DELTA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Oceanography and Coastal Sciences

by
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B.S., Louisiana State University, 1993
M.S., University of North Carolina at Wilmington, 1996
December 2001

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For my dad, Frank J. Hernandez, Sr., my sisters, Peep and Meek, nieces, Dabber and Winky, and great-nieces, Mac and Aubrey. Thanks for the love and support.

In memory of my mother, Mary A. Hernandez, Sr. (1940-1993), who's love and support I still feel today.

Also, in memory of my MS degree mentor, Dr. David G. Lindquist, for his guidance, encouragement and friendship.

ACKNOWLEDGMENTS

I would like to thank my major professor, Dr. Richard Shaw, for his assistance and guidance throughout the course of this project. I am also grateful for the assistance and encouragement I have received from my committee members, Drs. Chuck Wilson, Larry Rouse and Jay Geaghan. This has been a rewarding experience and it was a pleasure to work with such a knowledgeable and helpful committee.

This was a very large research effort and there are many others to thank. I would like to thank Joe Cope, Jim Ditty, James Tolan and Dr. Mark Benfield for all of their efforts, advice and guidance. I would especially like to thank Joe for his experimental design and SAS help when needed, as well as all the fun times at the jetties down in Fourchon. I would like to thank Talat Farooqi for helping me identify the most troublesome of larval fishes. I am also indebted to Dr. Joanne Lyczkowski-Shultz, Denice Drass and David Hanisko (NMFS, Pascagoula lab) for assistance with SEAMAP data acquisition and analyses, as well as advice and encouragement throughout.

This project could not have been accomplished without field and laboratory assistance from our trusted student workers: David Bunch, Nathan Craig, Robin Hargroder, Gregory Lavergne, Bradley McDonald, Cory New, Nick Ortega, Paul Rogers and Christopher Whatley. Other students, RAs and lab siblings were there to lend a hand or an ear when needed, including Heather Haas, Ross Horton, Dave Lindquist, Brian Milan and John Plunkett.

I also want to thank my many Red Stick and LSU friends, all of which have encouraged me along the way, or at least bought me a beer when I was tapped for cash. I owe you. The list is long, but I'll be brief, and just mention a special thanks to Scott Baker, Kelly Blessinger, Tim Coker, Costa Dimitriades, Andy Fischer, Will Patterson, Elena and Myrto Prakoura, Jimmy Tam and all the Greeks (Efharisto).

Finally, I gratefully acknowledge funding by the Minerals Management Service-Louisiana State University-Coastal Marine Institute (Contract Number 14-75-0001-30660, Task Order Number 19926) and by the Louisiana Sea Grant Program, part of the National Sea Grant College Program maintained by the National Oceanic and Atmospheric Administration. I would also like to thank the Louisiana Board of Regents fellowship program for their support. Logistically, I owe a great deal of thanks to John Mackler,

Mark Miller and Wilton Delaune. I am further indebted to Exxon USA, Inc. and Mobil USA Exploration and Production, Inc. for access to their offshore oil and gas platforms and logistical support, and to the crews of Mobil's West Cameron 352, West Cameron 71D, Green Canyon 18, and Grand Isle 94 and Exxon's South Timbalier 54 platforms for their hospitality.

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ABSTRACT

A cross-shelf transect of three petroleum platforms and a coastal rock jetty (another hard-substrate, artificial habitat) in the northcentral Gulf were sampled to examine the role that oil and gas platforms (hard substrate habitat) may play in the early life history stages of reef-dependent and reef-associated fishes. The ichthyoplankton and juvenile fish assemblages were sampled at 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 and at a coastal rock jetty (Belle Pass; 3-5 m depth) with a light-trap and a plankton pushnet. At all sites clupeiforms dominated samples, comprising 59-97% of the total catch. Results of Kolmogorov-Smirnov length-frequency comparisons of fish collected in plankton nets vs. light-traps (platforms) indicated light-traps generally collected significantly larger individuals. At the jetties, greater overlap in size distributions was observed for comparisons of the pushnet and light-trap. Reef-dependent (e.g., pomacentrids, scarids, chaetodontids and labrids) and reef-associated (e.g., serranids, lutjanids, blenniids and holocentrids) taxa were relatively rare in our collections compared to coastal pelagic (scombrids and carangids) and demersal taxa (sciaenids), which are also often associated with petroleum platforms. Taxonomic richness and diversity was highest at mid-shelf platform (GI 94), possibly a result of its proximity to a high density of upstream and surrounding platforms which may create generally favorable conditions for the recruitment of reef taxa. Preflexion and early larval stages of reef-dependent and reef-associated fishes were collected at the outer shelf platform (blenniids, holocentrids, serranids, lutjanids and scarids), mid-shelf platform (pomacentrids, blenniids, holocentrids, lutjanids and serranids), and inner shelf platform (blenniids and lutjanids), suggesting nearby spawning or local supply. Similarly, presettlement and settlement-sized reef-dependent and reef-associated fishes were collected at the outer shelf (pomacentrids, scarids, blenniids, serranids, lutjanids and holocentrids), mid-shelf (pomacentrids, blenniids, serranids, lutjanids and holocentrids), and inner shelf (labrids, blenniids, serranids and lutjanids) platforms. With the limited amount of hard-substrate habitat available in the northern Gulf, the addition of artificial habitats (platforms) may increase the chances of finding suitable spawning or settlement habitat.

CHAPTER 1

THE ACROSS-SHELF DISTRIBUTION OF REEF FISHES AND THE POTENTIAL IMPORTANCE OF OIL AND GAS PLATFORMS AS ARTIFICIAL HABITAT FOR FISHES IN THE NORTHERN GULF OF MEXICO

INTRODUCTION

The Gulf of Mexico (Gulf) yields about 40% of the commercial fish landings (NOAA/NMFS 1993) in the United States and supports 33% of the country's recreational fishery (Essig et al. 1991; Van Voorhies et al. 1992). The region also possesses the vast majority of the nation's coastal wetlands. Louisiana alone has over 3.8 million acres (>40% of the nation's total wetlands), but these areas are disappearing at an alarming rate, i.e., Louisiana land loss represents 60-80% of the nation's total annual coastal wetland loss (Boesch et al. 1994). The continual loss of Gulf estuarine and wetland habitats that serve as the nursery grounds for a large number of our commercially- and recreationally-important fisheries makes knowledge of the potential nursery function of other habitats critical. Habitat issues have received increased attention lately, in part due to the Essential Fish Habitat Provisions added to the Federal Sustainable Fisheries Act of 1996 that facilitate the long-term protection of waters and substrate necessary to fish for spawning, breeding, feeding and/or growth to maturity (USDOC 1996).

The introduction and proliferation of offshore oil and gas structures in the northern Gulf has undoubtedly affected the marine ecosystem. There are approximately 5,000 oil and gas structures in the northern Gulf, about 4,000 of which are in federal waters (Stanley and Wilson 2000). The central and western Gulf is dominated by a mud/silt/sand bottom with little relief or hard bottom habitat. Parker et al. (1983) reported only 2,780 km^2 of natural available reef in the central and western Gulf. Gallaway (1998) calculated that oil and gas platforms in the northern Gulf provided 11.7 km^2 (or <0.4 %) of the total "reef" habitat. Off the Louisiana coast, the contribution is relatively greater, as platforms account for 10.4% of the available hard bottom in Minerals Management Service (MMS) No Activity zones (Stanley and Wilson 2000). 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: 1) serve as new or additional spawning habitat, and 2) provide critical habitat for early life history stages.

The adult fish communities around natural and artificial reefs are fairly well known (Seaman and Sprague 1992; Rooker et al. 1997; Stanley and Wilson 2000) and the fish aggregation value of oil and gas structures is well-recognized in the Gulf (CDOP 1985). However, biologists still disagree as to whether

these artificial reefs (i.e., platforms) contribute significantly to new fish production or simply attract and concentrate existing fish biomass (Pickering and Whitmarsh 1997; Bortone 1998). Existing data on adult fishes support both sides of the debate (Stone et al. 1979; Alevizon et al. 1985). Bohnsack (1989) theorized that reef effects fall along a continuum between attraction of existing organisms and production, with increased productivity occurring for reef-dependent species in areas of limited hard substrate habitat. Since the central Gulf has little natural reef habitat relative to the western and eastern portions, it is possible that the contribution of artificial reefs to existing reef habitat has enhanced reef fish populations, but the overall or net impact of this augmentation is not known, especially when corrected for increased fishing mortality on aggregations associated with platforms (Stanley and Wilson 1990).

Across-Shelf Ichthyofaunal Zonation

Gallaway et al. (1980) and Gallaway (1981) reviewed previous descriptions of invertebrate and vertebrate faunal assemblages from the northcentral Gulf's continental shelf. They characterized differences largely upon different bottom types (fluvial/terrigenous sediments west of the Mississippi River Delta and carbonaceous sediments to the east), circulation patterns, climate, and related hydrographic conditions. Gallaway and his colleagues reported distinct changes in reef fish species assemblages when analyzed across depths. Overall, the outer shelf (>60 m depth) reefs appear to be more speciose, followed by the mid-shelf (20-60 m) and then the inner shelf (3-20 m). More tropical taxa were present on the outer shelf reefs, such as haemulids, labrids, and scarids, and similar taxa occurred on both natural and artificial reefs. There was some overlap between reef species on the outer shelf and mid-shelf (chaetodontids, pomacanthids, and pomacentrids), but the tropical taxa were replaced by more temperate reef species, such as serranids, *Archosargus probatocephalus*, pomatomids, and rachycentrids. Also, taxa that have been reported to be common on artificial reefs on the mid-shelf were generally common on the inner shelf as well. In general, *Caranx crysos* and other jacks were noted as being relatively common reef-associated species in each zone.

Ichthyoplankton Collected at Oil and Gas Platforms

Few baseline ecological ichthyoplankton studies within the oil field have been published (Finucane et al. 1979a; Finucane et al., 1979b; Bedinger et al. 1980), and none have been published that focus on the platform infrastructure. I am aware of only one study that investigated the ichthyoplankton

community found near oil and gas platforms. Finucane et al. (1979b), using bongo and neuston nets, sampled within 30-90 m of two platforms and two satellite (well) jackets all within the Buccaneer Oil Field, approximately 50 km south southeast of Galveston, Texas. Two far-field, control sites were also sampled for comparison. While the Buccaneer Oil Field study did attempt to address larval fish assemblages near platforms, all of the sites with structure were within a 5 km radius from each other, and all sites, including the controls, were in 17 m of water, not allowing for any comparisons of different community regimes across depth zones or large geographic areas. Also, sampling in the oil field study was limited to only three, 2-day cruises. In contrast, this study intensively sampled all three of Gallaway's (1981) depth zones, allowing for a preliminary characterization of ichthyoplankton assemblages collected within these platforms (i.e., artificial habitats) across the continental shelf.

Study Objectives

This study was part of a larger, coordinated research effort with other scientists investigating the overall importance of oil and gas platforms as habitat for larval and juvenile fishes (Tolan 2001), as well as adult fishes (Stanley and Wilson 2000). This study focused on three main objectives. The first was to provide much needed information on the role that oil and gas platforms (hard substrate habitat) may play as recruitment grounds and/or refugia for postlarval and juvenile fish, which could contribute to fish production. Secondly, I wished to provide more basic biological information on reef fish, e.g., larval, postlarval, and juvenile taxonomy, seasonality, lunar periodicity, distribution (vertical and across shelf), and relative abundance. Finally, as a long-term objective, I wished to evaluate the ecological significance that this artificial habitat building, which has occurred on an unprecedented scale in the northcentral Gulf, may have had on the early life history stages of fish. Specific objectives of the remaining chapters are given below.

In Chapter 2, I describe the larval, postlarval and juvenile fish assemblages collected at three offshore oil and gas platforms, i.e., Gallaway's (1981) three community zones, and a coastal rock jetty off Louisiana. These descriptions include information on seasonality, relative abundance and density of fishes collected, as well as comparisons of taxonomic richness, diversity and similarity between the sites (across-shelf). Also, abundances and densities of dominant taxa are related to measured environmental parameters (e.g., temperature, salinity, turbidity, dissolved oxygen and macrozooplankton biomass).

In Chapter 3, I describe the sampling methodologies utilized in this study. In this attempt to characterize the across-shelf ichthyoplankton assemblages collected at artificial structures in the northern Gulf, a variety of sampling gears were used in an effort to survey the widest range of taxa, size classes, and developmental stages available. This chapter reports the results of gear comparisons between a passive plankton net and light-trap used at the petroleum platforms, and between a bow-mounted, plankton pushnet and light-trap (the same design) used at the coastal jetty. In these comparisons, I examine the taxa collected by the different gears, the similarity and diversity of the catches, as well as the size selectivities of the gears.

In Chapter 4, I describe the spatial and vertical distributions of larval and juvenile fishes collected at oil and gas platforms. In order to comprehensively sample the platform environment, fish larvae and juveniles were collected at depth and near the surface within the platform infrastructure (plankton nets and light-traps), and near the surface immediately downstream (20 m) of the platform structure (light-traps). Differences in fish densities, taxonomic richness, diversity and similarity are compared between depths and locations within and around each platform.

In Chapter 5, I examine the relative abundances and size distributions of reef fish larvae and juveniles collected at oil and gas platforms. In order to determine which life history stages were collected and how those specimens relate to supply and recruitment, their size distributions are compared with literature-based sizes for hatchling, preflexion, flexion, postflexion, and juvenile reef fishes. Also, in an effort to compare the platform-collected fish abundances to continental shelf or open water "background" abundances, comparisons are made between reef-dependent and reef-associated fishes collected at the platforms and those collected in ichthyoplankton surveys by the Southeast Area Monitoring and Assessment Program (SEAMAP).

In Chapter 6, I present a summary of the relevant findings from Chapters 2-5. The potential importance of oil and gas platforms to larval and juvenile fishes is discussed in detail.

Each chapter has been prepared in manuscript form for scientific journal publication. These chapters have been arranged such that the holistic (or across-shelf) dynamics of the study are presented first (Chapter 2). Smaller (though relevant) components of the study are described in more detail in the following chapters (Chapters 3-5). The reader is directed to these chapters for a more complete and

in-depth discussion of gear selectivity and biases (Chapter 3), within-site fish vertical and spatial distributions (Chapter 4), and reef fish developmental stages (Chapter 5).

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CHAPTER 2

EARLY LIFE HISTORY STAGES OF FISHES COLLECTED ACROSS THE SHELF AT OFFSHORE OIL AND GAS PLATFORMS AND A ROCK JETTY WEST OF THE MISSISSIPPI RIVER DELTA

INTRODUCTION

The Gulf of Mexico (Gulf) yields about 40% of the commercial fish landings (NOAA/NMFS 1993) in the United States and supports 33% of the country's recreational fishery (Essig et al. 1991; Van Voorhies et al. 1992). The region also possesses the vast majority of the nation's coastal wetlands. Louisiana alone has over 3.8 million acres (>40% of the nation's total wetlands), but these areas are disappearing at an alarming rate, i.e., Louisiana land loss represents 60-80% of the nation's total annual coastal wetland loss (Boesch et al. 1994). The continual loss of Gulf estuarine habitats that serve as the nursery grounds for a large number of commercially- and recreationally-important fisheries makes knowledge of the potential nursery function of other habitats critical.

The introduction and proliferation of offshore oil and gas structures in the northern Gulf has undoubtedly affected the marine ecosystem. There are approximately 5,000 oil and gas structures in the northern Gulf, about 4,000 of which are in federal waters (Stanley and Wilson 2000). The central and western Gulf is dominated by a mud/silt/sand bottom with little relief or hard bottom habitat. Parker et al. (1983) reported only 2,780 km^2 of natural available reef in the central and western Gulf. While Gallaway (1998) calculated that oil and gas platforms in the northern Gulf provide 11.7 km^2 (or <0.4 %) of the total "reef" habitat, that platforms represent vertical artificial substrate that extends from the bottom to the surface (photic zone), regardless of location and depth, increases their significance.

The adult fish communities around natural and artificial reefs are fairly well known (Seaman and Sprague 1992; Rooker et al. 1997; Stanley and Wilson 2000) and the fish aggregation value of oil and gas structures is well-recognized in the Gulf (CDOP 1985). However, biologists still disagree as to whether these artificial reefs (i.e., platforms) contribute significantly to new fish production or simply attract and concentrate existing fish biomass (Pickering and Whitmarsh 1997; Bortone 1998). Existing data on adult fishes support both sides of the debate (Stone et al. 1979; Alevizon et al. 1985). Bohnsack (1989) theorized that reef effects fall along a continuum between attraction of existing organisms and production, with increased productivity occurring for reef-dependent species in areas of limited hard substrate habitat.

Few studies have attempted to compare the ichthyofaunal assemblages collected at oil and gas platforms in the northcentral Gulf across wide depth zones, and the information that is available primarily concerns adult fishes and not their early life history stages. Sonnier et al. (1976) surveyed oil and gas

platforms (18-55 m depth) as well as inshore (37-59 m) and offshore (110-155 m) reefs off Louisiana and described the offshore reefs as being more speciose than inshore reefs or platforms. This greater offshore reef species richness was primarily due to the presence of southern Gulf-Caribbean taxa (e.g., butterflyfishes, parrotfishes, and cleaning gobies) and taxa common to reefs in the northwestern Gulf off Texas. The authors suggested that the lower temperatures that occur at the inshore reefs and platforms are a limiting factor in the number of species, particularly tropicals, which inhabit inshore habitats. Gallaway et al. (1980) and Gallaway (1981) reviewed previous descriptions of invertebrate and vertebrate faunal assemblages from the northcentral Gulf's continental shelf. They characterized differences largely upon different bottom types (fluvial/terrigenous sediments west of the Mississippi River Delta and carbonaceous sediments to the east), circulation patterns, climate, and related hydrographic conditions.

Even fewer baseline, ecological ichthyoplankton studies within the oil field have been published (Finucane et al. 1979a; Finucane et al., 1979b; Bedinger et al. 1980), and none have been published that focus upon platform infrastructure. To my knowledge, only one study has investigated the ichthyoplankton community found in proximity to petroleum platforms. Finucane et al. (1979b), using bongo and neuston nets, sampled within 30-90 m of two oil platforms and two satellite (well) jackets, all within a 5 km radius of each other and in 17 m of water south southeast of Galveston, Texas. Three, 2-day cruises collected primarily engraulids, sciaenids, and bothids. Species richness was found to be greatest at the platform sites in July and October and at the satellite structures in February. Overall, of the 68 taxa identified to genus, 38 were associated exclusively with at least one of the structure sites, while another 29 were found near both structure sites and control sites. Dominant taxa at the structure sites included unidentified engraulids, *Anchoa* spp., *Cynoscion* spp., *Syacium* spp., *Micropogonias undulatus*, and unidentified clupeids. Based on eggs and larval abundance, the petroleum field was determined to be an active spawning area for anguilliforms, callionymids, clupeids, sciaenids, scombrids and soleids, but reef fish eggs and larvae were not abundant.

This study was part of a larger, coordinated research effort with other scientists investigating the overall importance of oil and gas platforms as habitat for larval and juvenile fishes (Tolan 2001), as well as adult fishes (Stanley and Wilson 2000). This study focused on three main objectives. The first was to provide much needed information on the role that oil and gas platforms (hard substrate habitat) may play

as recruitment grounds and/or refugia for postlarval and juvenile fish, which could contribute to fish production. Secondly, I wished to provide more basic biological information on reef fish, e.g., larval, postlarval, and juvenile taxonomy, seasonality, lunar periodicity, distribution (vertical and across shelf), and relative abundance. Finally, as a long-term objective, I wished to evaluate the ecological significance that this artificial habitat building, which has occurred on an unprecedented scale in the northcentral Gulf, may have had on the early life stages of fish.

MATERIALS AND METHODS

Study Sites

Data collection and analyses focused on three offshore oil and gas platforms in the northcentral Gulf west of the Mississippi River Delta and at a low-salinity, coastal rock jetty environment, which provided a far-field, non-platform site, end-member that was also structurally complex and represented another artificial, hard-substrate habitat (Figure 2.1). Platform site selection was based upon the work of Gallaway et al. (1980), Gallaway (1981), and Continental Shelf Associates (1982) who reported that nekton communities around platforms could be categorized by water depth in the northern Gulf (Table 2.1). Three communities were characterized: a coastal assemblage (3-20 m), an offshore assemblage (20-60 m), and a bluewater/tropical assemblage (>60 m). The platforms selected and the jetty site encompass all three zones. The outer shelf site, Mobil's Green Canyon (GC) 18, lies in about 230 m of water on the shelf slope (27°56'37"N, 91°01'45"W). The mid-shelf site, Mobil's Grand Isle (GI) 94B, lies in approximately 60 m of water (28°30'57"N, 90°07'23"W). The inner shelf site, Exxon's South Timbalier (ST) 54G, lies in approximately 20 m of water (28°50'01"N, 90°25'00"W). All platforms had very similar structural complexity. GC 18 is a very large six pile (column or leg) production platform, while GI 94 and ST 54 are eight pile production platforms. Although the platforms varied in age (installation for GC 18 in 1988, GI 94 in 1975 and ST 54 in 1956), all were at least seven years old at the beginning of the study, which was ample time for the development of mature biofouling communities. The stone rubble jetties (2-3 m depth) at the terminus of Belle Pass (BP), a major shipping channel near Fourchon, Louisiana (29°03'90" N, 90°13'80" W), were also sampled simultaneously with the sampling of ST 54. The two jetties are approximately 91 m apart and run in a general north-south direction. The east jetty is approximately 335 m long and the west jetty is approximately 305 m long.

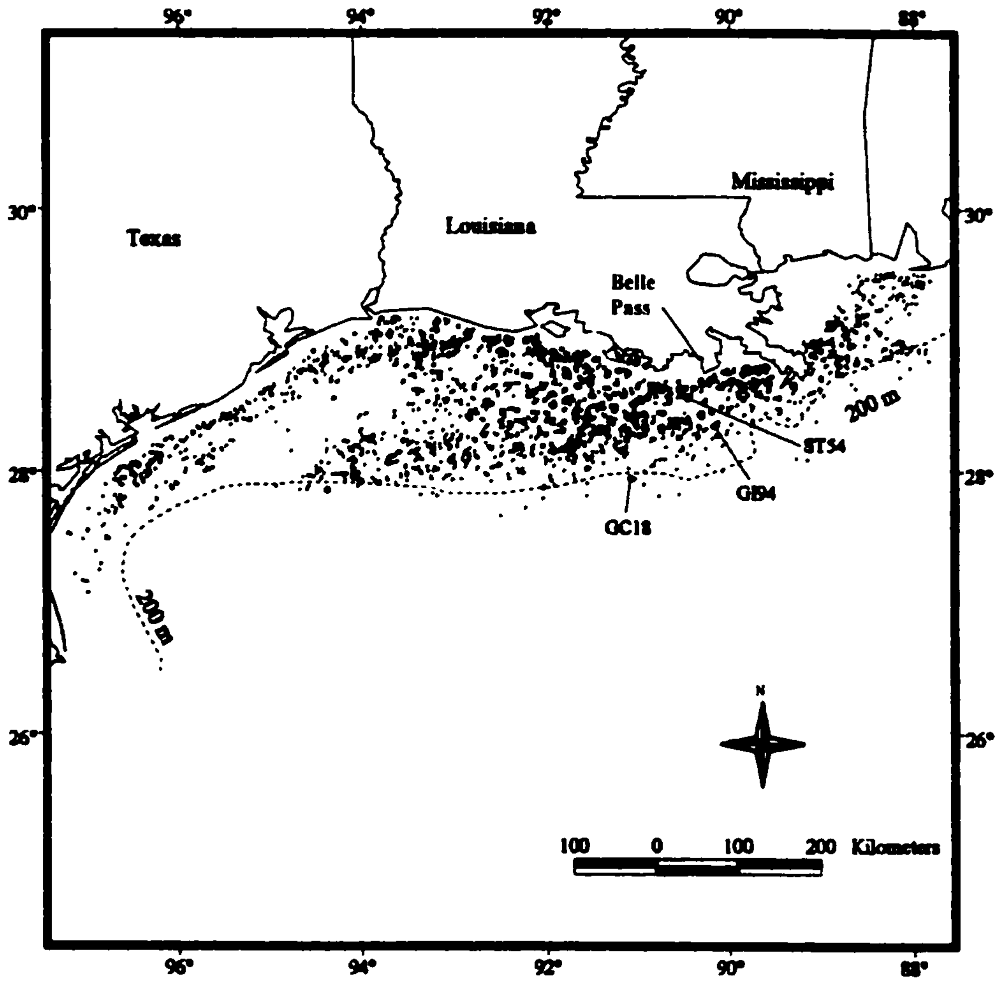


Figure 2.1. Location of the approximately 4,000 oil and gas platforms in the federal waters of the northcentral Gulf. Also indicated are the three platforms and the coastal jetty site sampled during the course of this study. Map modified from Tolan 2001.

Table 2.1. Summary of the commonly observed adult fish assemblage associated with reefs or platforms by depth as reported in Gallaway et al. (1980) and subsequently modified by Gallaway (1981). Taxa were reported from these depth zones as being affiliated with natural reefs (N) or artificial reefs (A).

Taxa		Ichthyofaunal Assemblage		
	Gallaway et al. (1980)	Coastal (3-27 m)	Offshore (27-64 m)	Blue Water or Tropical (>64 m)
	Gallaway (1981)	Inner Shelf (White Shrimp Ground) (3-20 m)	Intermediate Shelf (Brown Shrimp Ground) (20-60 m)	Outer Shelf (Tropical) (>60 m)
Serranidae				
Epinephelus spp. (grouper spp.)				N
Epinephelus itajara (jewfish)			A	
Epinephelus nigritus (warsaw grouper)			A	
Mycteroperca spp. (grouper spp.)				N
Paranthias furcifer (creole-fish)				N, A
Pomatomidae				
Pomatomus saltatrix (bluefish)		A	A	
Rachycentridae				
Rachycentron canadum (cobia)			A	
Carangidae				
Caranx crysos (blue runner)		A	A	R
Caranx hippos (crevalle jack)			A	
carangid spp. (jack spp.)		A	A	N
Selene setapinnis (moonfish)			A	
Selene vomer (lookdown)		A	A	
Seriola rivoliana (almaco jack)				N, A
Lutjanidae				
Lutjanus campechanus (red snapper)			A	N
Lutjanus synagris (lane snapper)		A	A	
Rhomboplites aurorubens (vermilion snapper)				N
Haeumulidae				
Haeumulon melanurum (cottonwick)				N
Sparidae				
Archosargus probatocephalus (sheepshead)		A	A	
Kyphosidae				
Kyphosus sectatrix (Bermuda chub)			A	
Ephippidae				
Chaetodipterus faber (Atlantic spadefish)		A	A	
Chaetodontidae				
butterflyfish spp.			A	N

Table 2.1. (continued)

Taxa		Ichthyofaunal Assemblage		
	Gallaway et al. (1980)	Coastal (3-27 m)	Offshore (27-64 m)	Blue Water or Tropical (>64 m)
	Gallaway (1981)	Inner Shelf (White Shrimp Ground) (3-20 m)	Intermediate Shelf (Brown Shrimp Ground) (20-60 m)	Outer Shelf (Tropical) (>60 m)
Pomacanthidae				
Holacanthus tricolor (rock beauty)				A
pomacanthid spp. (angelfish spp.)			A	N, A
Pomacentridae				
damselfish spp.			A	N, A
Cirrhitidae				
Amblycirrhitus pinos (redspotted hawkfish)				A
Sphyraenidae				
Sphyraena barracuda (great barracuda)			A	A
Labridae				
Bodianus rufus (Spanish hogfish)				A
Decodon puellaris (red hogfish)				A
Clepticus parrai (creole wrasse)				N, A
Scaridae				
parrotfish spp.				N
Blenniidae				
blenny spp.			A	
Acanthuridae				
surgeonfish/tang spp.			A	A
Balistidae				
Balistes capriscus (gray triggerfish)			A	A

Sampling Procedure

Sampling protocols for the outer shelf, mid-shelf and inner shelf platforms were similar. At the outer shelf site (GC 18), eleven monthly sampling trips were taken over a 2-3 night period coinciding with new moon phases from July 1995-June 1996, with the exception of the month of December (adverse weather). New moon phases were targeted at this platform because they have been associated with the peak recruitment periods of many reef-dependent fishes (Johannes 1978; Robertson et al. 1988). 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 (vertical 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 and at a depth between 15 and 23 m, depending upon the depths of the other platforms' first set of underwater 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 (General Oceanics flowmeter model 2030 with slow velocity rotor), 60-cm diameter, 333µm mesh net dyed dark green. The nets had a vane (to help orient into the current) which was fixed to a gimbled attachment on the net ring, allowing the net to be set and retrieved closed for the at depth deployment. In addition, 3 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. For light-traps sampled at depth or off-platform, the trap was deployed with the light off, fished with the light on, and then retrieved with the light off.

Temperature (°C), salinity (ppt) , and turbidity (NTU) were determined during each set using a Data Sonde 3 Hydrolab. During each set, a vertical plankton net (20-cm diameter, 63-µm mesh) which was held rigidly to the guidewire by a net frame, was lowered codend first to the bottom of the monorail, left at depth for 5 minutes for water column restabilization, and then hauled to the surface at approximately 1m/s to ascertain microzooplankton biomass as a measure of food availability. The samples were returned to the lab where they were dried in an oven for 24 h at 60°C and then weighed to determine the dry weight biomass (g/m^3). Also, surface water samples were collected during each set in order to determine total suspended sediments, an estimate of turbidity. These water samples were later filtered in the lab through a pre-weighed, microfiber filter (1.2 µm), dried in an oven for 24 h at 60°C, and weighed to determine the suspended sediment load (g/L).

A total of 11 sampling trips were taken at the mid-shelf site (GI 94). Samples were collected twice monthly during new and full moons for 3 consecutive nights from April-August 1996 (the peak recruitment period for most reef-associated species in the northern Gulf). Sampling at GC 18 and GI 94, therefore, overlapped monthly from April-June 1996. In addition, during May extra samples during the first quarter and third quarter moon phases were collected, but due to inclement weather, full moon collections were cancelled. At the inner shelf site (ST 54) sampling occurred twice monthly from April-September 1997 (8 trips total), during new and full moon periods over two consecutive nights. Sampling

effort was modified at GI 94 and ST 54 to obtain one (rather than two) subsurface, surface, and off-platform light-trap collection per set.

Samples were collected twice monthly (new and full moon phases) over 2-night periods at Belle Pass from April-September 1997 (11 trips total) simultaneously with the sampling of ST 54. For sampling purposes, the sides of the two, channel jetties were labeled as East Exterior (EE), East Interior (EI), West Interior (WI), and West Exterior (WE). A total of four sampling stations, one on each side of each jetty, were located approximately at the jetty mid-points and were identified during sampling by distinct rock outcroppings that were sprayed with fluorescent paint. Two sets of samples were taken each night. A set included a light-trap and a bow-mounted, pushnet sample at each of the four stations. The order of stations sampled within each set was chosen using a random number table. Light-traps were equipped with a submersible battery that was secured to the top of the light-trap with bungee cords. At each station, a buoyed mooring was used to suspend the light-trap approximately 1 m below the surface as close to the jetty as possible, which was usually within 2 m of the surface-exposed rocks. Light-traps were allowed to fish for 10 minutes. A bow-mounted pushnet (1 m x 1 m, 1000 μm mesh net dyed green) was pushed by an 18 foot boat at approximately 1 m/sec just below the surface along the edge of the jetty for 3-5 minutes, depending upon the density of plankton. A General Oceanics flowmeter (large rotor) was used to determine the volume of water filtered. Salinity (ppt), temperature (°C), dissolved oxygen (% saturation and mg/l), and turbidity (NTU) were measured at each station during each set using a DataSonde 3 Hydrolab and Multiprobe Logger.

Samples collected at outer and mid-shelf platforms were preserved in ethanol with a subsequent change to fresh ethanol within 12-18 hours. Samples collected at the inner shelf platform and the jetties were fixed in 4% buffered formaldehyde and changed over to ethanol within 8-12 hours. Fish were removed from all samples, enumerated, and measured under a dissecting microscope with the aid of an ocular micrometer, and identified to the lowest taxonomic level possible using primarily the taxonomy of Robins et al. (1991). Large samples were split using a Folsom plankton splitter (Van Guelpen et al. 1982). In the event that the number of fish in a sample or a split was greater than 50 for any single species, the largest, smallest and a random subsample of 50 individuals were measured. Preflexion larvae were measured to the end of the notochord (NL) and all postflexion larvae, juveniles, and adults were

measured to the posterior end of the vertebral column (SL). Light-trap samples were standardized to a catch-per-unit-effort (CPUE) of fish per 10 min. Plankton net and pushnet samples were standardized to the number of fish per 100 m^3 (density). This core sampling sequence formed the basis of the sampling protocols at all other platforms. Sea states, adverse weather, transportation delays, and platform safety concerns often forced us to suspend some sample collections. Only seven subsurface plankton net collections were taken at the inner shelf platform (April 7-8) because of problems with the monorail rigging and biofouling. Similar gear problems reduced the number of subsurface net samples collected at the outer shelf platform. The number of samples collected by trip, gear type, and depth/location for all platforms and the jetties is summarized in Table 2.2.

Analyses of Data

Due to the very large numbers of clupeiform (Clupeidae and Engraulidae) fishes collected, particularly in light-trap samples, some analyses were run with and without these taxa. These fish are seldom the taxa of interest in studies of hard substrate habitats and their abundances tend to overwhelm the trends of other taxa (Choat et al. 1993). All ANOVA, Tukey's Studentized Range Tests, Student's t-tests, and canonical correlations were run with SAS version 6.12 (SAS 1989).

Studentized t-tests (α=0.05) were used to compare overall plankton net densities between locations (subsurface and surface) within the three platform sites. Light-trap CPUEs were compared between locations (subsurface, surface, and off-platform) within each of the platform sites using an ANOVA model with location as a main effect. Tukey's Studentized Range tests were used to determine which mean light-trap CPUEs were significantly different. Before testing, plankton net densities were log transformed ($\log_{10}(x+1)$) in an effort to conform to model assumptions of normality and homogeneity of variances. Analyses on light-trap CPUEs were run on ranked-transformed data. Plankton net and light-trap analyses were run with and without clupeiform fishes. The same analyses were also run on some of dominant taxa (top three taxa identified at least to the level of genus for each gear location/depth) collected at each of the sites.

Schoener's index of niche overlap was calculated for all sites by combining fish collected by all gears within each site as an indication of the fish assemblage similarity among sites (Schoener 1970). Only fish identified to at least the genus level were used in the analyses. Since this type of analysis can

Table 2.2. Number of samples collected at each site by date, gear type, and depth/location. (Lunar phases: N, new moon; F, full moon; 1, first quarter; 3, last quarter)

	Subsurface Net	Surface Net	Subsurface Light-trap	Surface Light-trap	Off-platform Light-trap	Pushnet
Outer Shelf (GC18) 1995-1996						
Jul 26-29 (N)	0	9	18	18	5	
Aug 25-28 (N)	0	12	18	18	9	
Sep 24-25 (N)	0	12	12	12	6	
Oct 23-25 (N)	9	9	18	18	9	
Nov 21-23 (N)	9	9	18	17	9	
Jan 19 (N)	3	3	6	6	3	
Feb 17-18 (N)	5	5	10	6	4	
Apr 15-18 (N)	0	0	0	0	15	
May 17-20 (N)	2	9	5	5	18	
Jun 18-21 (N)	13	16	14	13	9	
Totals	**41**	**84**	**119**	**113**	**87**	
Mid-Shelf (GI 94) 1996						
Apr 16-18 (N)	6	6	4	8	8	
Apr 26-29 (1)	18	18	18	18	18	
May 10-12 (3)	10	12	12	12	12	
May 17-20 (N)	18	18	18	18	18	
May 24-26 (1)	12	13	12	13	11	
Jun 14-17 (N)	18	18	18	18	18	
Jun 28-Jul 1 (F)	17	17	13	12	13	
Jul 12-15 (N)	17	17	15	13	16	
Jul 29-Aug 1 (F)	11	13	11	12	12	
Aug 12-15 (N)	16	17	15	17	17	
Aug 26-29 (F)	18	19	18	18	18	
Totals	**161**	**168**	**154**	**159**	**161**	
Inner Shelf (ST 54) 1997						
Apr 7-8 (N)	7	7	5	6	8	
May 5-8 (N)	0	15	0	16	12	
May 20-23 (F)	0	18	12	18	10	
Jun 4-5 (N)	0	6	6	6	5	
Jun 20-21 (F)	0	8	6	9	9	
Jul 3-5 (N)	0	5	7	7	3	
Aug 17-20 (F)	0	13	4	12	14	
Sep 3-5 (N)	0	10	9	10	0	
Totals	**7**	**82**	**49**	**84**	**61**	
Jetties (Belle Pass) 1997						
Apr 4-7 (N)				9		9
Apr 21-23 (F)				8		8
May 5-7 (N)				16		16
May 20-22 (F)				16		16
Jun 3-5 (N)				16		16
Jun 20-21 (F)				8		8
Jul 3-5 (N)				16		15
Jul 19-21 (F)				12		15
Aug 1-3 (N)				15		14
Aug 18-20 (F)				16		16
Aug 31-Sep 2 (N)				16		16
Totals				**148**		**149**

be heavily influenced by large abundances of a single species, these analyses were conducted without the most dominant taxa included at each site. At times, sampling effort differed temporally among sites (Table 2.2), so the samples used for comparisons were limited to only those months where samples were collected for both sites in a pairing. For example, only April-August samples were used to compare the outer shelf platform assemblage (GC 18) to the mid-shelf (GI 94), inner shelf (ST 54), and jetty (Belle Pass) assemblages. Full data sets were used in comparisons between the mid-shelf and inner shelf platforms and the jetty site. Shannon-Weiner diversity indices (Magurran 1988) were calculated for each sample collected at all sampling sites. Only fish identified to at least the genus level were used in the analyses. Differences in diversity among sites were analyzed with ANOVA models using site as a main effect. Post-ANOVA tests (Tukey's Studentized Range, $\alpha=0.05$) were used to determine which sites where significantly different in mean taxonomic diversity. Since the intent of the similarity and diversity indices was to characterize the taxonomic assemblages sampled by each gear type, clupeiform fishes were included in these analyses. Taxonomic richness (either at the family or genus/species level) is used in reference to the number of taxa collected.

Canonical correlations were used to determine relationships at each site between plankton net or pushnet densities or light-trap CPUEs for dominant taxa and environmental variables. For the outer shelf (GC 18) and mid-shelf (GI 94) platforms, log-transformed densities of the top 15 taxa (excluding clupeiforms) collected in subsurface and surface plankton nets combined were analyzed along with temperature, salinity, microzooplankton biomass, and total suspended sediments (turbidity). The same analyses were performed for log-transformed CPUEs of the top 15 taxa collected in subsurface and surface light-traps. Occasionally more than 15 taxa were analyzed for light-trap data due to ties in the ranking of CPUEs. For the inner shelf platform (ST 54), the same analyses were performed, but only surface plankton net data were used because there were very few subsurface plankton net samples collected at this site (Table 1.2). The same analyses were performed for the jetty site (Belle Pass), but included Hydrolab measurements of turbidity and dissolved oxygen, and did not include total suspended sediments and zooplankton biomass estimates since these data were not collected at this site. The importance of an environmental variable was based on the magnitude of its correlation with the environmental variate, with the sign of the correlation indicating if the variable was directly (positively)

or inversely (negative) related with the variate. A species was considered to be related to the variate if the absolute value of the inter-set correlation was greater than 0.387 (i.e., the variate predicted 15% or more of the species variation within the model).

RESULTS

Environmental Characterization of Sampling Sites

Mean temperatures varied seasonally at all platforms and at the jetty site and were similar between sites for the late spring and summer months (Figure 2.2). At the outer shelf platform (GC 18), the only platform sampled during all seasons, mean temperatures peaked at 31.8 °C in July 1995 and steadily decreased to a mean of 19.2 °C in January 1996. Mean temperatures rose throughout the spring to 29.1 °C by the end of the sampling effort in June 1996. Mean temperatures for the late spring and summer months (April-September), the same months sampled at the other sites, ranged from 21.5-31.8 °C. At the mid-shelf platform (GI 94), temperatures ranged from a mean low of 20.8 °C in April to a mean high of 30.7 °C in July. At the inner shelf platform (ST 54), mean temperatures ranged from 22.3 °C in May to 31.6 °C in August. Similarly at the Belle Pass jetties temperatures ranged from a mean low of 20.2 °C in April to a mean high of 32.8 °C in August.

Mean surface salinities at GC 18 (outer shelf) were relatively stable ranging from 34.8-36.6 ppt for most of the sampling trips (Figure 2.3). However, surface salinity means during June and August 1995 were relatively low (24.3-28.4 ppt) for shelf break waters. These low salinity values were associated with a visibly "green" water mass that pulsed through the area. This water mass was further characterized by high abundances of cnidarians, ctenophores, and patches of *Sargassum*. Similarly, mean salinity values for GI 94 (mid-shelf) ranged from 35.2-36.0 ppt for much of the sampling season, but also experienced pulses of relatively low salinity water. Lower mean surface salinities were recorded for ST 54 (inner shelf) and Belle Pass (jetties) and ranged from 22.7-28.5 ppt and 18.0-26.2 ppt, respectively.

Mean microzooplankton biomass estimates were generally low, with little variation within each platform site (Figure 2.4). At GC 18 (outer shelf), estimates ranged between 0.03-0.29 g/m^3, with a peak in July 1995. Even less variation was observed at GI 94 (mid-shelf), where microzooplankton biomass estimates ranged from 0.03-0.10 g/m^3. The greatest variation in microzooplankton biomass was observed at ST 54 (inner shelf) where estimates ranged from 0.11-0.17 g/m^3, with the exception of two peaks of

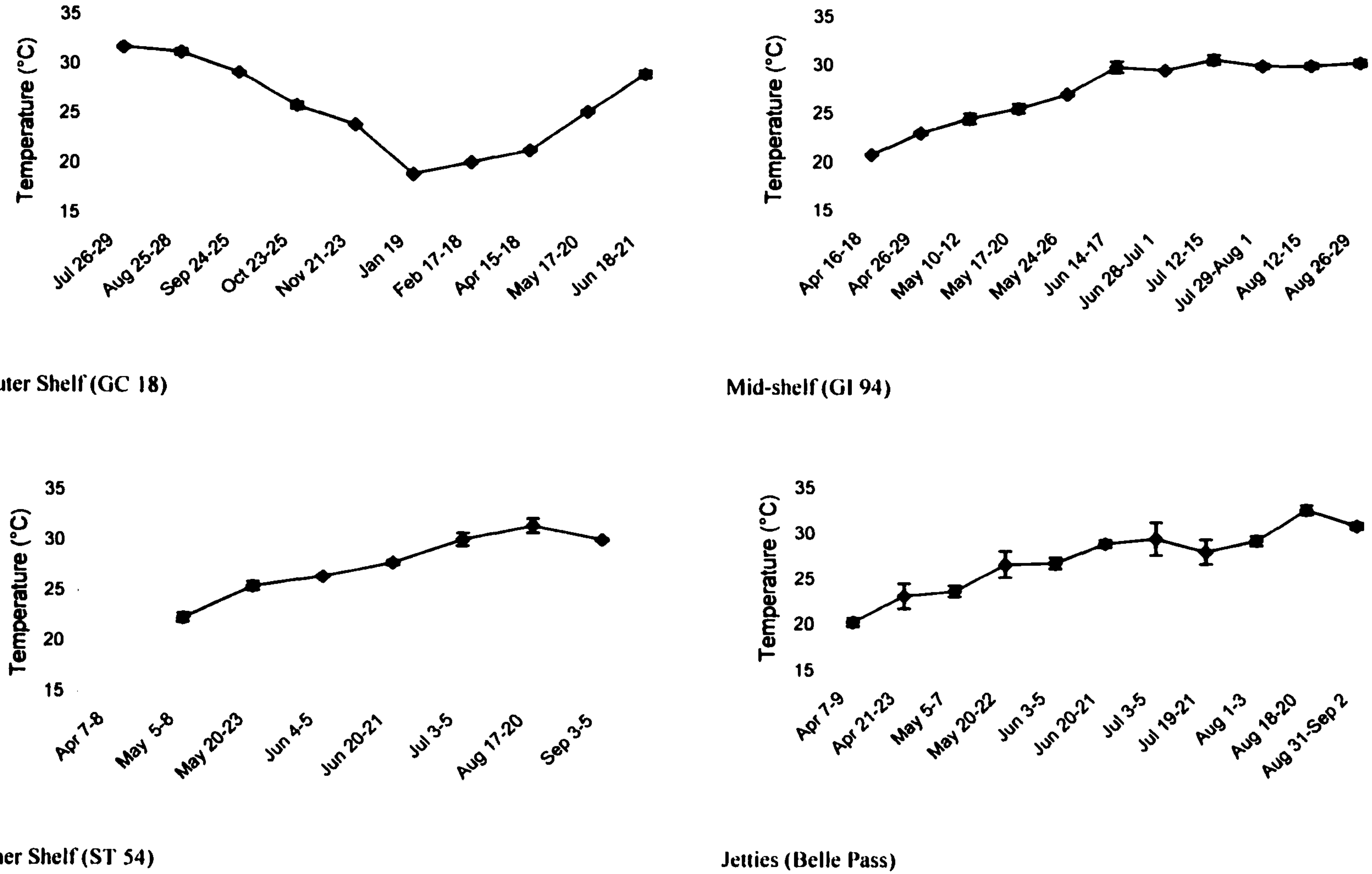


Figure 2.2. Mean surface temperatures (and standard errors) for each sampling site.

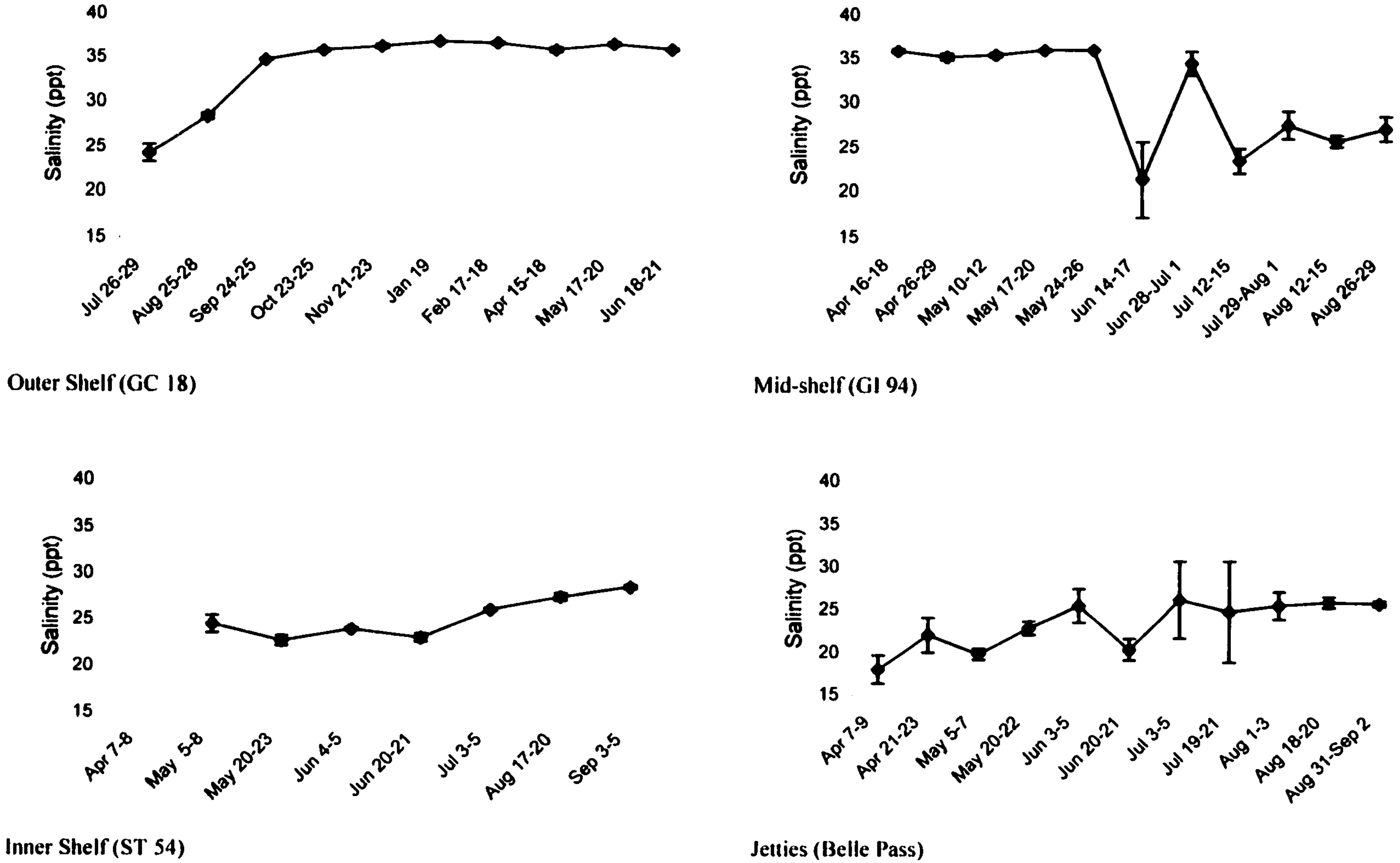
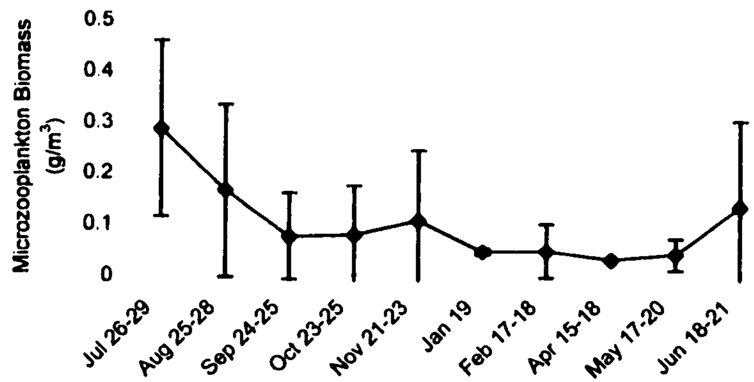
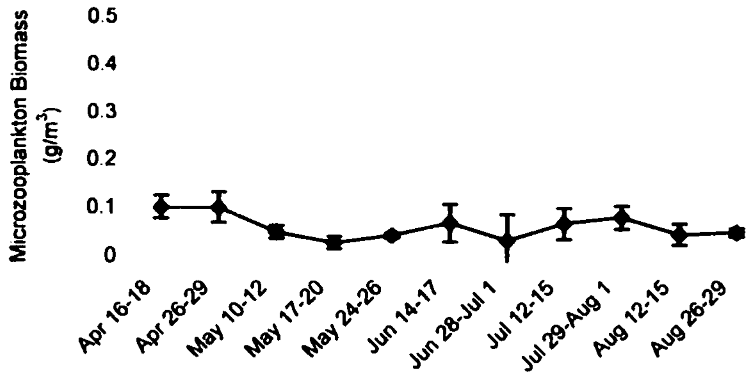


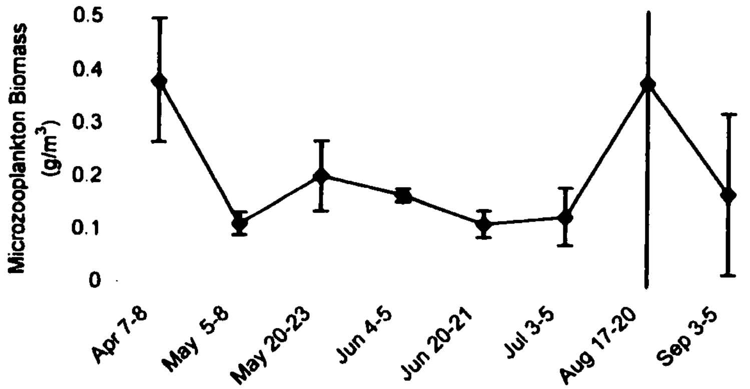
Figure 2.3. Mean surface salinities (and standard errors) for each sampling site.



Outer Shelf (GC 18)



Mid-shelf (GI 94)



Inner Shelf (ST 54)

Figure 2.4. Mean microzooplankton biomass (and standard errors) for each platform site.

0.38 g/m^3 in April and August. Microzooplankton biomass samples were not collected for the Belle Pass jetty site.

Mean suspended sediment values (turbidity estimates) did not vary greatly either within sites or between sites (Figure 2.5). At GC 18 (outer shelf), mean suspended sediments concentrations ranged from approximately 0.01-0.02 g/L, with the exception of a peak of approximately 0.05 g/L in February. At GI 94 (mid-shelf) and ST 54 (inner shelf), mean suspended sediment concentrations fluctuated slightly throughout the sampling season but only ranged from approximately 0.01-0.03 g/L. At the Belle Pass jetties, mean turbidity measurements (NTU) ranged from 10.4-19.0 NTU, with the exception of a large turbidity peak in April (40.0 NTU) and two smaller peaks in June (26.2 NTU) and July (30.8 NTU).

Larval and Juvenile Fish Collected at the Outer Shelf Platform (GC 18)

A total of 5,057 fish were collected at the outer shelf platform (GC 18) over the course of the year (Table 2.3). Light-traps and plankton nets collected 1,114 and 3,943 fish, respectively. Plankton nets collected fish from 45 different families, 15 of which were not collected with light-traps. Light-traps collected fish from 37 different families, 7 of which were only collected with light-traps. Plankton nets collected fish from 64 taxa (identified at least to genus), 25 of which were not collected with light-traps, while light-traps collected fish from 59 taxa with 18 being unique to light-trap collections.

The ichthyoplankton community at GC 18 (located in 230 m water depth on the shelf slope) was dominated by coastal pelagic species, particularly engraulids and clupeids which accounted for 33% and 25% of the total catch by both gear types, respectively. *Opisthonema oglinum* was the dominant species in the mid-to-late summer months, while unidentified engraulids peaked in November. *Engraulis eurystole* was also relatively common throughout the summer and early fall. Gobies and *Mugil cephalus* were among the most common non-clupeiform fishes in the plankton net collections. *Mugil cephalus* was relatively common in the fall-winter months and peaked in November. The carangids *Caranx crysos* and *C. hippos/latus* were relatively common, and though they are usually considered pelagic species, they congregate around platform structures (Table 1.1).

Some of the more abundant demersal taxa included the flatfish *Citharichthys spilopterus*, *Symphurus* spp., and *Syacium* spp., as well as the sciaenid *Sciaenops ocellatus* and bregmacerotid *Bregmaceros cantori*. While not unique to this site, the mesopelagic species, *Cyclothone braueri*, was

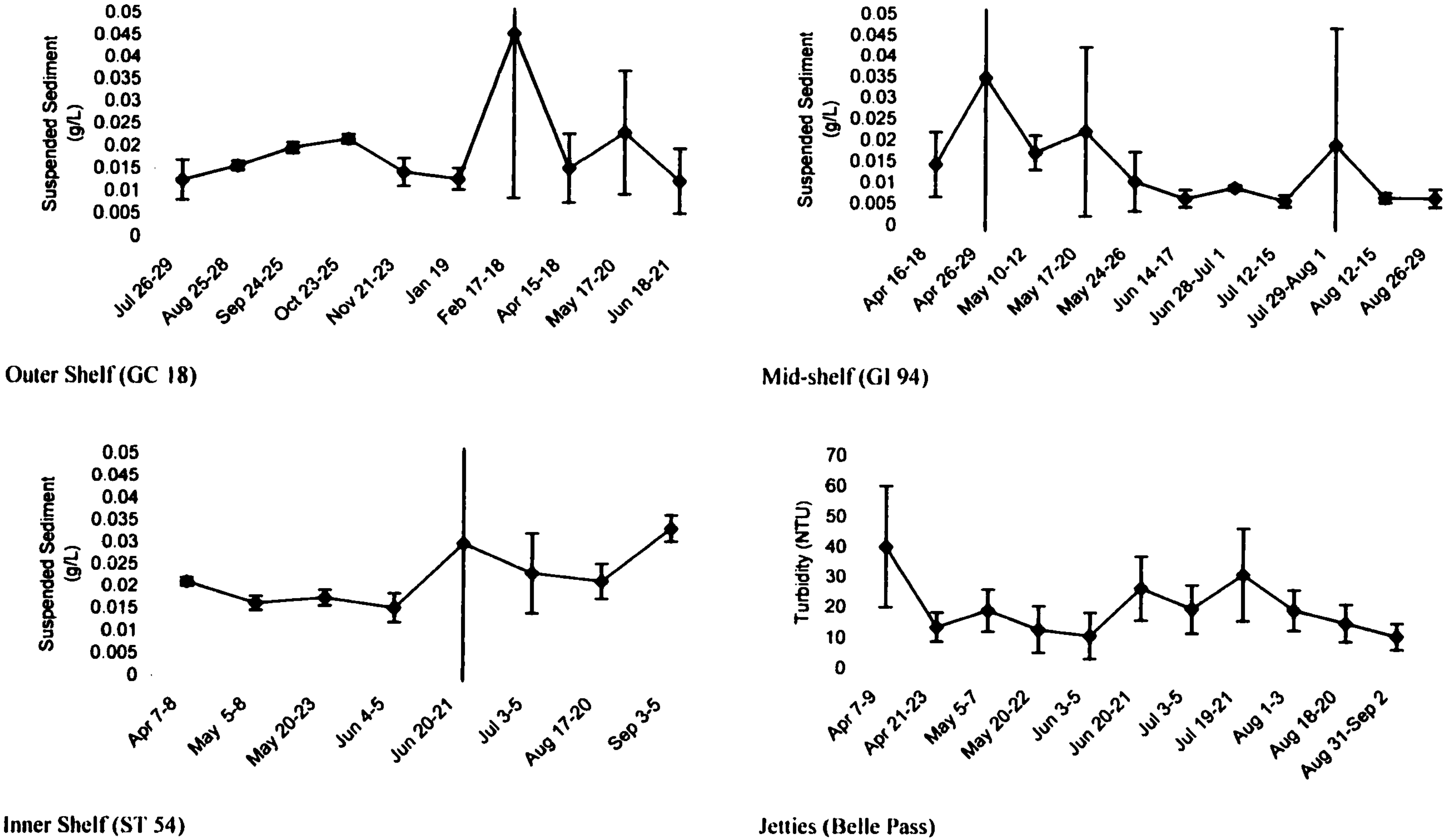


Figure 2.5. Mean suspended sediments (and standard errors) for each platform site and mean surface turbidity (and standard errors) for the Belle Pass jetty site.

Table 2.3. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for fish collected at Green Canyon 18 with standard error (SE), rank, percent of total catch (%), and months collected for each taxa. (N) indicates taxa collected only with plankton nets. (L) indicates taxa collected only with light-traps. For ranks, tied values received the mean of the corresponding ranks. ‡ indicates a value <1.00%.

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Osteichthyes						
Unidentified	Feb, Apr. Jun, Jul, Aug, Sep, Oct, Nov	0.85 (0.39) 23 ‡	4.93 (2.73) 6 (1.54)	0.08 (0.04) 7 (3.27)	0.02 (0.01) 41.5 ‡	0.26 (0.16) 4 (8.36)
Elopiformes						
Elopidae						
Elops saurus (N) (ladyfish)	Oct	0 (0)	0.35 (0.35) 35 ‡	0 (0)	0 (0)	0 (0)
Anguilliformes						
Unidentified (eel)	Jul, Oct, Nov	1.57 (0.72) 13 ‡	4.32 (2.46) 9 ‡	<0.01 (0.01) 28.5 ‡	0.02 (0.01) 41.5 ‡	0.01 (0.01) 40.5 ‡
Moringuidae						
Neoconger mucronatus (ridged eel)	Oct	0.21 (0.21) 52 ‡	0 (0)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Muraenidae						
Unidentified (moray eel)	Jun, Jul, Aug, Sep, Oct	0.02 (0.02) 85 ‡	0 (0)	<0.01 (0.01) 28.5 ‡	0.03 (0.02) 33 ‡	0.02 (0.02) 25 ‡
Ophichthidae						
Unidentified (snake eel)	Jul, Oct, Nov	1.09 (0.71) 19 ‡	2.87 (1.27) 11 ‡	0 (0)	0.05 (0.02) 22 (1.06)	0 (0)
Myrophis punctatus (L) (speckled worm eel)	Feb	0 (0)	0 (0)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Ophichthus gomesi (L) (shrimp eel)	Jul	0 (0)	0 (0)	<0.01 (0.01) 28.5 ‡	0.03 (0.03) 33 ‡	0 (0)
Congridae						
Unidentified (L) (conger eel)	Jul	0 (0)	0 (0)	0 (0)	0.03 (0.02) 33 ‡	0 (0)
Clupeiformes						
Unidentified (herring/anchovy)	Jul, Sep	1.08 (0.92) 20 (1.08)	0 (0)	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Clupeidae						
Brevoortia patronus (gulf menhaden)	Jan, Feb, Nov	1.12 (0.55) 18 ‡	2.44 (1.21) 12 ‡	0 (0)	0.03 (0.02) 33 ‡	0.02 (0.02) 25 ‡
Etrumeus teres (N) (round herring)	Jan, Feb	1.16 (1.05) 16 ‡	0.19 (0.19) 42.5 ‡	0 (0)	0 (0)	0 (0)

Table 2.3. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Harengula jaguana	Jul, Aug	0.06 (0.04)	0 (0)	<0.01 (0.01)	0.15 (0.06)	0 (0)
(scaled sardine)		71 ‡		28.5 ‡	11.5 (3.01)	
Opisthonema oglinum	Jul, Aug, Sep	39.41 (16.26)	0 (0)	0.11 (0.06)	0.42 (0.11)	0.28 (0.11)
(Atlantic thread herring)		1 (38.40)		4 (4.73)	3 (8.51)	2.5 (8.73)
Engraulidae						
Unidentified	Feb, Jun, Jul, Aug, Sep Oct,	39.21 (12.21)	57.18 (26.10)	0.46 (0.11)	0.51 (0.15)	0.28 (0.13)
(anchovy)	Nov	2 (24.32)	1 (53.90)	2 (20.00)	1 (10.28)	2.5 (8.73)
Anchoa spp. (L.)	Jul	0 (0)	0 (0)	0.07 (0.07)	0 (0)	0 (0)
(anchovy spp.)				8 (2.91)		
Anchoa mitchilli	Jul	0.03 (0.03)	0 (0)	0 (0)	0.15 (0.12)	0 (0)
(bay anchovy)		79 ‡			11.5 (3.01)	
Anchoa nasuta/hepsetus (L.)	Jul, Aug, Sep, Nov	0 (0)	0 (0)	0.80 (0.31)	0.22 (0.12)	0.16 (0.10)
(longnose/striped anchovy)				1 (34.91)	8 (4.43)	8 (5.09)
Engraulis eurystole	Jun, Jul, Aug, Sep, Oct	0.34 (0.30)	8.63 (8.63)	0.15 (0.04)	0.25 (0.11)	0.02 (0.02)
(silver anchovy)		42 ‡	5 (9.45)	3 (6.55)	5 (5.14)	25 ‡
Stomiiformes						
Gonostomatidae						
Cyclothone braueri	Jan, May, Jun, Jul, Oct, Nov	1.01 (0.65)	3.05 (1.55)	0 (0)	0.23 (0.21)	0 (0)
		21 ‡	10 ‡		7 (4.61)	
Diplophos taenia (N)	Nov	0.29 (0.29)	0.41 (0.41)	0 (0)	0 (0)	0 (0)
		44.5 ‡	31 ‡			
Aulopiformes						
Chlorophthalmidae						
Chlorophthalmus agassizi (N)	Jun, Nov	0 (0)	0.70 (0.61)	0 (0)	0 (0)	0 (0)
(shortnose greeneye)			24 ‡			
Scopelarchidae						
Scopelarchoides spp. (N)	Jan	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(pearleye spp.)		80 ‡				
Synodontidae						
Unidentified	Jan, May, Jul, Oct	0.27 (0.16)	0.61 (0.61)	<0.01 (0.01)	<0.01 (0.01)	0 (0)
(lizardfish)		46 ‡	26 ‡	28.5 ‡	55 ‡	
Saurida brasiliensis		<0.01 (<0.01)	0 (0)	0.03 (0.02)	0.20 (0.14)	0 (0)
(largescale lizardfish)		92 ‡		12.5 (1.09)	9 (4.08)	
Synodus synodus	Jun	0.29 (0.29)	0 (0)	0 (0)	0.03 (0.02)	0 (0)
(red lizardfish)		44.5 ‡			33 ‡	

Table 2.3. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Trachinocephalus myops (snakefish)	Sep, Oct	0.10 (0.10) 63 ‡	0 (0)	0 (0)	0.04 (0.02) 25 ‡	0.03 (0.02) 19 (1.09)
Paralepidae						
Unidentified (N) (barracudina)	Nov	0.26 (0.26) 47 ‡	0.41 (0.41) 31 ‡	0 (0)	0 (0)	0 (0)
Paralepis atlantica (L) (duckbill barracudina)	Jul	0 (0)	0 (0)	0.02 (0.01) 18 ‡	0 (0)	0 (0)
Lestrolepis intermedia (L)	Jul	0 (0)	0 (0)	0.02 (0.02) 18 ‡	0 (0)	0 (0)
Myctophiformes						
Myctophidae						
Unidentified (lanternfish)	Jan, Feb, Apr, May, Jun, Jul, Sep, Nov	0.83 (0.45) 24 ‡	0.31 (0.22) 36 ‡	0.03 (0.02) 12.5 (1.09)	0.04 (0.02) 27.5 ‡	0.17 (0.06) 7 (5.45)
Gadiformes						
Unidentified (N)	Sep, Oct	0.19 (0.15) 55 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Bregmacerotidae						
Bregmaceros cantori (codlet)	Jan, May, Aug, Sep, Oct	1.80 (0.88) 11 (1.08)	2.42 (1.21) 13 ‡	0.03 (0.02) 11 (1.45)	<0.01 (0.01) 55 ‡	0.05 (0.02) 15.5 (1.45)
Merlucciidae						
Unidentified (L) (whiting)	Nov	0 (0)	0 (0)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Ophidiidae						
Unidentified (N) (cuskeel)	May	<0.01 (<0.01) 89.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Lepophidium spp. (cusk-eel spp.)	Aug, Sep, Oct	0.43 (0.27) 37 ‡	1.30 (0.94) 17 ‡	0.02 (0.01) 18 ‡	0 (0)	0.01 (0.01) 40.5 ‡
Bythitidae						
Unidentified (brotula)	Oct, Nov	0.33 (0.23) 43 ‡	0.41 (0.41) 31 ‡	<0.01 (0.01) 28.5 ‡	<0.01 (0.01) 55 ‡	0.01 (0.01) 40.5 ‡
Lophiiformes						
Unidentified	May, Aug	<0.01 (<0.01) 92 ‡	0 (0)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Gobiesociformes						
Gobiesocidae						

Table 2.3. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Gobiesox strumosus (L) (skilletfish)	Jul	0 (0)	0 (0)	0 (0)	0.08 (0.08) 16 (1.60)	0 (0)
Atheriniformes						
Exocoetidae						
Unidentified (flyingfish)	Jun, Aug, Sep	0.63 (0.40) 31 ‡	0.27 (0.20) 38 ‡	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Cypselurus cyanopterus (L) (margined flyingfish)	Jul	0 (0)	0 (0)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Cypselurus furcatus heterurus (L) (spotfin/Atlantic flyingfish)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Parexocoetus brachypterus (L) (sailfin flyingfish)	Jul	0 (0)	0 (0)	0 (0)	0.04 (0.02) 27.5 ‡	0 (0)
Beryciformes						
Holocentridae						
Holocentrus spp. (squirrelfish)	Jun	0.18 (0.10) 56 ‡	0 (0)	0 (0)	0.07 (0.04) 18 (1.42)	0.11 (0.05) 11 (3.64)
Melamphaidae						
Melamphaes spp. (N)	Jan, Jun	0.05 (0.04) 73 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Scorpaeniformes						
Unidentified (N)	Oct	0.24 (0.17) 48 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Scorpaenidae						
Unidentified (N) (scorpionfish)	Oct	0.08 (0.08) 68 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Scorpaena spp. (N) (scorpionfish spp.)	Jun, Aug	0.09 (0.07) 67 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Triglidae						
Prionotus spp. (N) (searobin)	May	0.01 (0.01) 87.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Perciformes						
Unidentified	Jan, May, Jun, Jul, Aug, Sep, Oct	2.60 (1.27) 9 (1.11)	1.48 (0.64) 16 (1.23)	0.09 (0.05) 5.5 (4.00)	0.03 (0.02) 33 ‡	0.02 (0.02) 25 ‡
Serranidae						
Unidentified (sea bass/grouper)	Jan, Jun, Oct, Nov	0.22 (0.14) 50 ‡	1.86 (1.28) 15 ‡	0 (0)	<0.01 (0.01) 55 ‡	0 (0)

Table 2.3. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Anthinae	Apr, May, Jun, Nov	0.46 (0.19)	0.38 (0.23)	0 (0)	<0.01 (0.01)	0.02 (0.02)
(sea perch)		34 ‡	33 ‡		55 ‡	25 ‡
Epinephelinae (N)	May, Jun	0.41 (0.23)	0.23 (0.13)	0 (0)	0 (0)	0 (0)
(grouper)		38 ‡	39 ‡			
Grammistinae (N)	Jun	0 (0)	0.14 (0.10)	0 (0)	0 (0)	0 (0)
			48 ‡			
Priacanthidae						
Unidentified (N)	May, Jun	0.10 (0.07)	0.08 (0.08)	0 (0)	0 (0)	0 (0)
(bigeye)		64 ‡	53 ‡			
Priacanthus spp. (L)	Jun	0 (0)	0 (0)	0 (0)	<0.01 (0.01)	0 (0)
(bigeye/glasseye spp.)					55 ‡	
Apogonidae						
Unidentified (N)	May	<0.01 (<0.01)	0 (0)	0 (0)	0 (0)	0 (0)
(cardinalfish)		89.5 ‡				
Apogon spp. (N)	May	<0.01 (<0.01)	0 (0)	0 (0)	0 (0)	0 (0)
(cardinalfish spp.)		92 ‡				
Pomatomidae						
Pomatomus saltatrix (L)	Sep, Oct	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (0.03)
(bluefish)						15.5 (1.45)
Echeneidae						
Unidentified (N)	Jun	0.14 (0.10)	0 (0)	0 (0)	0 (0)	0 (0)
(remora)		59.5 ‡				
Carangidae						
Unidentified (N)	May, Jun, Jul	0.41 (0.28)	0.23 (0.16)	0 (0)	0 (0)	0 (0)
(jack)		39 ‡	40 ‡			
Caranx spp.	May, Jun	0 (0)	0.07 (0.07)	0 (0)	0 (0)	0.01 (0.01)
(jack spp.)			56 ‡			40.5 ‡
Caranx crysos	Jun, Jul, Aug, Sep	2.75 (1.30)	0.56 (0.49)	<0.01 (0.01)	0.24 (0.08)	0.30 (0.10)
(blue runner)		8 ‡	27 ‡	28.5 ‡	6 (4.79)	1 (9.45)
Caranx hippos/latus	May, Jun, Jul, Aug, Oct	1.89 (0.65)	4.45 (1.62)	<0.01 (0.01)	0.08 (0.03)	0.22 (0.06)
(crevalle/horse-eye jack)		10 (1.85)	8 (4.31)	28.5 ‡	16 (1.60)	5 (6.91)
Chloroscombrus chrysurus	Jun, Jul, Aug, Sep	0.57 (0.24)	0 (0)	0 (0)	0.03 (0.02)	0 (0)
(Atlantic bumper)		33 ‡			33 ‡	
Decapterus punctatus	Jun, Jul	0.03 (0.03)	0 (0)	<0.01 (0.01)	<0.01 (0.01)	0 (0)
(round scad)		77.5 ‡		28.5 ‡	55 ‡	

Table 2.3. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Elagatis bipinnulata (rainbow runner)	May	0.19 (0.12) 54 ‡	0 (0)	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Selar crumenopthalmus (N) (bigeye scad)	May, Jun	0.02 (0.02) 86 ‡	0.19 (0.19) 42.5 ‡	0 (0)	0 (0)	0 (0)
Selene vomer (N) (lookdown)	Sep	0.24 (0.24) 49 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Seriola spp. (jack spp.)	May, Jun, Aug, Oct	0.11 (0.06) 62 ‡	0.44 (0.36) 28 ‡	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Trachurus lathami (rough scad)	Jan, Feb, Apr, May	0.12 (0.07) 61 ‡	0.19 (0.19) 42.5 ‡	0 (0)	<0.01 (0.01) 55 ‡	0.02 (0.02) 25 ‡
Coryphaenidae						
Coryphaena equiselis (N) (pompano dolphin)	May	0.01 (0.01) 87.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Coryphaena hippurus (N) (dolphin)	Jun, Sep	0.09 (0.07) 65 ‡	0.09 (0.09) 51 ‡	0 (0)	0 (0)	0 (0)
Lutjanidae						
Unidentified (snapper)	Feb, May	0.04 (0.04) 76 ‡	0.03 (0.03) 58 ‡	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Lutjanus spp. (snapper spp.)	Jun	0.14 (0.10) 59.5 ‡	0.19 (0.19) 42.5 ‡	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Lutjanus apodus vivanus (L) (schoolmaster/silk snapper)	Jul	0 (0)	0 (0)	0 (0)	0.02 (0.01) 41.5 ‡	0 (0)
Lutjanus campechanus (L) (red snapper)	Sep	0 (0)	0 (0)	0 (0)	0.02 (0.02) 41.5 ‡	0 (0)
Pristipomoides aquilonaris (N) (wenchman)	Jun, Oct	0.91 (0.71) 22 ‡	1.95 (0.88) 14 (2.16)	0 (0)	0 (0)	0 (0)
Rhomboplites aurorubens (N) (vermillion snapper)	Jul	0.05 (0.05) 72 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Gerreidae						
Eucinostomus spp. (L) (jenny/mojarra spp.)	Jun, Jul, Sep	0 (0)	0 (0)	0 (0)	0.05 (0.02) 22 (1.06)	0.10 (0.07) 12 (3.27)
Sparidae						
Unidentified (N) (porgy)	May	0 (0)	0.07 (0.07) 56 ‡	0 (0)	0 (0)	0 (0)
Lagodon rhomboides (N) (pinfish)	Jan	0.17 (0.14) 57 ‡	0.38 (0.38) 34 ‡	0 (0)	0 (0)	0 (0)

Table 2.3. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Sciaenidae						
Cynoscion arenarius	Jul, Aug	1.51 (0.66)	0 (0)	0 (0)	0.04 (0.02)	0 (0)
(sand seatrout)		14 (2.09)			25 ‡	
Leiostomus xanthurus	Jan	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (0.01)
(spot)						40.5 ‡
Micropogonias undulatus	Oct	0.45 (0.23)	0.30 (0.30)	0.02 (0.01)	<0.01 (0.01)	0.02 (0.02)
(Atlantic croaker)		35 ‡	37 ‡	18 ‡	55 ‡	25 ‡
Sciaenops ocellatus	Sep	4.11 (1.92)	0 (0)	0 (0)	<0.01 (0.01)	0 (0)
(red drum)		5 (3.70)			55 ‡	
Mullidae						
Unidentified (L)	Jun	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (0.01)
(goatfish)						40.5 ‡
Upeneus parvus (L)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (0.01)
(dwarf goatfish)						40.5 ‡
Ephippidae						
Chaetodipterus faber (N)	May, Jul	0.05 (0.04)	0 (0)	0 (0)	0 (0)	0 (0)
(Atlantic spadefish)		74 ‡				
Chaetodontidae						
Unidentified (N)	Jun	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(butterfly fish)		77.5 ‡				
Pomacentridae						
Pomacentrus spp. (L)	Jun, Jul	0 (0)	0 (0)	0.02 (0.01)	0.14 (0.08)	0.03 (0.03)
(damselfish spp.)				18 ‡	13 (2.84)	19 (1.09)
Mugilidae						
Mugil cephalus	Jan, Feb, Oct, Nov	8.27 (4.58)	32.05 (15.62)	0 (0)	0.04 (0.02)	0.14 (0.06)
(striped mullet)		3 ‡	2 (5.54)		25 ‡	9.5 (4.36)
Sphyraenidae						
Sphyraena guachancho	Jun, Jul	0.44 (0.39)	0.08 (0.08)	0 (0)	0.03 (0.03)	0.01 (0.01)
(guaguanche)		36 ‡	53 ‡		33 ‡	40.5 ‡
Scaridae						
Unidentified	Aug, Oct, Nov	3.01 (1.35)	16.31 (5.64)	<0.01 (0.01)	0.06 (0.03)	0 (0)
(parrotfish)		7 ‡	3 (3.08)	28.5 ‡	19.5 (1.24)	
Blenniidae						
Unidentified	May, Jun, Jul, Sep, Oct	0.34 (0.19)	0.98 (0.98)	0.06 (0.06)	0.17 (0.15)	0.01 (0.01)
(blenny)		41 ‡	19 ‡	9.5 (2.55)	10 (3.37)	40.5 ‡

Table 2.3. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Hypsoblennius invemar	Jun, Oct	0 (0)	0.08 (0.08)	0 (0)	0 (0)	0.01 (0.01)
(tessellated blenny)			53 ‡			40.5 ‡
Ophioblennius atlanticus	Jun, Oct	0.65 (0.47)	0 (0)	0 (0)	<0.01 (0.01)	0.01 (0.01)
(redlip blenny)		29 ‡			55 ‡	40.5 ‡
Callionymidae						
Foetorepus agassizi (N)	Aug	0.05 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(spotfin dragonet)		75 ‡				
Paradiplogramus bairdi (N)	Aug	0.03 (0.02)	0 (0)	0 (0)	0 (0)	0 (0)
(lancer dragonet)		84 ‡				
Gobiidae						
Unidentified	Jan, Feb, Apr, Jun, Jul, Aug,	4.63 (1.78)	11.08 (3.87)	0.09 (0.04)	0.44 (0.40)	0.05 (0.02)
(goby)	Oct Nov	4 (2.02)	4 (4.41)	5.5 (4.00)	2 (8.87)	15.5 (1.45)
Microdesmidae						
Microdesmus spp. (N)	Jun, Aug	0.03 (0.03)	0.75 (0.52)	0 (0)	0 (0)	0 (0)
(wormfish spp.)		83 ‡	23 ‡			
Microdesmus lanceolatus (N)	Jun, Jul, Aug	0.65 (0.41)	0.15 (0.11)	0 (0)	0 (0)	0 (0)
(lancetail wormfish)		28 ‡	47 ‡			
Microdesmus longipinnis	Jul	0.04 (0.06)	0 (0)	0 (0)	0.05 (0.03)	0.02 (0.02)
(pink wormfish)		70 ‡			22 (1.06)	25 ‡
Scombridae						
Unidentified	May, Jun, Jul, Aug, Sep	1.75 (1.01)	0.75 (0.75)	0 (0)	0.01 (0.01)	0.02 (0.01)
(mackerel)		12 (2.73)	22 ‡		41.5 ‡	40.5 ‡
Acanthocybium solandri	Jun	0 (0)	0.09 (0.09)	0 (0)	0 (0)	0 (0)
(wahoo)			49.5 ‡			
Auxis spp.	May, Jun, Aug, Sep, Oct	1.41 (0.42)	0.94 (0.50)	0.02 (0.01)	0.40 (0.13)	0.14 (0.04)
(mackerel spp.)		15 (1.99)	20 ‡	18 ‡	4 (8.16)	9.5 (4.36)
Euthynnus alletteratus	May, Jun, Jul, Aug, Sep, Oct	0.65 (0.25)	0.09 (0.09)	0 (0)	0.06 (0.02)	0.18 (0.08)
(little tunny)		30 ‡	49.5 ‡		19.5 (1.24)	6 (5.82)
Scomberomorus cavalla	Aug	0.09 (0.07)	0 (0)	(<0.01) (0.01)	0.02 (0.02)	0.03 (0.03)
(king mackerel)		66 ‡		28.5 ‡	41.5 ‡	19 (1.09)
Scomberomorus maculatus	Jul, Aug	0.75 (0.42)	0 (0)	0 (0)	0.02 (0.01)	0 (0)
(Spanish mackerel)		26 ‡			41.5 ‡	
Thunnus spp.	May, Jun	0.01 (0.02)	0.17 (0.12)	0 (0)	0.02 (0.01)	0.03 (0.01)
(tuna spp.)		82 ‡	46 ‡		41.5 ‡	40.5 ‡
Thunnus thynnus (N)	Jun	0.06 (0.07)	0.18 (0.18)	0 (0)	0 (0)	0 (0)
(bluefin tuna)		69 ‡	45 ‡			

Table 2.3. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Stromateidae						
Ariomma spp. (driftfish spp.)	Apr, May	0.77 (0.52) 25 (2.16)	0.44 (0.36) 29 ‡	0 (0)	0 (0)	0.02 (0.02) 25 ‡
Nomeidae						
Cubiceps pauciradiatus (N) (bigeye cigarfish)	May	0.03 (0.03) 81 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Peprilus burti (gulf butterfish)	Jan, Jun, Aug, Oct, Nov	0.72 (0.34) 27 ‡	1.05 (0.64) 18 ‡	0.02 (0.01) 18 ‡	0.03 (0.02) 33 ‡	0.05 (0.03) 15.5 (1.45)
Tetragonuridae						
Tetragonurus atlanticus (N) (bigeye squaretail)	Nov	0.20 (0.20) 53 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Pleuronectiformes						
Bothidae						
Unidentified (lefteye flounder)	Jul, Oct, Nov	0.59 (0.59) 32 ‡	0.81 (0.81) 21 ‡	<0.01 (0.01) 28.5 ‡	0 (0)	0 (0)
Bothus spp. (flounder spp.)	May, Sep, Oct, Nov	0.17 (0.17) 58 ‡	0 (0)	0.02 (0.01) 18 ‡	0 (0)	0.01 (0.01) 40.5 ‡
Citharichthys spilopterus (baywhiff)	Feb, Oct, Nov	1.14 (0.92) 17 ‡	4.85 (1.98) 7 (1.44)	0 (0)	<0.01 (0.01) 55 ‡	0 (0)
Etropus crossotus (fringed flounder)	Aug, Nov	0.39 (0.39) 40 ‡	0 (0)	0 (0)	0 (0)	0.01 (0.01) 40.5 ‡
Monolene sessilicauda (L) (deepwater flounder)	Feb	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.01) 40.5 ‡
Syacium spp. (flounder spp.)	Jul, Aug, Sep	0.22 (0.12) 51 ‡	0 (0)	0.02 (0.01) 18 ‡	0.08 (0.05) 16 (1.60)	0.01 (0.01) 40.5 ‡
Soleidae						
Symphurus spp. (tonguefish spp.)	Feb, Jul, Aug, Sep, Oct	3.03 (1.16) 6 (2.02)	0.70 (0.70) 25 ‡	0.06 (0.05) 9.5 (2.55)	0.10 (0.04) 14 (1.95)	0.07 (0.03) 13 (2.18)
Tetraodontiformes						
Tetraodontidae						
Sphoeroides spp. (N) (puffer spp.)	May	0 (0)	0.07 (0.07) 56 ‡	(0)	0 (0)	0 (0)

common in subsurface net collections, and myctophids were present in subsurface light-trap collections. Though not abundant, other outer shelf species of note include *Diplophos taenia*, *Chlorophthalamus agassizi*, *Scopelarchoides* spp., *Paralepis atlantica*, and *Lestrolepis intermedia*. While the adults are seldom observed, the planktonic nature of the early life stages of these mesopelagic taxa made them a significant component of the outer shelf ichthyoplankton assemblage at GC 18.

The dominant reef-associated fishes at GC 18 were unidentified gobiids. Second in abundance were serranids, 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 fairly common among the reef fish taxa, 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).

Larval and Juvenile Fish Collected at the Mid-Shelf Platform (GI 94)

A total of 45,754 fish were collected at the mid-shelf platform (GI 94). Light-traps collected 31,353 fish and plankton nets collected 14,401 fish (Table 2.4). Plankton nets collected fish from 40 different families, six of which were not collected by light-traps. Light-traps sampled fish from 37 families, only three of which were not sampled by plankton nets. Plankton nets collected fish from 83 taxa (identified at least to genus), 26 of which were not collected in light-traps, while light-traps collected fish from 90 taxa, 31 of which were not sampled with plankton nets.

At GI 94 (located in 60 m water depth), pelagic species dominated the catches as well, but there appeared to be a taxonomic shift in dominance. Clupeiforms again dominated the collections, but engraulids became more prominent in abundance (57%) than clupeids (9%). Unidentified engraulids were the most abundant pelagic taxa in the plankton nets, and *Engraulis eurystole* were very common in light-trap collections. *Opisthonema oglinum*, which was the most dominant clupeid at the outer shelf platform (GC 18), ranked third in overall abundance. *Caranx crysos* and *C. hippos/latus* were not as dominant at this site as they were at GC 18, but as a family, the carangids had more species richness at GI 94. *Oligoplites saurus*, *Seriola dumerili/rivoliana*, *S. fasciata*, *Trachinotus carolinus*, and *T. falcatus/goodei* were all present at GI 94, but absent at the outer shelf platform (GC 18). Similarly,

Table 2.4. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for fish collected at Grand Isle 94 with standard error (SE), rank, percent of total catch (%), and months collected for each taxa. (N) indicates taxa collected only with plankton nets. (L) indicates taxa collected only with light-traps. For ranks, tied values received the mean of the corresponding ranks. ‡ indicates a value <1.00%.

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Osteichthyes						
Unidentified	Apr, May, Jun, July, Aug	0.92 (0.60)	0.78 (0.41)	0.28 (0.26)	0.13 (0.10)	1.12 (0.94)
		19 ‡	23 (1.31)	10 (1.13)	22 ‡	9 (4.55)
Anguilliformes						
Unidentified (N)	Jun	0.07 (0.07)	0 (0)	0 (0)	0 (0)	0 (0)
(eel)		69 ‡				
Muraenidae						
Unidentified	May, Jun, Jul	0.07 (0.05)	0.44 (0.23)	<0.01 (<0.01)	0 (0)	0 (0)
(moray eel)		71 ‡	33 ‡	49 ‡		
Ophichthidae						
Unidentified	Jun, Jul, Aug	0.10 (0.05)	0.69 (0.35)	0.04 (0.02)	0.02 (0.01)	0 (0)
(snake eel)		55 ‡	26 ‡	26.5 ‡	51 ‡	
Ophichthus spp.	Aug	0 (0)	0 (0)	0 (0)	0.03 (0.02)	0 (0)
(snake eel)					46.5 ‡	
Ophichthus gomesi (N)	Jun	0.01 (0.01)	0 (0)	0 (0)	0 (0)	0 (0)
(shrimp eel)		98 ‡				
Nettastomatidae						
Hoplunnis macrurus (L)	May	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0 (0)
(freckled-pike conger)					61.5 ‡	
Clupeiformes						
Unidentified	Apr, May, Jun, Jul, Aug	2.38 (2.14)	0.05 (0.04)	<0.01 (<0.01)	<0.01 (<0.01)	0 (0)
(herring/anchovy)		12 ‡	69 ‡	58 ‡	81.5 ‡	
Clupeidae						
Unidentified	Apr, May, Aug	0 (0)	0.52 (0.37)	0 (0)	0.01 (<0.01)	0 (0)
(herring)			30 ‡		61.5 ‡	
Brevoortia patronus (L)	Apr	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)	0 (0)
(gulf menhaden)				49 ‡		
Etrumeus teres	Apr	0.08 (0.06)	0.23 (0.16)	0.02 (0.01)	0.03 (0.02)	0.01 (<0.01)
(round herring)		66 ‡	44 ‡	32 ‡	46.5 ‡	51.5 ‡
Harengula jaguana	Apr, Jun, Jul, Aug	0.61 (0.27)	0.31 (0.31)	0.06 (0.02)	0.69 (0.18)	0.68 (0.15)
(scaled sardine)		25 ‡	38.5 ‡	21 ‡	18 ‡	11 (2.76)
Opisthonema oglinum	Apr, Jun, Jul, Aug	70.99 (35.34)	4.81 (1.97)	1.26 (0.85)	6.04 (1.23)	4.11 (1.11)
(Atlantic thread herring)		2 (15.81)	5 (2.20)	6 (4.99)	8 (4.07)	1 (16.66)
Sardinella aurita	Apr, Jul, Aug	0.08 (0.06)	0.16 (0.16)	0 (0)	0.04 (0.02)	0 (0)
(Spanish sardine)		67 ‡	54 ‡		41.5 ‡	

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Engraulidae						
Unidentified	Apr, May, Jun, Jul, Aug	232.66 (44.32)	66.92 (17.27)	0.41 (0.09)	0.55 (0.12)	0.96 (0.17)
(anchovy)		1 (62.01)	1 (24.74)	7 (1.64)	20 ‡	10 (3.92)
***Anchoa* spp.**	Apr, May, Jun, Jul, Aug	14.23 (8.25)	1.21 (0.73)	0.18 (0.17)	0.02 (0.01)	<0.01 (<0.01)
(anchovy spp.)		3 (3.55)	21 ‡	15 ‡	51 ‡	64 ‡
Anchoa hepsetus	Aug	0 (0)	0 (0)	0.10 (0.08)	0.70 (0.49)	0.50 (0.47)
(striped anchovy)				16.5 ‡	16 ‡	12 (2.04)
Anchoa mitchilli	Jun, Jul, Aug	6.24 (2.37)	2.70 (1.03)	0.37 (0.18)	1.89 (0.83)	0.47 (0.23)
(bay anchovy)		6 (1.89)	11 ‡	8 (1.46)	10 (1.27)	14 (1.91)
Anchoa nasuta	Aug	0 (0)	0 (0)	7.80 (6.15)	11.10 (5.93)	1.31 (0.70)
(longnose anchovy)				1 (30.96)	4 (7.47)	6 (5.30)
Anchoa nasuta/hepsetus	Apr, May, Jun, Jul, Aug	5.64 (2.80)	4.59 (1.69)	2.73 (0.52)	30.11 (12.33)	1.45 (0.53)
(longnose/striped anchovy)		8 (1.87)	7 (3.14)	3 (10.88)	2 (20.27)	5 (5.86)
Anchoviella perfasciata	Aug	0 (0)	0 (0)	0 (0)	0.07 (0.07)	0.09 (0.09)
(flat anchovy)					33.5 ‡	24 ‡
Engraulis eurystole	Apr, May, Jun, Jul, Aug	1.93 (1.90)	2.43 (1.12)	5.72 (1.41)	38.79 (13.81)	1.25 (0.48)
(silver anchovy)		13 ‡	12 (1.15)	2 (22.79)	1 (26.12)	7 (5.08)
Stomiiformes						
Gonostomatidae						
***Cyclothone braueri* (N)**	Apr, Jul	0.02 (0.02)	0.11 (0.08)	0 (0)	0 (0)	0 (0)
		94 ‡	60 ‡			
***Vinciguerria nimbaria* (L)**	Apr	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
					81.5 ‡	
Aulopiformes						
Synodontidae						
Unidentified	Apr, May, Jun, Jul, Aug	0.22 (0.08)	2.11 (0.56)	0.10 (0.03)	0.90 (0.39)	0.12 (0.06)
		40 ‡	15 (1.05)	16.5 ‡	14 ‡	21 ‡
Saurida brasiliensis	Apr, May, Jun, Jul, Aug	0.81 (0.22)	4.77 (1.26)	1.97 (0.42)	3.35 (0.51)	0.50 (0.14)
(largescale lizardfish)		21 ‡	6 (4.86)	5 (7.84)	9 (2.27)	13 (2.01)
***Saurida normani* (L)**	Apr, May	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0 (0)
(shortjaw lizardfish)					61.5 ‡	
***Saurida normani/brasiliensis* (L)**	May	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(shortjaw/largescale lizardfish)					81.5 ‡	
***Saurida suspicio* (L)**	May	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
					81.5 ‡	

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Synodus spp.	May, Jun	0 (0)	0.03 (0.03)	<0.01 (<0.01)	0.06 (0.06)	0.04 (0.03)
(lizardfish spp.)			72.5 ‡	49 ‡	37.5 ‡	35.5 ‡
Synodus foetens	Apr, May, Jun, Jul, Aug	0.64 (0.26)	2.12 (0.77)	0.20 (0.06)	22.11 (5.24)	0.20 (0.05)
(inshore lizardfish)		24 ‡	14 (1.20)	12 ‡	3 (14.92)	19 ‡
Synodus poeyi	Apr, May, Jun, Jul, Aug	0.17 (0.13)	1.35 (0.44)	0.34 (0.09)	9.98 (1.78)	0.13 (0.28)
(offshore lizardfish)		47 ‡	17 ‡	9 (1.36)	5 (6.74)	8 (4.57)
Synodus synodus (L)	May	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0 (0)
(red lizardfish)					61.5 ‡	
Trachinocephalus myops (L)	Apr, May, Jun, Aug	0 (0)	0 (0)	0 (0)	0.08 (0.03)	<0.01 (<0.01)
(snakefish)					30.5 ‡	64 ‡
Paralepidae						
Unidentified (N)	May	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(barracudina)		88 ‡				
Lestrolepis intermedia	May, Jun, Aug	0 (0)	0.15 (0.11)	0.02 (0.01)	<0.01 (<0.01)	0 (0)
			56 ‡	32 ‡	81.5 ‡	
Lestrolepis spp. (L)	Aug	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)	0 (0)
(barracudina spp.)				49 ‡		
Myctophiformes						
Unidentified (N)	Jun	0 (0)	0.21 (0.21)	0 (0)	0 (0)	0 (0)
			48 ‡			
Myctophidae						
Unidentified	Apr, May, Jun, Jul, Aug	0.09 (0.05)	0.75 (0.41)	0.03 (0.02)	0.05 (0.02)	0.06 (0.02)
(lanternfish)		60 ‡	25 ‡	28 ‡	40 ‡	29.5 ‡
Gadiformes						
Bregmacerotidae						
Bregmaceros cantori	Apr, May, Jun, Jul, Aug	1.59 (0.42)	16.67 (3.00)	2.18 (1.02)	0.06 (0.02)	0.03 (0.02)
		16 ‡	3 (15.06)	4 (8.68)	35.5 ‡	38.5 ‡
Ophidiiformes						
Ophidiidae						
Unidentified	May, Jun, Jul	0.31 (0.13)	0.21 (0.21)	0 (0)	<0.01 (<0.01)	0 (0)
(cusk-eel)		35 ‡	48 ‡		81.5 ‡	
Lepophidium spp. (N)	Jul	0 (0)	0.13 (0.13)	0 (0)	0 (0)	0 (0)
(cusk-eel spp.)			58.5 ‡			
Lepophidium profundorum (N)	Jun	0.03 (0.02)	0.23 (0.21)	0 (0)	0 (0)	0 (0)
(fawn cusk-eel)		84 ‡	45 ‡			
Lepophidium staurophor (N)	May, Jun, Aug	0.09 (0.06)	0 (0)	0 (0)	0 (0)	0 (0)
		59 ‡				

Table 2.4. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Ophidiinae Type A (N) (cusk-eel spp.)	Jun	0 (0)	0.02 (0.02) 80 ‡	0 (0)	0 (0)	0 (0)
Ophidion nocomis	May, Jun	0 (0)	0.05 (0.05) 68 ‡	0.01 (<0.01) 37 ‡	0 (0)	0 (0)
Ophidion nocomis/selenops (cusk-eel spp.)	May	0.09 (0.06) 63 ‡	0.31 (0.23) 38.5 ‡	0 (0)	<0.01 (<0.01) 81.5 ‡	0 (0)
Ophidion selenops (N) (mooneye cusk-eel)	May, Jun	0 (0)	0.19 (0.14) 50 ‡	0 (0)	0 (0)	0 (0)
Lophiiformes						
Caulophrynidae						
Robia legula (N)	Jul	0 (0)	0.09 (0.08) 61 ‡	0 (0)	0 (0)	0 (0)
Atheriniformes						
Exocoetidae						
Unidentified (flyingfish)	Jun	0.14 (0.07) 51 ‡	0.07 (0.07) 64.5 ‡	0 (0)	0 (0)	0 (0)
Cypselurus spp. (flyingfish spp.)	May, Jun	0 (0)	0.07 (0.07) 64.5 ‡	0 (0)	<0.01 (<0.01) 81.5 ‡	<0.01 (<0.01) 64 ‡
Cypselurus cyanopterus (L) (margined flyingfish)	Jul	0 (0)	0 (0)	0 (0)	<0.01 (<0.01) 81.5 ‡	0 (0)
Beryciformes						
Holocentridae						
Holocentrus spp. (squirrelfish spp.)	May, Jun, Jul	0.18 (0.08) 44 ‡	0 (0)	0.01 (<0.01) 40 ‡	0 (0)	<0.01 (<0.01) 64 ‡
Scorpaeniformes						
Scorpaenidae						
Unidentified (N) (scorpionfish)	May, Jun	0.01 (0.01) 95 ‡	0.16 (0.16) 54 ‡	0 (0)	0 (0)	0 (0)
Scorpaena spp. (scorpionfish spp.)	May, Jul, Aug	0 (0)	0.45 (0.34) 32 ‡	0 (0)	0.01 (<0.01) 61.5 ‡	0 (0)
Triglidae						
Unidentified (N) (searobin)	Jul	0.01 (0.01) 99 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Prionotus spp. (searobin spp.)	Apr	0.21 (0.11) 42 ‡	0.09 (0.09) 62 ‡	0 (0)	<0.01 (<0.01) 81.5 ‡	0 (0)
Perciformes						

Table 2.4. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Unidentified	Apr, May, Jun, Jul, Aug	1.74 (0.69) 15 ‡	2.22 (0.76) 13 (1.41)	0.05 (0.02) 24.5 ‡	0.09 (0.05) 27 ‡	0.04 (0.02) 34 ‡
Serranidae						
Unidentified (N) (seabass/grouper)	Apr, May, Jun	0.08 (0.05) 68 ‡	0.16 (0.13) 52 ‡	0 (0)	0 (0)	0 (0)
Anthinae (sea perch)	May	0.17 (0.09) 46 ‡	0.35 (0.24) 36 ‡	0 (0)	0.01 (<0.01) 61.5 ‡	0 (0)
Epinephelinae (grouper)	May, Jun	0.07 (0.04) 72 ‡	0 (0)	0 (0)	0.03 (0.01) 43 ‡	0 (0)
Grammistinae (N)	Jun, Jul	0.04 (0.03) 80 ‡	0.01 (0.01) 81 ‡	0 (0)	0 (0)	0 (0)
Serraninae (sea bass)	Apr, May, Jun, Aug	0.36 (0.14) 31 ‡	0.95 (0.33) 22 ‡	<0.01 (<0.01) 49 ‡	0.08 (0.03) 30.5 ‡	0 (0)
Priacanthidae						
Priacanthus spp. (N) (bigeye/glasseye spp.)	May	0 (0)	0.03 (0.03) 74.5 ‡	0 (0)	0 (0)	0 (0)
Pomatomidae						
Pomatomus saltatrix (bluefish)	Apr, May	0.08 (0.06) 65 ‡	0 (0)	0 (0)	0.01 (<0.01) 61.5 ‡	0 (0)
Rachycentridae						
Rachycentron canadum (N) (cobia)	May, Jun, Jul	0.14 (0.07) 52 ‡	0.02 (0.02) 78 ‡	0 (0)	0 (0)	0 (0)
Carangidae						
Unidentified (jack)	Jun, Jul	0.17 (0.11) 45 ‡	0.03 (0.03) 72.5 ‡	0 (0)	0 (0)	<0.01 (<0.01) 64 ‡
Caranx spp. (N) (jack spp.)	Jun	0.16 (0.09) 49 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Caranx crysos (blue runner)	Jun, Jul, Aug	1.14 (0.41) 17 ‡	0.62 (0.43) 28 ‡	0.04 (0.03) 26.5 ‡	0.08 (0.03) 30.5 ‡	0.08 (0.02) 25 ‡
Caranx hippos/latus (crevalle/horse-eye jack)	May, Jun, Jul, Aug	0.50 (0.31) 27 ‡	0 (0)	<0.01 (<0.01) 49 ‡	0.11 (0.03) 24 ‡	0.09 (0.03) 23 ‡
Chloroscombrus chrysurus (Atlantic bumper)	Jul, Aug	1.00 (0.34) 18 ‡	0.29 (0.18) 40 ‡	<0.01 (<0.01) 49 ‡	0.01 (<0.01) 61.5 ‡	0.02 (0.01) 44.5 ‡
Decapterus punctatus (L) (round scad)	Apr, May, Jul, Aug	0 (0)	0 (0)	0 (0)	0.06 (0.02) 35.5 ‡	<0.01 (<0.01) 64 ‡
Oligoplites saurus (N) (leatherjack)	Jul	0.16 (0.12) 48 ‡	0 (0)	0 (0)	0 (0)	0 (0)

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Selar crumenopthalmus (N)	Jun, Jul	0.34 (0.15)	0.13 (0.13)	0 (0)	0 (0)	0 (0)
(bigeye scad)		34 ‡	58.5 ‡			
Selene vomer (N)	Jun, Jul	0.01 (0.01)	0.05 (0.03)	0 (0)	0 (0)	0 (0)
(lookdown)		96 ‡	70 ‡			
Seriola spp. (N)	May	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(jack spp.)		85 ‡				
Seriola dumerili/rivoliana (L)	May, Jun	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)	0.02 (0.01)
(greater amberjack/almaco jack)				49 ‡		44.5 ‡
Seriola fasciata (L)	May	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(lesser amberjack)					93 ‡	
Trachinotus carolinus (L)	Jun	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (<0.01)
(Florida pompano)						51.5 ‡
Trachinotus falcatus/goodei (L)	May	0 (0)	0 (0)	0 (0)	0.03 (0.02)	0 (0)
(permit/palometa)					46.5 ‡	
Trachurus lathami	Apr, May	0.04 (0.04)	0.15 (0.10)	0.02 (0.01)	0.06 (0.03)	0.01 (<0.01)
(rough scad)		82 ‡	57 ‡	32 ‡	37.5 ‡	51.5 ‡
Coryphaenidae						
Coryphaena equiselis (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)
(pompano dolphin)						64 ‡
Coryphaena hippurus	May, Jul	0.03 (0.03)	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)
(dolphin)		86.5 ‡				64 ‡
Lutjanidae						
Unidentified	May, Jun, Jul	0.09 (0.05)	0.06 (0.06)	<0.01 (<0.01)	<0.01 (<0.01)	0 (0)
(snapper)		61 ‡	67 ‡	49 ‡	81.5 ‡	
Lutjanus spp.	May, Jun, Jul	0.67 (0.24)	0.02 (0.02)	0 (0)	0.01 (<0.01)	0.01 (0.01)
(snapper spp.)		22 ‡	78 ‡		61.5 ‡	51.5 ‡
Lutjanus campechanus	May, Jun, Jul	0.02 (0.02)	0 (0)	0 (0)	0.02 (0.02)	0 (0)
(red snapper)		93 ‡			49 ‡	
Rhomboplites aurorubens	May, Jun, Jul	0.40 (0.25)	0.37 (0.21)	0.20 (0.06)	0.07 (0.03)	<0.01 (<0.01)
(vermilion snapper)		30 ‡	35 ‡	13 ‡	33.5 ‡	64 ‡
Gerreidae						
Eucinostomus spp.	May, Jun, Jul, Aug	0 (0)	0 (0)	<0.01 (<0.01)	<0.01 (<0.01)	0.02 (0.01)
(jenny/mojarra spp.)				49 ‡	81.5 ‡	41 ‡
Sparidae						
Unidentified	Apr, May	0.04 (0.04)	0 (0)	0 (0)	0.01 (<0.01)	0.02 (0.01)
(porgy)		83 ‡			61.5 ‡	44.5 ‡

Table 2.4. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Calamus spp. (L)	May	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(porgy spp.))					81.5 ‡	
Sciaenidae						
Unidentified (N)	Aug	<0.01 (<0.01)	0 (0)	0 (0)	0 (0)	0 (0)
(drum spp.)		100 ‡				
Cynoscion arenarius	Apr, May, Jul, Aug	3.12 (1.11)	1.25 (0.88)	<0.01 (<0.01)	0 (0)	0.01 (<0.01)
(sand seatrout)		11 ‡	19 ‡	49 ‡		51.5 ‡
Menticirrhus spp. (N)	Aug	0.15 (0.11)	0.63 (0.63)	0 (0)	0 (0)	0 (0)
(kingfish spp.)		50 ‡	27 ‡			
Stellifer lanceolatus (N)	Aug	0.09 (0.09)	0 (0)	0 (0)	0 (0)	0 (0)
(star drum)		64 ‡				
Mullidae						
Unidentified	Apr, May, Jul	0.25 (0.14)	0 (0)	<0.01 (<0.01)	<0.01 (<0.01)	0.05 (0.02)
(goatfish)		38 ‡		49 ‡	81.5 ‡	32 ‡
Mullus auratus (L)	Apr, May	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (0.02)
(red goatfish)						27 ‡
Pseudupeneus maculatus (L)	Apr, May	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (0.03)
(spotted goatfish)						28 ‡
Upeneus parvus (L)	May, Jun	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0.38 (0.09)
(dwarf goatfish)					61.5 ‡	15 (1.58)
Chaetodontidae						
Unidentified (N)	May	0.02 (0.02)	0 (0)	0 (0)	0 (0)	0 (0)
(butterflyfish)		91 ‡				
Pomacentridae						
Unidentified (L)	May, Jun	0 (0)	0 (0)	<0.01 (<0.01)	0.01 (<0.01)	0.01 (0.01)
(damselfish)				49 ‡	61.5 ‡	51.5 ‡
Abudefduf saxatilis (L)	May, Jun, Aug	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (0.02)
(sergeant major)						38.5 ‡
Abudefduf taurus (L)	May	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0 (0)
(night sergeant)					61.5 ‡	
Chromis spp.	May, Jun	0.29 (0.29)	0 (0)	0.01 (<0.01)	0.37 (0.13)	0.06 (0.02)
(chromis spp.)		37 ‡		37 ‡	21 ‡	31 ‡
Pomacentrus spp.	May, Jun, Jul, Aug	0.09 (0.05)	0.03 (0.03)	0.07 (0.02)	0.12 (0.03)	0.30 (0.14)
(damselfish spp.)		62 ‡	74.5 ‡	20 ‡	23 ‡	16 (1.28)
Mugilidae						
Mugil curema (L)	May, Jun	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0.02 (0.01)
(white mullet)					61.5 ‡	41 ‡

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Sphyraenidae						
Sphyraena borealis (L)	May	0 (0)	0 (0)	0 (0)	0.01 (<0.01)	0 (0)
(northern sennet)					61.5 ‡	
Sphyraena guachancho	Jun, July, Aug	1.83 (0.60)	0 (0)	0 (0)	0.01 (<0.01)	0.01 (<0.01)
(guaguanche)		14 ‡			61.5 ‡	57 ‡
Labridae						
Unidentified	May, Aug	0.05 (0.05)	0.16 (0.16)	0 (0)	<0.01 (<0.01)	0 (0)
(wrasse)		78 ‡	54 ‡		81.5 ‡	
Opisthognathidae						
Unidentified	Apr, May, Jun	0.46 (0.14)	0.48 (0.33)	0 (0)	0.63 (0.20)	0.06 (0.02)
(jawfish)		28 ‡	31 ‡		19 ‡	29.5 ‡
Opisthognathus spp. (N)	May	0.05 (0.05)	0 (0)	0 (0)	0 (0)	0 (0)
(jawfish spp.)		77 ‡				
Opisthognathus aurifrons	May	0.06 (0.06)	0 (0)	0 (0)	0.03 (0.02)	0 (0)
(yellowhead jawfish)		76 ‡			44 ‡	
Opisthognathus lonchurus (N)	May	0.10 (0.10)	0 (0)	0 (0)	0 (0)	0 (0)
(moustache jawfish)		58 ‡				
Blenniidae						
Unidentified	Apr, May, Jun, Jul, Aug	4.73 (3.95)	1.22 (0.69)	0.05 (0.04)	0.69 (0.21)	0.04 (0.03)
(blenny)		9 (1.53)	20 ‡	24.5 ‡	17 ‡	33 ‡
Hypsoblennius hentz/ionthus (L)	May, Jun, Jul	0 (0)	0 (0)	0.02 (0.01)	1.76 (0.57)	0.04 (0.01)
(feather/freckled blenny)				29 ‡	11 (1.21)	37 ‡
Hypsoblennius invemar	Apr, May, Jun, Jul	0.04 (0.04)	0 (0)	0.08 (0.03)	6.33 (1.77)	3.58 (0.67)
(tessellated blenny)		81 ‡		18 ‡	7 (4.32)	2 (14.55)
Ophioblennius atlanticus (N)	Aug	0.42 (0.42)	0 (0)	0 (0)	0 (0)	0 (0)
(redlip blenny)		29 ‡				
Parablennius marmoreus	Apr, May, Jun	0.02 (0.02)	0 (0)	0.19 (0.04)	7.20 (1.06)	1.62 (0.35)
(seaweed blenny)		92 ‡		14 ‡	6 (4.87)	4 (6.61)
Scartella/Hypleurochilus	Apr, May, Jun, Jul	0.06 (0.04)	0.21 (0.15)	<0.01 (<0.01)	1.14 (0.24)	0.11 (0.03)
(blenny spp.)		74.5 ‡	46 ‡	49 ‡	12 ‡	22 ‡
Callionymidae						
Unidentified (N)	Jul	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(dragonet)		86.5 ‡				
Gobiidae						
Unidentified	Apr, May, Jun, Jul, Aug	5.75 (0.80)	10.73 (1.76)	0.21 (0.06)	0.05 (0.02)	0.01 (<0.01)
		7 (1.77)	4 (8.53)	11 ‡	39 ‡	51.5 ‡

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Bollmannia communis (L)	Jun	0 (0)	0 (0)	0.01 (0.01)	0 (0)	0 (0)
(ragged goby)				37 ‡		
Gobionellus oceanicus	Jun, Aug	0.03 (0.03)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(highfin goby)		89 ‡			81.5 ‡	
Microdesmidae						
Microdesmus spp. (N)	Apr, May, Jun, Jul	0.30 (0.11)	0 (0)	0 (0)	0 (0)	0 (0)
(wormfish spp.)		36 ‡				
Microdesmus lanceolatus	Apr, May, Jun, Jul, Aug	0.89 (0.18)	0.77 (0.31)	0.02 (0.01)	<0.01 (<0.01)	0.01 (<0.01)
(lancetail wormfish)		20 ‡	24 ‡	32 ‡	81.5 ‡	51.5 ‡
Microdesmus longipinnis (N)	Apr, May, Jul	0.53 (0.18)	0 (0)	0 (0)	0 (0)	0 (0)
(pink wormfish)		26 ‡				
Trichiuridae						
Gempylus spp. (N)	Jul	0 (0)	0.02 (0.02)	0 (0)	0 (0)	0 (0)
(snake mackerel spp.)			78 ‡			
Trichiurus lepturus	Apr, May, Jun, Jul, Aug	0.35 (0.13)	0.26 (0.13)	0.05 (0.02)	0.01 (0.01)	<0.01 (<0.01)
(Atlantic cutlassfish)		33 ‡	43 ‡	22.5 ‡	61.5 ‡	64 ‡
Scombridae						
Unidentified	May, Jun, Jul, Aug	0.10 (0.06)	0.43 (0.29)	0.01 (<0.01)	0.10 (0.08)	0.04 (0.01)
(mackerel)		56 ‡	34 ‡	37 ‡	25 ‡	35.5 ‡
Auxis spp.	Apr, May, Jun, Jul, Aug	6.61 (2.32)	1.26 (0.79)	0.02 (0.01)	0.76 (0.19)	0.24 (0.06)
(mackerel spp.)		5 (1.69)	18 ‡	32 ‡	15 ‡	18 ‡
Euthynnus alletteratus	May, Jun, Jul, Aug	4.55 (1.05)	4.10 (1.06)	0.08 (0.03)	0.92 (0.17)	2.83 (0.62)
(little tunny)		10 (1.39)	8 (3.09)	19 ‡	13 ‡	3 (11.54)
Katsuwonus pelamis	May	0.06 (0.04)	0 (0)	0 (0)	0.08 (0.03)	0 (0)
(skipjack tuna)		74.5 ‡			30.5 ‡	
Scomber japonicus (L)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(chub mackeral)						44.5 ‡
Scomberomorus cavalla	May, Jun, Jul, Aug	0.13 (0.06)	0.07 (0.04)	<0.01 (<0.01)	0.09 (0.03)	0.27 (0.11)
(king mackerel)		54 ‡	66 ‡	49 ‡	26 ‡	17 (1.11)
Scomberomorus maculatus	Jun, Jul, Aug	0.36 (0.14)	0.21 (0.21)	0 (0)	0.04 (0.02)	0.17 (0.05)
(Spanish mackerel)		32 ‡	48 ‡		41.5 ‡	20 ‡
Thunnus spp. (L)	Aug	0 (0)	0 (0)	0 (0)	0 (0)	0.01 (0.01)
(tuna spp.)						51.5 ‡
Thunnus thynnus (L)	May	0 (0)	0 (0)	0 (0)	0.01 (0.01)	0 (0)
(bluefin tuna)					61.5 ‡	
Stromateidae						

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Ariomma regulus (L)	Aug	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(spotted driftfish)					81.5 ‡	
Centrolophus medusophagus	Apr	0 (0)	0.32 (0.26)	0 (0)	<0.01 (<0.01)	<0.01 (<0.01)
(brown ruff)			37 ‡		81.5 ‡	64 ‡
Peprilus burti	Apr, May	0.07 (0.05)	0.04 (0.04)	<0.01 (<0.01)	0.03 (0.02)	0.02 (0.01)
(gulf butterfish)		70 ‡	71 ‡	49 ‡	46.5 ‡	41 ‡
Peprilus alepidotus (N)	May, Jul, Aug	0.21 (0.11)	2.79 (1.72)	0 (0)	0 (0)	0 (0)
(harvestfish)		43 ‡	10 ‡			
Pleuronectiformes						
Unidentified (N)	Aug	0.01 (0.01)	0.08 (0.08)	0 (0)	0 (0)	0 (0)
(flounder)		97 ‡	63 ‡			
Bothidae						
Unidentified	Apr, May, Jul	0.06 (0.05)	0.17 (0.13)	<0.01 (<0.01)	0 (0)	0 (0)
(lefteye flounder)		73 ‡	51 ‡	49 ‡		
Bothus spp. (L)	May	0 (0)	0 (0)	0 (0)	<0.01 (<0.01)	0 (0)
(flounder spp.)					81.5 ‡	
Citharichthys spilopterus	Apr, May, Jul	0.05 (0.04)	0.28 (0.20)	0 (0)	0 (0)	<0.01 (<0.01)
(bay whiff)		79 ‡	41 ‡			64 ‡
Cyclopsetta spp. (N)	Jun, Jul	0.10 (0.08)	0.53 (0.47)	0 (0)	0 (0)	0 (0)
(flounder spp.)		57 ‡	29 ‡			
Engyophrys senta (N)	Jul	0 (0)	0.02 (0.02)	0 (0)	0 (0)	0 (0)
(spiny flounder)			76 ‡			
Etropus crossotus	Apr, May, Jun, Jul, Aug	0.65 (0.19)	1.79 (0.54)	0.01 (<0.01)	<0.01 (<0.01)	0.01 (<0.01)
(fringed flounder)		23 ‡	16 (1.57)	37 ‡	81.5 ‡	51.5 ‡
Syacium spp.	Apr, Jun, Jul, Aug	0.25 (0.12)	3.78 (1.14)	0 (0)	0.02 (0.01)	<0.01 (<0.01)
(flounder spp.)		39 ‡	9 (2.82)		51 ‡	64 ‡
Soleidae						
Achirus lineatus (N)	Jun, Jul	0.21 (0.08)	0 (0)	0 (0)	0 (0)	0 (0)
(lined sole)		41 ‡				
Symphurus spp.	Apr, May, Jun, Jul, Aug	6.79 (1.18)	17.00 (3.82)	0.05 (0.02)	0.08 (0.02)	0.07 (0.03)
(tonguefish spp.)		4 (1.69)	2 (14.49)	22.5 ‡	28 ‡	26 ‡
Tetraodontiformes						
Balistidae						
Unidentified (N)	Jul	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(leatherjacket)		90 ‡				
Tetraodontiformes						
Tetraodontidae						

Table 2.4. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Sphoeroides spp. (puffer spp.)	Apr, May, Jun, Jul	0.14 (0.07) 53 ‡	0.28 (0.22) 42 ‡	0 (0)	<0.01 (<0.01) 81.5 ‡	0 (0)

Rachycentron canadum, although not very common, were also collected at GI 94 and not at GC 18. As with the carangids, *R. canadum* is also considered to be a reef-associated species.

Second in abundance to the pelagic forms at the mid-shelf platform (GI 94) were demersal taxa, particularly synodontids which comprised 14.7% of the total catch and were approximately equal to the total catch of all perciform fishes combined (15.1%). Unidentified synodontids, *Saurida brasiliensis*, *Synodus foetens*, and *Synodus poeyi* were very common in the late spring and summer months. Like the carangids, this group was more species rich at GI 94, with seven taxa identified to species as compared to three at the outer shelf platform (GC 18). Other common demersal taxa included *Symphurus* spp., *Syacium* spp., and *Bregmaceros cantori*. Mesopelagic species were not as speciose and abundant as those at GC 18, but some were collected, including *Cyclothone braueri*, *Vinciguerria nimbaria*, and *Lestrolepis intermedia*.

Overall, there was greater taxonomic richness among reef fishes at the mid-shelf platform than the outer shelf or inner shelf sites. Blenniids and gobiids were relatively common, as well as taxa that were not collected at the other sites, such as *Chromis* spp. and opistognathids. Also noteworthy was the relatively high abundance of mullids collected at GI 94 (only one individual was collected at GC 18), particularly *Upeneus parvus*, a common species on the mid-to-inner shelf (Hoese and Moore 1977). Lutjanids were also relatively common at this site, with *Rhomboplites aurorubens* the dominant species, followed by *Lutjanus* spp. While *Pristipomoides aquilonaris* was the primary lutjanid collected at the outer shelf site, none were collected at the mid-shelf site. With regards to serranids, the dominant group was serraniines (e.g., *Diplectrum* spp., *Centropristis* spp., and *Serranus* spp.), while relatively few anthiines were collected.

Larval and Juvenile Fish Collected at the Inner Shelf Platform (ST 54)

A total of 97,697 fish were collected at the inner shelf platform (ST 54). Light-traps collected 6,116 fish and plankton nets collected 91,583 fish (Table 2.5). Due to problems with the deploying the subsurface net at this site (Table 2.2), the plankton net catch is almost exclusively from the surface. The plankton nets collected fish from 34 families, eight of which were not present in light-trap collections. Light-traps also collected fish from a total of 34 families, eight of which were not collected with plankton nets. The plankton nets caught fish from 59 taxa (identified at least to genus), 19 of which were not in

Table 2.5. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for fish collected at South Timbalier 54 with standard error (SE), rank, percent of total catch (%), and months collected for each taxa. (N) indicates taxa collected only with plankton nets. (L) indicates taxa collected only with light-traps. For ranks, tied values received the mean of the corresponding ranks. ‡ indicates a value <1.00%.

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Osteichthyes						
Unidentified	Apr, May	3.93 (3.66) 12 ‡	0 (0)	0 (0)	0.50 (0.50) 6 (1.20)	0 (0)
Albuliformes						
Albulidae						
Albula vulpes (L) (bonefish)	Apr	0 (0)	0 (0)	0 (0)	0.01 (0.01) 42 ‡	0 (0)
Anguilliformes						
Unidentified (eel)	Jun	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Muraenidae						
Unidentified (L) (moray eel)	Jun	0.43 (0.41) 40 ‡	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Ophichthidae						
Unidentified (snake eel)	Apr, May, Jun	0.20 (0.18) 52 ‡	0 (0)	0 (0)	<0.01 (0.01) 50 ‡	0.02 (0.02) 50 ‡
Clupeiformes						
Unidentified (N) (herring/anchovy)	May	1.92 (1.92) 17 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Clupeidae						
Brevoortia patronus (L) (gulf menhaden)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Etrumeus teres (N) (round herring)	Apr	0.04 (0.03) 68 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Harengula jaguana (scaled sardine)	Apr, May, Jun, Jul	1.27 (0.50) 24 ‡	0 (0)	0 (0)	0.56 (0.17) 5 (1.29)	0.55 (0.22) 8 (1.43)
Opisthonema oglinum (Atlantic thread herring)	Apr, May, Jun, Jul	3689.84 (1964.23) 1 (96.56)	0 (0)	0.35 (0.14) 3 (7.05)	23.26 (9.41) 1 (54.60)	25.53 (7.93) 1 (66.71)
Sardinella aurita (Spanish sardine)	Apr	0.03 (0.03) 74 ‡	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Engraulidae						
Unidentified (anchovy)	Apr, May, Jun, Jul	146.75 (39.54) 2 (1.49)	10.73 (7.58) 2 (46.38)	0.13 (0.06) 5 (2.90)	1.13 (0.53) 4 (2.71)	0.90 (0.20) 4 (2.36)
Anchoa spp. (anchovy spp.)	May	0.61 (0.61) 31 ‡	0 (0)	0 (0)	0 (0)	0 (0)

Table 2.5. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Anchoa hepsetus (L)	Jun	0 (0)	0 (0)	0 (0)	0.01 (0.01)	0 (0)
(striped anchovy)					42 ‡	
Anchoa mitchilli	Apr, May, Jun, Jul	4.23 (1.61)	0 (0)	0.04 (0.03)	0.38 (0.13)	0.31 (0.17)
(bay anchovy)		11 ‡		13 ‡	9 ‡	11 ‡
Anchoa nasuta (L)	May, Jun	0 (0)	0 (0)	0 (0)	0.06 (0.04)	0.02 (0.03)
(longnose anchovy)					21 ‡	33 ‡
Anchoa nasuta/hepsetus	Apr, May, Jun, Jul	2.27 (0.77)	0 (0)	0.57 (0.20)	9.89 (3.63)	3.66 (1.49)
(longnose/striped anchovy)		16 ‡		2 (11.62)	2 (23.74)	2 (9.57)
Anchoviella perfasciata (N)	Apr	0.02 (0.02)	0 (0)	0 (0)	0 (0)	0 (0)
(flat anchovy)		77.5 ‡				
Engraulis eurystole	Apr, May, Jun, Jul	0.22 (0.15)	0 (0)	0 (0)	0.26 (0.07)	0.03 (0.02)
(silver anchovy)		49 ‡			11 ‡	33 ‡
Stomiiformes						
Gonostomatidae						
Cyclothone braueri (N)	Apr	0.10 (0.06)	0 (0)	0 (0)	0 (0)	0 (0)
		60 ‡				
Aulopiformes						
Synodontidae						
Unidentified (L)	Apr, May	0 (0)	0 (0)	0 (0)	0.01 (0.01)	0.02 (0.02)
(lizardfish)					42 ‡	50 ‡
Saurida brasiliensis (L)	May, Jun	0 (0)	0 (0)	0.04 (0.03)	0.06 (0.03)	0.08 (0.03)
(largescale lizardfish)				9.5 (1.24)	21 ‡	26.5 ‡
Saurida suspicio (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
						50 ‡
Synodus foetens	Apr, May, Jun	0.21 (0.14)	0.26 (0.26)	2.88 (1.55)	3.16 (1.25)	0.27 (0.10)
(inshore lizardfish)		50 ‡	11 (1.45)	1 (58.51)	3 (7.60)	12 ‡
Synodus poeyi	Apr, May	0.23 (0.19)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(offshore lizardfish)		48 ‡				50 ‡
Myctophiformes						
Myctophidae						
Unidentified	Apr, Jul	0.24 (0.13)	4.09 (3.52)	0 (0)	0 (0)	0.03 (0.2)
(lanternfish)		47 ‡	4 (4.35)			33 ‡
Gadiformes						
Bregmacerotidae						
Bregmaceros cantori	Apr, May	1.85 (0.66)	0.26 (0.26)	0.06 (0.03)	0.01 (0.01)	0.10 (0.05)
(codlet)		20 ‡	11 (1.45)	9.5 (1.24)	42 ‡	24 ‡

Table 2.5. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Ophidiidae						
Lepophidium spp. (cusk-eel spp.)	Apr, May	0.41 (0.41) 42.5 ‡	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Lepophidium staurophor (L.)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Ophidion spp. (N) (cusk-eel spp.)	Apr	0.03 (0.03) 72 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Ophidion nocomis selenops (cusk-eel spp.)	May	3.09 (1.77) 13 ‡	0 (0)	0.02 (0.02) 18.5 ‡	0 (0)	0 (0)
Ophidion robinsi (L.) (cusk-eel spp.)	May	0 (0)	0 (0)	0.02 (0.02) 18.5 ‡	0 (0)	0 (0)
Ophidion selenops (L.) (mooneye cusk-eel)	May	0 (0)	0 (0)	0.02 (0.02) 18.5 ‡	0.01 (0.01) 42 ‡	0 (0)
Bythitidae						
Unidentified (N) (brotula)	May	0.41 (0.41) 42.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Gobiesociformes						
Gobiesocidae						
Gobiesox strumosus (skilletfish)	Apr, May	0.03 (0.03) 69.5 ‡	0 (0)	0 (0)	0.06 (0.04) 21 ‡	0.03 (0.02) 36 ‡
Atheriniformes						
Exocoetidae						
Unidentified (N) (flyingfish)	Apr	0.03 (0.03) 71 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Cypselurus spp. (N) (flyingfish spp.)	Apr	0.03 (0.03) 69.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Cypselurus cyanopterus (L.) (margined flyingfish)	Jun	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Cypselurus furcatus (L.) (spotfin flyingfish)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Atherinidae						
Unidentified (N) (silverside)	Apr	0.29 (0.20) 45 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Membras martinica (L.) (rough silverside)	Jun	0 (0)	0 (0)	0 (0)	0.02 (0.02) 32 ‡	0 (0)
Gasterosteiformes						

Table 2.5. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Syngnathidae						
Syngnathus spp. (N)	Apr	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(pipefish spp.)		74 ‡				
Syngnathus louisiana (N)	Apr	0.02 (0.02)	0 (0)	0 (0)	0 (0)	0 (0)
(chain pipefish)		80.5 ‡				
Scorpaeniformes						
Scorpaenidae						
Scorpaena spp.	Apr, Jun	0 (0)	0.26 (0.26)	0 (0)	0.02 (0.02)	0.02 (0.02)
(scorpionfish spp.)			11 (1.45)		32 ‡	50 ‡
Triglidae						
Prionotus spp.	Apr	0.58 (0.26)	0 (0)	0 (0)	0.01 (0.01)	0.02 (0.02)
(searobin spp.)		36 ‡			42 ‡	50 ‡
Perciformes						
Unidentified	Apr, May, Jun, Jul	10.47 (3.57)	14.29 (14.29)	0 (0)	0.02 (0.02)	0.16 (0.07)
		6 ‡	1 (10.14)		32 ‡	17.5 ‡
Serranidae						
Unidentified (N)	Apr	0.06 (0.06)	0 (0)	0 (0)	0 (0)	0 (0)
(seabass/grouper)		65 ‡				
Epinephelinae (N)	Apr	0.03 (0.03)	0 (0)	0 (0)	0 (0)	0 (0)
(grouper)		74 ‡				
Serraninae	Apr, May	0.34 (0.24)	0 (0)	0 (0)	0.01 (0.01)	0 (0)
(seabass)		44 ‡			42 ‡	
Priacanthidae						
Priacanthus spp. (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(bigeye spp.)						50 ‡
Carangidae						
Unidentified (N)	Apr, Jun	0.43 (0.28)	0 (0)	0 (0)	0 (0)	0 (0)
(jack)		41 ‡				
Caranx crysos (L)	May, Jun, Jul	0 (0)	0 (0)	0.02 (0.02)	0.05 (0.03)	0.24 (0.08)
(blue runner)				23.5 ‡	19 ‡	14 ‡
Caranx hippos/latus	May, Jun, Jul	2.70 (2.44)	0 (0)	0 (0)	0.04 (0.02)	0.61 (0.25)
(crevalle/horse-eye jack)		14 ‡			26.5 ‡	6 (1.60)
Chloroscombrus chrysurus	May, Jun, Jul	30.00 (11.03)	0 (0)	0.02 (0.02)	0.09 (0.04)	0.11 (0.06)
(Atlantic bumper)		4 ‡		18.5 ‡	17 ‡	22 ‡
Decapterus punctatus	Apr, May, Jun	0.02 (0.02)	0 (0)	0 (0)	0.02 (0.02)	0.02 (0.02)
(round scad)		77.5 ‡			32 ‡	50 ‡

Table 2.5. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Oligoplites saurus (N)	Jun	0.48 (0.37)	0 (0)	0 (0)	0 (0)	0 (0)
(leatherjack)		37 ‡				
Selar crumenopthalmus (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(bigeye scad)						50 ‡
Selene spp. (N)	May	0.61 (0.61)	0 (0)	0 (0)	0 (0)	0 (0)
(moonfish/lookdown spp.)		31 ‡				
Seriola spp. (L)	Apr	0 (0)	0 (0)	0 (0)	0.01 (0.01)	0 (0)
(jack spp.)					49 ‡	
Trachinotus carolinus (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (0.03)
(Florida pompano)						33 ‡
Trachurus lathami	Apr, May	0.02 (0.02)	0 (0)	0 (0)	0.06 (0.05)	0.02 (0.02)
(rough scad)		80.5 ‡			18 ‡	50 ‡
Lutjanidae						
Unidentified (N)	Jul	0.17 (0.17)	0 (0)	0 (0)	0 (0)	0 (0)
(snapper)		54.5 ‡				
Lutjanus spp. (N)	May, Jul	0.61 (0.45)	0 (0)	0 (0)	0 (0)	0 (0)
(snapper spp.)		31 ‡				
Lutjanus campechanus	May, Jun	0.61 (0.61)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(red snapper)		31 ‡				50 ‡
Rhomboplites aurorubens (L)	May, Jun	0 (0)	0 (0)	0.12 (0.07)	0 (0)	0 (0)
(vermilion snapper)				6 (2.49)		
Gerreidae						
Unidentified (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(jenny/mojarra)						50 ‡
Haemulidae						
Unidentified (N)	May	0.61 (0.61)	0 (0)	0 (0)	0 (0)	0 (0)
(grunt)		31 ‡				
Sparidae						
Unidentified (N)	Apr	0.14 (0.14)	0 (0)	0 (0)	0 (0)	0 (0)
(porgy)		58 ‡				
Calamus spp. (N)	Apr	0.10 (0.10)	0 (0)	0 (0)	0 (0)	0 (0)
(porgy spp.)		61 ‡				
Sciaenidae						
Unidentified	Apr, May, Jun	0.15 (0.15)	0 (0)	0 (0)	0.02 (0.02)	0.02 (0.02)
(drum)		57 ‡			32 ‡	50 ‡
Bairdiella chrysoura	Jun	0.12 (0.12)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(silver perch)		59 ‡				50 ‡

Table 2.5. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Cynoscion arenarius (sand seatrout)	Apr, May, Jun, Jul	42.16 (8.56) 3 ‡	7.99 (3.21) 3 (21.74)	0.10 (0.04) 7 (2.07)	0.42 (0.11) 8 (1.03)	0.56 (0.13) 7 (1.47)
Larimus fasciatus (N) (banded drum)	Apr	0.05 (0.04) 66 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Menticirrhus spp. (kingfish spp.)	Apr, May, Jun, Jul	1.45 (0.36) 22 ‡	0 (0)	0 (0)	0 (0)	0.03 (0.02) 33 ‡
Stellifer lanceolatus (N) (star drum)	Apr	0.44 (0.25) 39 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Mullidae						
Upeneus parvus (L) (dwarf goatfish)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Ephippidae						
Chaetodipterus faber (N) (Atlantic spadefish)	May, Jul	0.86 (0.39) 25 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Pomacentridae						
Abudefduf saxatilis (L) (sergeant major)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.10 (0.07) 24 ‡
Pomacentrus spp. (L) (damselfish spp.)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Mugilidae						
Mugil cephalus (L) (striped mullet)	Apr	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Mugil curema (L) (white mullet)	May	0 (0)	0 (0)	0 (0)	0.01 (0.01) 42 ‡	0.05 (0.04) 29.5 ‡
Sphyraenidae						
Sphyraena borealis (L) (northern sennet)	May	0 (0)	0 (0)	0 (0)	0.01 (0.01) 42 ‡	0 (0)
Labridae						
Unidentified (L) (wrasse)	Jun	0 (0)	0 (0)	0.02 (0.02) 18.5 ‡	0 (0)	0 (0)
Scaridae						
Unidentified (N) (parrotfish)	Apr	0.02 (0.02) 77.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Blenniidae						
Unidentified (blenny)	Apr, May, Jun, Jul	2.47 (0.90) 15 ‡	1.10 (1.10) 6 (1.45)	0.02 (0.02) 18.5 ‡	0.09 (0.03) 16 ‡	0.08 (0.05) 26.5 ‡

Table 2.5. (continued)

Taxa	Months Collected	Surface Net Density (SE) Rank (%)	Bottom Net Density (SE) Rank (%)	Bottom Light-trap CPUE (SE) Rank (%)	Surface Light-trap CPUE (SE) Rank (%)	Off-platform Light-trap CPUE (SE) Rank (%)
Hypsoblennius hentz/ionthas (feather/freckled blenny)	Apr, May, Jun	0.17 (0.17) 54.5 ‡	0 (0)	0 (0)	0.21 (0.08) 12 ‡	0.48 (0.22) 9.5 (1.26)
Hypsoblennius invemar (tessellated blenny)	Apr, May, Jun	0.61 (0.61) 31 ‡	0 (0)	0 (0)	0.11 (0.05) 15 ‡	0.48 (0.19) 9.5 (1.26)
Parablennius marmoreus (seaweed blenny)	May, Jul	0.20 (0.20) 53 ‡	0 (0)	0 (0)	0 (0)	0.02 (0.02) 50 ‡
Scartella/Hypleurochilus (blenny spp.)	Apr, May, Jun, Jul	1.89 (1.29) 19 ‡	0 (0)	0.06 (0.03) 9.5 (1.24)	0.49 (0.26) 7 (1.17)	0.16 (0.08) 17.5 ‡
Eleotridae						
Dormitator maculatus (N) (fat sleeper)	Apr	0.02 (0.02) 77.5 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Gobiidae						
Unidentified (goby)	Apr, May, Jun, Jul	29.96 (12.71) 5 ‡	1.41 (0.96) 5 (4.35)	0.06 (0.03) 9.5 (1.24)	0.03 (0.02) 28 ‡	0.23 (0.08) 15 ‡
Microdesmidae						
Microdesmus spp. (wormfish spp.)	Apr, Jul	0.58 (0.43) 35 ‡	0 (0)	0 (0)	0.01 (0.01) 42 ‡	0 (0)
Microdesmus lanceolatus (N) (lancetail wormfish)	Jun, Jul	1.28 (0.86) 23 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Trichiuridae						
Trichiurus lepturus (Atlantic cutlassfish)	Apr, May, Jun	0 (0)	0.52 (0.52) 8.5 (2.90)	0.18 (0.07) 4 (3.73)	0.01 (0.01) 42 ‡	0 (0)
Scombridae						
Unidentified (N) (mackerel)	Apr, Jul	0.25 (0.18) 46 ‡	0 (0)	0 (0)	0 (0)	0 (0)
Auxis spp. (mackerel spp.)	May, Jun, Jul	0 (0)	0 (0)	0 (0)	0.02 (0.02) 32 ‡	0.26 (0.17) 13 ‡
Euthynnus alletteratus (little tunny)	May, Jun, Jul	0.47 (0.27) 38 ‡	0 (0)	0.02 (0.02) 23.5 ‡	0.37 (0.23) 10 ‡	1.08 (0.47) 3 (2.82)
Scomberomorus cavalla (king mackerel)	Apr, May, Jun, Jul	5.39 (3.15) 10 ‡	0 (0)	0.04 (0.03) 13 ‡	0.05 (0.04) 24 ‡	0.10 (0.05) 24 ‡
Scomberomorus maculatus (Spanish mackerel)	Apr, May, Jun, Jul	6.56 (2.09) 9 ‡	0 (0)	0 (0)	0.18 (0.06) 13 ‡	0.81 (0.18) 5 (2.11)
Stromateidae						
Ariomma spp. (N) (driftfish spp.)	Apr	0.05 (0.04) 67 ‡	0.52 (0.52) 8.5 (2.90)	0 (0)	0 (0)	0 (0)

Table 2.5. (continued)

Taxa	Months Collected	Surface Net	Bottom Net	Bottom Light-trap	Surface Light-trap	Off-platform Light-trap
		Density (SE) Rank (%)	Density (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)	CPUE (SE) Rank (%)
Peprilus burti	Apr, May	1.65 (1.23)	0 (0)	0.02 (0.02)	0.14 (0.05)	0.13 (0.05)
(gulf butterfish)		21 ‡		18.5 ‡	14 ‡	20.5 ‡
Peprilus alepidotus	Apr, May, Jul	1.92 (0.77)	0 (0)	0.04 (0.03)	0.04 (0.02)	0.15 (0.06)
(harvestfish)		18 ‡		13 ‡	26.5 ‡	19 ‡
Pleuronectiformes						
Bothidae						
Unidentified (N)	May	0.81 (0.81)	0 (0)	0 (0)	0 (0)	0 (0)
(lefteye flounder)		26 ‡				
Citharichthys spilopterus	Apr, May, Jun	0.21 (0.13)	0 (0)	0 (0)	0 (0)	0.05 (0.04)
(bay whiff)		51 ‡				29.5 ‡
Cyclopsetta fimbriata (L)	May	0 (0)	0 (0)	0 (0)	0 (0)	0.02 (0.02)
(spotfin flounder)						50 ‡
Etropus crossotus	Apr, May, Jun	7.59 (2.94)	0.89 (0.89)	0 (0)	0.05 (0.02)	0.13 (0.06)
(fringed flounder)		8 ‡	7 (1.45)		24 ‡	20.5 ‡
Syacium spp. (L)	May	0.61 (0.61)	0 (0)	0 (0)	0 (0)	0 (0)
(flounder spp.)		31 ‡				
Soleidae						
Unidentified	Jun, Jul	0.06 (0.06)	0 (0)	0.02 (0.02)	0 (0)	0 (0)
(sole)		63.5 ‡		18.5 ‡		
Achirus lineatus	Apr, May, Jul	0.16 (0.10)	0 (0)	0 (0)	0.02 (0.02)	0 (0)
(lined sole)		56 ‡			32 ‡	
Gymnachirus spp. (N)	May	0.09 (0.09)	0 (0)	0 (0)	0 (0)	0 (0)
(sole spp.)		62 ‡				
Trinectes maculatus (N)	Apr, May	0.70 (0.42)	0 (0)	0 (0)	0 (0)	0 (0)
(hogchoker)		27 ‡				
Symphurus spp.	Apr, May, Jun, Jul	8.84 (3.84)	0 (0)	0 (0)	0.01 (0.01)	0.06 (0.04)
(tonguefish spp.)		7 ‡			42 ‡	28 ‡
Tetraodontiformes						
Tetraodontidae						
Sphoeroides spp.	Apr, May, Jun	0.06 (0.06)	0 (0)	0 (0)	0.05 (0.03)	0.21 (0.12)
(puffer spp.)		63.5 ‡			24 ‡	16 ‡
Sphoeroides parvus (L)	Apr	0 (0)	0 (0)	0 (0)	0.01 (0.01)	0 (0)
(least puffer)					42 ‡	

light-trap samples. Light-traps caught fish from 65 taxa, 27 of which were not in plankton net collections.

At the inner shelf platform, clupeiform fishes (mostly clupeids) overwhelmed the plankton net and light-trap collections, and comprised 97% of the total catch (all gears combined). The dominant clupeid was *Opisthonema oglinum*, which alone comprised 94% of the total catch. *Harengula jaguana*, though present at the mid-shelf site (GI 94), were more prominent at the inner shelf platform. This trend of increasing dominance of clupeiform fishes continued as sampling efforts moved inshore. In general, it is difficult to discuss the abundances of the other taxa except in very relative terms, since no families of fishes (with the exception of clupeids and engraulids) comprised over 1% of the total catch. Among pelagic fishes, the reef-associated carangids and scombrids were relatively abundant, particularly *Caranx hippos/latus*, *Euthynnus alletteratus*, and *Scomberomorus maculatus*.

Similar to the mid-shelf platform (GI 94), the second most abundant group of fishes at the inner shelf site was composed of demersal species. However, unlike GI 94 where synodontids dominated, sciaenids were the most dominant family, primarily *Cynoscion arenarius*, which was collected throughout the sampling season. Not only did the number of sciaenids increase, but the number of their taxa increased as well, from three at the mid-shelf site to five at the inner shelf site. *Cynoscion arenarius* dominated the plankton net catches, but synodontids, primarily *Synodus foetens*, dominated the light-trap collections. Synodontids were not as prominent at the inner shelf site as they were at the mid-shelf platform, and the number of taxa decreased from seven to four. Other demersal taxa collected included unidentified myctophiforms, *Trichiurus lepturus*, *Symphurus* spp., and *Etropus crossotus*.

The most abundant reef/structure-associated fishes were blenniids and gobiids. Unlike GI 94, *Parablennius marmoreus* was relatively uncommon. The dominant species at ST 54 were *Scartella/Hypleurochilus* spp., *Hypsoblennius hentz/ionthas*, and *H. invemar*. Difficulties in identification prevent us from confidently separating *H. hentz* from *H. ionthas* and *Scartella* spp. from *Hypleurochilus* 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 the inner shelf platform, reef fish, although not abundant, were relatively well represented in terms of number of taxa, rivaling that of the mid-shelf site. 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.

Larval and Juvenile Fish Collected at the Belle Pass Jetties

At the jetties (Belle Pass), the light-trap and pushnet collected 17,949 fish and 111,854 fish, respectively. Catches by both gear types were dominated by clupeiform fishes that comprised 95.3% of the light-trap total catch and 68.3% of the total pushnet catch (Table 2.6). The pushnet collected fish from 41 families with 85 taxa identifiable to at least genus. The jetties, though different in its structural complexity, vertical height, and hydrodynamics shared at least one similarity with the platforms in that it was also dominated by clupeiform fishes (74% of total catch). The taxonomic composition of this group was different, however, in that engraulids, particularly *Anchoa mitchilli*, dominated catches. The trend of increasing numbers of *Harengula jaguana* and *Brevoortia patronus* as the sampling sites moved progressively inshore continued as well. Overall, the light-trap collected fish from 21 families with 42 taxa identifiable to at least the genus level. Only one non-clupeiform species, *Membras martinica*, comprised over 1% of the total light-trap catch. The pushnet collected fish from 20 families and 44 taxa unique to this gear type. All families and all but three taxa that were sampled with the light-trap were also collected by the pushnet.

By far the most dominant demersal species was *Cynoscion arenarius*, and in general, the number of sciaenid taxa increased from the platform sites. *Bairdiella chrysoura* was also relatively common. *Micropogonias undulatus*, *Sciaenops ocellatus*, *Pogonias chromis*, and *C. nebulosus* were all collected as well, none of which were collected at the inner and mid-shelf platforms, although some *M. undulatus* and *S. ocellatus* were collected at the outer shelf. The jetty site also commonly had the predominantly estuarine species, *Gobiesox stromosus*. The ophichthid eels were most abundant at Belle Pass where they were also the most speciose taxonomic group, with *Myrophis punctatus* being the dominant species. The flatfish *Citharichthys* spp. and *Symphurus* spp. were also very common.

The reef/structure-associated fish group was dominated by small, estuarine/coastal species, primarily *Gobiosoma bosc*, which comprised 75% of the gobiids collected. The second most abundant gobiid was *Gobionellus oceanicus* (formerly *Gobionellus hastatus*) which comprised 14% of the total catch. Other common gobiid taxa were *Microgobius* spp. and *Gobiosoma* spp. Based on the dominance

Table 2.6. Total mean light-trap CPUE (fish/10 min) and pushnet density (fish/100 m^3) for fish collected at Belle Pass with standard error (SE), rank, percent of total catch (%), and months collected for each taxa. For ranks, tied values received the mean of the corresponding ranks. ‡ indicates a value <1.00%.

Taxa	Months Collected	Light-trap CPUE (SE) Rank (%)	Pushnet Density (SE) Rank (%)
Osteichthyes			
Unidentified	Apr, May, Jun, Jul, Aug	0.14 (0.06)	1.23 (0.65)
		17 ‡	20 ‡
Elopiformes			
Elopidae			
Elops saurus	Apr, May, Jun, Jul, Aug	<0.01 (<0.01)	0.22 (0.06)
(ladyfish)		48 ‡	36 ‡
Megalops atlanticus	Aug	0 (0)	0.03 (0.01)
(tarpon)			60 ‡
Anguilliformes			
Unidentified	Apr, May, Jun, Jul, Aug	<0.01(<0.01)	0.17(0.08)
(eel)		48‡	41‡
Ophichthidae			
Unidentified	Apr, May, Jun	0.03(0.02)	0.03(0.03)
(snake eel)		31‡	57‡
Bascanichthys spp.	Jun, Jul, Aug	0 (0)	0.13(0.03)
(sooty/whip eel spp.)			44‡
Myrophis punctatus	Apr, May, Jun, Jul	0.04(0.02)	0.64(0.31)
(speckled worm eel)		28‡	27‡
Ophichthus gomesi	Jul	0 (0)	0.15(0.07)
(shrimp eel)			42‡
Ophichthus melanoporus	Aug	0 (0)	<0.01(<0.01)
(blackpored eel)			82‡
Congridae			
Paraconger caudilimbatus	Jun	0 (0)	<0.01(<0.01)
(margintail conger)			82‡
Clupeiformes			
Unidentified	May, Jun, Jul, Aug	0.01(<0.01)	10.85(3.88)
(herring/anchovy)		41‡	5(2.05)
Clupeidae			
Unidentified	Apr, May, Aug	0.07(0.04)	2.48(1.42)
(herring)		22‡	13‡
Brevoortia spp.	Apr, Aug	0.15(0.08)	2.77(2.09)
(menhaden spp.)		16‡	11‡
Brevoortia patronus	Apr, May, Jun, Jul, Aug	0.04(0.03)	0.60(0.37)
(gulf menhaden)		27‡	29‡
Harengula jaguana	May, Jun, July, Aug	1.12(0.36)	0.53(0.10)
(scaled sardine)		4‡	30‡
Opisthonema oglinum	May, Jun, July, Aug	0.28(0.12)	0.40(0.10)
(Atlantic thread herring)		11‡	32‡
Engraulidae			
Unidentified	Apr, May, Jun, Jul, Aug	16.33(7.07)	138.43(21.12)
(anchovy)		2(13.47)	2(27.74)
Anchoa hepsetus	Apr, May, Jun, Jul, Aug	0.73(0.24)	1.30(0.50)
(striped anchovy)		6‡	18‡
Anchoa mitchilli	Apr, May, Jun, Jul, Aug	95.80(37.97)	153.25(33.48)
(bay anchovy)		1(79.07)	1(38.23)
Anchoa nasuta	May, Jun, Jul, Aug	0.24(0.08)	0.18(0.06)
(longnose anchovy)		13‡	38‡
Anchoa nasuta hepsetus	Apr, May, Jun, Jul, Aug	0.64(0.22)	1.90(0.45)
(longnose/striped anchovy)		7‡	15‡
Siluriformes			
Ariidae			
Arius felis	May, Jul	0 (0)	0.09(0.06)
(hardhead catfish)			48‡
Bagre marinus	Jul, Aug	0 (0)	0.10(0.08)
(gafftopsail catfish)			46‡

Table 2.6. (continued)

Taxa	Months Collected	Light-trap CPUE (SE) Rank (%)	Pushnet Density (SE) Rank (%)
Aulopiformes			
Synodontidae			
Unidentified (lizardfish)	May	0 (0)	<0.01(<0.01) 88‡
Synodus spp. (lizardfish spp.)	Apr, May	0 (0)	0.02(0.02) 61‡
Synodus foetens (inshore lizardfish)	Apr, May, Jun, Jul, Aug	0.15(0.04) 15‡	0.93(0.14) 23‡
Paralepidae			
Paralepis atlantica (duckbill barracudina)	Apr	0 (0)	<0.01(<0.01) 90‡
Gadiformes			
Ophidiidae			
Unidentified (cuskeel)	Apr	0 (0)	<0.01(<0.01) 89‡
Lepophidium spp. (cusk-eel spp.)	Jun	0 (0)	<0.01(<0.01) 108‡
Gobiesociformes			
Gobiesocidae			
Gobiesox strumosus (skilletfish)	Apr, May, Jun, Jul, Aug	0.47(0.13) 10‡	1.55(0.25) 16‡
Atheriniformes			
Exocoetidae			
Unidentified (flyingfish)	May, Jun	0 (0)	0.01(<0.01) 80‡
Cypselurus spp. (flying fish spp.)	Jun	<0.01(<0.01) 48‡	0 (0)
Hyporhamphus unifasciatus (silverstriped halfbeak)	May, Jun, Jul, Aug	<0.01(<0.01) 48‡	0.04(0.01) 55‡
Atherinidae			
Unidentified (silverside)	Apr, May, Jun, Jul, Aug	0 (0)	0.18(0.08) 40‡
Membras martinica (rough silverside)	Apr, May, Jun, Jul, Aug	1.30(0.56) 3(1.09)	0.98(0.22) 21‡
Menidia beryllina (inland silverside)	May	0 (0)	0.02(0.02) 66‡
Gasterosteiformes			
Syngnathidae			
Hippocampus erectus (lined seahorse)	Jun	0 (0)	<0.01(<0.01) 99‡
Syngnathus spp. (pipefish spp.)	Apr, May, Jun, Jul, Aug	<0.01(<0.01) 48‡	0.09(0.03) 49‡
Syngnathus louisianae (chain pipefish)	Jul	0 (0)	<0.01(<0.01) 111‡
Scorpaeniformes			
Triglidae			
Prionotus spp. (searobin spp.)	Jun	0 (0)	<0.01(<0.01) 110‡
Prionotus roseus (bluespotted searobin)	Jul	0 (0)	<0.01(<0.01) 101‡
Prionotus tribulus (bighead searobin)	Jul	0 (0)	<0.01(<0.01) 94‡
Perciformes			
Serranidae			
Epinephelinae (grouper spp.)	Apr	0 (0)	<0.01(<0.01) 97‡
Rachycentridae			
Rachycentron canadum (cobia)	May	0 (0)	<0.01(<0.01) 86‡

Table 2.6. (continued)

Taxa	Months Collected	Light-trap CPUE (SE) Rank (%)	Pushnet Density (SE) Rank (%)
Carangidae			
Unidentified		0 (0)	0.02(0.02)
(jack)			62‡
Caranx spp.	Aug	0 (0)	0.64(0.26)
(jack spp.)			28‡
Caranx hippos/latus	Jun, Jul, Aug	<0.01(<0.01)	0.09(0.04)
(crevalle/horse-eye jack)		48‡	47‡
Chloroscombrus chrysurus	Jun, Jul, Aug	0.05(0.02)	0.28(0.15)
(Atlantic bumper)		23‡	35‡
Oligoplites saurus	Aug	<0.01(<0.01)	0.02(<0.01)
(leatherjack)		48‡	71‡
Selene vomer	Jul	0 (0)	<0.01(<0.01)
(lookdown)			98‡
Selene setapinnis	Jul	0 (0)	<0.01(<0.01)
(Atlantic moonfish)			104‡
Lutjanidae			
Lutjanus griseus	Jun, Jul, Aug	0 (0)	0.03(0.01)
(gray snapper)			59‡
Lutjanus synagris	Jul, Aug	0.01(<0.01)	0.07(0.02)
(lane snapper)		38‡	51‡
Lutjanus spp.	Aug	<0.01(<0.01)	0 (0)
(snapper spp.)		48‡	
Gerreidae			
Unidentified	May, Jun, Aug	0.02(0.01)	0.19(0.07)
(jenny/mojarra)		34‡	37‡
Eucinostomus spp.	Jun, Aug	<0.01(<0.01)	0.02(0.01)
(mojarra/jenny spp.)		48‡	70‡
Haemulidae			
Unidentified	Jul	0 (0)	<0.01(<0.01)
(grunt)			102‡
Sparidae	Apr, May		
Unidentified		0 (0)	0.02(0.01)
(porgy)			63‡
Sparidae Type B	May	0 (0)	0.02(<0.01)
(porgy spp.)			68‡
Sciaenidae			
Unidentified	May, Jun, Jul, Aug	0.02(0.01)	2.54(0.96)
(drum)		34‡	12‡
Bairdiella chrysoura	Apr, May, Jun, Jul, Aug	0.12(0.08)	3.07(0.73)
(silver perch)		19‡	10‡
Cynoscion arenarius	Apr, May, Jun, Jul, Aug	0.59(0.28)	40.74(8.02)
(sand seatrout)		9‡	4(7.85)
Cynoscion nebulosus	Apr, May, Jun, Aug	0.01(<0.01)	0.85(0.21)
(spotted seatrout)		38‡	24‡
Cynoscion nebulosus/arenarius	Jul	0 (0)	0.01(0.01)
(spotted/sand seatrout)			74‡
Menticirrhus spp.	Apr, May, Jul, Aug	0.03(0.01)	0.51(0.09)
(kingfish spp.)		29‡	31‡
Menticirrhus americanus/littoralis	Jun, Aug	0 (0)	0.02(0.01)
(gulf/northern kingfish)			64‡
Micropogonias undulatus	Apr, Jul	0 (0)	0.04(0.02)
(Atlantic croaker)			56‡
Pogonias cromis	May	0.01(<0.01)	0.74(0.21)
(black drum)		38‡	26‡
Sciaenops ocellatus	Aug	<0.01(<0.01)	1.29(0.59)
(red drum)		48‡	19‡
Stellifer lanceolatus	Apr, Jun, Jul	0 (0)	0.05(0.02)
(star drum)			54‡
Mullidae			
Unidentified	May	0 (0)	<0.01(<0.01)
(goatfish)			87‡

Table 2.6. (continued)

Taxa	Months Collected	Light-trap CPUE (SE) Rank (%)	Pushnet Density (SE) Rank (%)
Ephippidae			
Chaetodipterus faber	Jun, Aug	0 (0)	0.05(0.02)
(Atlantic spadefish)			52‡
Mugilidae			
Mugil cephalus	Apr	0 (0)	<0.01(<0.01)
(striped mullet)			97‡
Mugil curema	Apr, May, Jun	0 (0)	0.02(<0.01)
(white mullet)			69‡
Polynemidae			
Polydactylus octonemus	Aug	0 (0)	<0.01(<0.01)
(Atlantic threadfin)			93‡
Labridae			
Unidentified	Apr	0 (0)	0.01(<0.01)
(wrasse)			77‡
Scaridae			
Sparisoma spp.	Apr	0 (0)	0.01(<0.01)
(parrotfish spp.)			72‡
Uranoscopidae			
Unidentified	Jun	0 (0)	<0.01(<0.01)
(stargazer)			92‡
Blenniidae			
Unidentified	May, Jun, Jul, Aug	0.02(0.01)	0.03(0.02)
(blenny)		35‡	58‡
Chasmodes spp.	Apr	0 (0)	<0.01(<0.01)
(striped/Florida blenny)			100‡
Hypleurochilus bermudensis	Aug	0 (0)	<0.01(<0.01)
(barred blenny)			95‡
Hypsoblennius spp.	Jul	0 (0)	<0.01(<0.01)
(blenny spp.)			104(<.1.00)
Hypsoblennius hentz ionthas	Apr, May, Jun, Jul, Aug	1.04(0.27)	1.95((0.45)
(feather/tessellated blenny)		5‡	14‡
Scartella cristata	Apr, May, Jun, Jul, Aug	0.03(0.02)	0.34(0.08)
(molly miller)		31‡	33‡
Eleotridae			
Unidentified	Jun, Jul, Aug	0.01(<0.01)	0.02(0.01)
(sleeper)		38‡	67‡
Eleotridae Type A	Jun, Aug	<0.01(<0.01)	0.18(0.06)
(sleeper spp.)		48‡	39‡
Dormitator maculatus	Apr, May, Jun, Jul, Aug	0.12(0.06)	0.96(0.34)
(fat sleeper)		18‡	22‡
Gobiidae			
Unidentified	Apr, May, Jun, Jul, Aug	0.03(0.01)	0.81(0.23)
(goby)		31‡	25‡
Bathygobius soporator	Jun, Jul	0 (0)	0.01(<0.01)
(frillfin goby)			76‡
Evorthodus lyricus Gobionellus boleosoma	Jun, Jul, Aug	0 (0)	0.01(<0.01)
(lyre goby/darter goby)			78‡
Gobionellus oceanicus	Apr, May, Jun, Jul, Aug	0.11(0.06)	8.82(2.13)
(highfin goby)		20‡	6(1.97)
Gobiosoma spp.	Apr, May, Jun, Jul, Aug	0.26(0.18)	1.48(0.43)
(goby spp.)		12‡	17‡
Gobiosoma bosc	Apr, May, Jun, Jul, Aug	0.59(0.16)	46.88(7.88)
(naked goby)		8‡	3(10.64)
Microgobius spp.	May, Jun, Jul, Aug	0.04(0.03)	4.17(1.30)
(goby spp.)		26‡	9(1.05)
Microdesmidae			
Microdesmus longipinnis	Jun, Jul, Aug	0.05(0.02)	0.14(0.04)
(pink wormfish)		24‡	43‡

Table 2.6. (continued)

Taxa	Months Collected	Light-trap	Pushnet
		CPUE (SE) Rank (%)	Density (SE) Rank (%)
Trichiuridae			
Unidentified	May	0 (0)	<0.01(<0.01)
(snake mackerel)			91‡
Trichiurus lepturus	Apr, Jul	0 (0)	0.01(<0.01)
(Atlantic cutlassfish)			79‡
Scombridae			
Unidentified	May, Jun	0 (0)	0.01(<0.01)
(mackerel)			73‡
Scomberomorus spp.	Aug	<0.01(<0.01)	0 (0)
(mackeral spp.)		48‡	
Scomberomorus maculatus	May, Aug	0 (0)	<0.01(<0.01)
(Spanish mackeral)			83‡
Stromateidae			
Peprilus alepidotus	Jun, Jul, Aug	0 (0)	0.01(<0.01)
(harvestfish)			75‡
Peprilus burti	Apr	0 (0)	<0.01(<0.01)
(gulf butterfish)			85‡
Pleuronectiformes			
Bothidae			
Unidentified	Apr, Jun	0 (0)	0.02(0.01)
(lefteye flounder)			65‡
Citharichthys spp.	Apr, May, Jun, Jul, Aug	0.08(0.03)	6.53(1.02)
(whiff/sanddab spp.)		21‡	7(1.49)
Citharichthys spilopterus	Jul	0 (0)	<0.01(<0.01)
(bay whiff)			81‡
Etropus crossotus	Jul	0 (0)	<0.01(<0.01)
(fringed flounder)			104‡
Soleidae			
Achirus lineatus	Jun	0 (0)	<0.01(<0.01)
(lined sole)			84‡
Trinectes maculatus	May, Jun, Jul, Aug	0 (0)	0.07(0.02)
(hogchoker)			50‡
Cynoglossidae			
Symphurus spp.	Apr, May, Jun, Jul, Aug	0.05(0.02)	5.66(0.89)
(tonguefish spp.)		25‡	8(1.27)
Symphurus plagiusa	Jul	0 (0)	<0.01(<0.01)
(blackcheek tonguefish)			106‡
Tetraodontiformes			
Balistidae			
Monacanthus hispidus	Jun	0 (0)	<0.01(<0.01)
(planehead filefish)			110‡
Tetraodontidae			
Unidentified	May, Jun	0 (0)	0.05(0.02)
(puffer)			53‡
Sphoeroides spp.	Apr, May, Jun, Aug	0.01(<0.01)	0.12(0.04)
(puffer spp.)		38‡	45‡
Sphoeroides parvus	Apr, May, Jun, Jul, Aug	0.17(0.06)	0.34(0.08)
(least puffer)		14‡	34‡

of estuarine species collected at Belle Pass within this family, it is likely that the individuals in these two genera are also estuarine forms, even though these genera contain tropical forms as well. Taxa from a related group, the eleotrids, were also relatively common in jetty samples. Blenniids were also a very common group, particularly *Hypsoblennius hentz/ionthas* and *Scartella* spp. Other reef or structure-associated fish taxa collected at Belle Pass include labrids, ephippids, scarids, and sparids.

Lutjanus griseus and *L. synagris* juveniles, though not abundant, were also collected at Belle Pass. *Lutjanus griseus* juveniles are more common along the western Gulf and Florida coasts where they are collected in their preferred habitat, relatively high salinity seagrass beds (Patillo et al. 1997) or mangroves. However, they have been reported (although less frequently) in association with other structures, such as pilings, jetties and rocks (Starck 1971). Young *L. synagris* are also present in coastal areas (Hoese and Moore 1977).

Overall Taxonomic Richness and Seasonality

A total of 67 families were represented in the plankton net and light-trap collections from the three platform sites. The number of families represented in passive plankton net collections was 45 at GC 18 (outer shelf), 40 at GI 94 (mid-shelf) and 34 at ST 54 (inner shelf). At the Belle Pass jetties, the pushnet collected fish from 41 families. The number of families represented in light-trap collections at platforms was fairly consistent: 37 at both GC 18 and GI 94 and 34 at ST 54. At the jetties, the light-trap collected fish from only 21 families.

In general, trends in seasonality were consistent for taxa collected at the different sites across the shelf (Ditty et al. 1988). Many groups (e.g., clupeiforms, carangids, and scombrids) were present throughout the sampling periods for the mid- and inner shelf platforms and the Belle Pass jetties, and throughout the spring-summer at the outer shelf platform (GC 18). At GC 18, the only site that included fall and winter sampling, only a few taxa were represented solely during these months, and included *Etremeus teres* (January-February), *Diplophos taenia* (November) and *Mugil cephalus* (October-November and January-February), among others.

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 (even with clupeiforms removed from the total catch) at the three platforms (Table 2.7). At the outer shelf platform (GC 18), these groups of fishes

Table 2.7. Total plankton net density (fish/100m^3), pushnet density (fish/100m^3), and light-trap CPUE (fish/10 min) for reef-dependent (RD) and reef-associated (RA) families of fish collected at each site with standard error (SE). Densities calculated for the platforms include both surface and subsurface samples. CPUEs calculated for the platforms include surface, subsurface, and offplatform samples. † indicates a value <0.01.

		Green Canyon		Grand Isle		South Timbalier		Belle Pass	
Taxa	Ecology	Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Pushnet density (SE)	Light-trap CPUE (SE)
Anguilliformes									
Muraenidae	RA								
Unidentified		0.01	0.02	0.25	†	0.40	0.01		
(moray eel)		0.01	0.01	0.12	†	0.38	0.01		
Beryciformes	RA								
Holocentridae									
Holocentrus spp.		0.12	0.06	0.09	0.01				
(squirrelfish spp.)		0.07	0.02	0.04	†				
Perciformes									
Serranidae	RA								
Unidentified		0.75		0.12		0.05			
(seabass/grouper)		0.43		0.07		0.05			
Anthinae		0.43	0.01	0.25	†				
(sea perch)		0.15	0.01	0.12	†				
Epinephelinae		0.35	†	0.03	0.01	0.03		†	
(grouper)		0.16	†	0.02	†	0.03		†	
Grammistinae		0.05		0.03					
		0.03		0.02					
Serraninae				0.65	0.03	0.31	0.01		
(sea bass)				0.18	0.01	0.22	0.01		
Priacanthidae	RA								
Unidentified		0.09	†						
(bigeye)		0.06	†						
Priacanthus spp.				0.02			0.01		
(bigeye/glasseye spp.)				0.02			0.01		
Apogonidae	RA	0.01							
Unidentified		0.01							
(cardinalfish)									
Apogon spp.		0.01							
(cardinalfish spp.)		0.01							
Rachycentridae	RA								
Rachycentron canadum				0.08				†	
(cobia)				0.04				†	
Carangidae	RA								

Table 2.7. (continued)

Taxa	Ecology	Green Canyon		Grand Isle		South Timbalier		Belle Pass	
		Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Pushnet density (SE)	Light-trap CPUE (SE)
Unidentified		0.35		0.10	†	0.40		0.02	
(jack)		0.19		0.06	†	0.26		0.02	
Caranx spp.		0.02	†	0.08				0.64	
(jack spp.)		0.02	†	0.05				0.26	
Caranx crysos		2.03	0.17	0.89	0.07		0.11		
(blue runner)		0.89	0.04	0.30	0.02		0.03		
Caranx hippos/latus		2.72	0.09	0.26	0.07	2.49	0.21	0.09	†
(crevalle/horse-eye jack)		0.69	0.02	0.16	0.02	2.25	0.08	0.04	†
Chloroscombrus chrysurus		0.38	0.01	0.65	0.01	27.64	0.08	0.28	0.05
(Atlantic bumper)		0.16	0.01	0.20	0.01	10.19	0.03	0.15	0.02
Decapterus punctatus		0.02	0.01		0.02	0.02	0.02		
(round scad)		0.02	†		0.01	0.02	0.01		
Elagatis bipinnulata		0.13	†						
(rainbow runner)		0.08	†						
Oligoplites saurus				0.08		0.45		0.02	†
(leatherjack)				0.06		0.34		†	†
Selar crumenopthalmus		0.07		0.23			0.01		
(bigeye scad)		0.06		0.10			0.01		
Selene spp.						0.56			
(moonfish/lookdown spp.)						0.56			
Selene vomer		0.16		0.03				†	
(lookdown)		0.16		0.02				†	
Selene setapinnis								†	
(Atlantic moonfish)								†	
Seriola spp.		0.22	†	0.02			†		
(jack spp.)		0.12	†	0.02			†		
Seriola dumerili/rivoliana					0.01				
(greater amberjack/almaco jack)					†				
Seriola fasciata					†				
(lesser amberjack)					†				
Trachinotus carolinus					†		0.01		
(Florida pompano)					†		0.01		
Trachinotus falcatus/goodei					0.01				
(permit/palometa)					0.01				
Trachurus lathami		0.14	0.01	0.09	0.03	0.02	0.04		
(rough scad)		0.08	0.01	0.05	0.01	0.02	0.02		

Table 2.7. (continued)

Taxa	Ecology	Green Canyon Plankton net density (SE)	Green Canyon Light-trap CPUE (SE)	Grand Isle Plankton net density (SE)	Grand Isle Light-trap CPUE (SE)	South Timbalier Plankton net density (SE)	South Timbalier Light-trap CPUE (SE)	Belle Pass Pushnet density (SE)	Belle Pass Light-trap CPUE (SE)
Lutjanidae	RA								
Unidentified		0.03	†	0.08	†	0.16			
(snapper)		0.03	†	0.04	†	0.16			
Lutjanus spp.		0.15	†	0.35	0.01	0.56			†
(snapper spp.)		0.09	†	0.12	0.01	0.42			†
Lutjanus griseus								0.03	
(gray snapper)								0.01	
Lutjanus synagris								0.07	0.01
(lane snapper)								0.02	†
Lutjanus apodus vivanus			0.01						
(schoolmaster/silk snapper)			†						
Lutjanus campechanus			0.01	0.01	0.01	0.56	0.01		
(red snapper)			0.01	0.01	0.01	0.56	0.01		
Pristipomoides aquilonaris		1.25							
(wenchman)		0.56							
Rhomboplites aurorubens		0.03		0.39	0.09		0.03		
(vermilion snapper)		0.03		0.17	0.02		0.02		
Haemulidae	RA								
Unidentified						0.56		†	
(grunt)						0.56		†	
Sparidae	RA								
Unidentified		0.02		0.02	0.01	0.13		0.02	
(porgy)		0.02		0.02	†	0.13		0.01	
Sparidae Type B								0.02	
(porgy sp.)								0.01	
Calamus spp.					†	0.09			
(porgy spp.)					†	0.09			
Lagodon rhomboides		0.24							
(pinfish)		0.16							
Mullidae	RA								
Unidentified			†	0.13	0.02			†	
(goatfish)			†	0.07	0.01			†	
Mullus auratus			†		0.02				
(red goatfish)			†		0.01				
Pseudupeneus maculatus					0.02				
(spotted goatfish)					0.01				
Upeneus parvus					0.13		0.01		
(dwarf goatfish)					0.03		0.01		

Table 2.7. (continued)

Taxa	Ecology	Green Canyon Plankton net density (SE)	Green Canyon Light-trap CPUE (SE)	Grand Isle Plankton net density (SE)	Grand Isle Light-trap CPUE (SE)	South Timbalier Plankton net density (SE)	South Timbalier Light-trap CPUE (SE)	Belle Pass Pushnet density (SE)	Belle Pass Light-trap CPUE (SE)
Ephippidae	**RA**								
Chaetodipterus faber		0.03				0.79		0.05	
(Atlantic spadefish)		0.02				0.36		0.02	
Chaetodontidae	**RD**								
Unidentified		0.02		0.01					
(butterflyfish)		0.02		0.01					
Pomacentridae	**RD**								
Unidentified					0.01				
(damselfish)					0.01				
Abudefduf saxatilis					0.01		0.03		
(sergeant major)					0.01		0.02		
Abudefduf taurus					†				
(night sergeant)					†				
Chromis spp.				0.15	0.15				
(chromis spp.)				0.15	0.04				
Pomacentrus spp.			0.07	0.06	0.17		0.01		
(damselfish spp.)			0.03	0.03	0.05		0.01		
Sphyraenidae	**RA**								
Sphyraena borealis					†		0.01		
(northern sennet)					†		0.01		
Sphyraena guachancho		0.32	0.01	0.94	0.01				
(guaguanche)		0.27	0.01	0.31	†				
Labridae	**RD**								
Unidentified				0.10	†		0.01	0.01	
(wrasse)				0.08	†		0.01	†	
Scaridae	**RD**								
Unidentified		7.33	0.03			0.02			
(parrotfish)		2.11	0.01			0.02			
Sparisoma spp.								0.01	
(parrotfish spp.)								†	
Opisthognathidae	**RA**								
Unidentified				0.47	0.23				
(jawfish)				0.17	0.07				
Opisthognathus spp.				0.03					
(jawfish spp.)				0.03					
Opisthognathus aurifrons				0.03	0.01				
(yellowhead jawfish)				0.03	0.01				

Table 2.7. (continued)

Taxa	Ecology	Green Canyon		Grand Isle		South Timbalier		Belle Pass	
		Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Plankton net density (SE)	Light-trap CPUE (SE)	Pushnet density (SE)	Light-trap CPUE (SE)
Opisthognathus lonchurus				0.05					
(moustache jawfish)				0.05					
Blenniidae	RA								
Unidentified		0.55	0.08	3.02	0.26	2.36	0.07	0.03	0.02
(blenny)		0.34	0.05	2.05	0.07	0.83	0.02	0.02	0.01
Chasmodes spp.								†	
(striped/Florida blenny)								†	
Hypleurochilus bermudensis								†	
(barred blenny)								†	
Hypsoblennius spp.								†	
(blenny spp.)								†	
Hypsoblennius hentz/ionthas					0.61	0.16	0.25	1.95	1.04
(feather/freckled blenny)					0.19	0.16	0.08	0.45	0.27
Hypsoblennius invemar		0.03	†	0.02	3.35	0.56	0.20		
(tessellated blenny)		0.03	†	0.02	0.64	0.56	0.07		
Ophioblennius atlanticus		0.44	0.01	0.22					
(redlip blenny)		0.32	†	0.22					
Parablennius marmoreus				0.01	3.01	0.19	0.01		
(seaweed blenny)				0.01	0.40	0.19	0.01		
Scartella cristata								0.34	0.03
(molly miller)								0.08	0.02
Scartella/Hypleurochilus				0.14	0.42	1.74	0.28		
(blenny spp.)				0.08	0.08	1.18	0.12		
Gobiidae	RA								
Unidentified		6.73	0.20	8.18	0.09	27.7	0.10	0.81	0.03
(goby)		1.75	0.14	0.96	0.02	11.7	0.03	0.23	0.01
Bathygobius soporator								0.01	
(frillfin goby)								†	
Evorthodus lyricus/Gobionellus								0.01	
boleosoma								†	
(lyre goby/darter goby)									
Bollmannia communis					†				
(ragged goby)					†				
Gobionellus oceanicus				0.01	†				
(highfin goby)				0.01	†				
Gobiosoma spp.								1.48	0.26
(goby spp.)								0.43	0.18

Table 2.7. (continued)

Taxa	Ecology	Green Canyon Plankton net density (SE)	Green Canyon Light-trap CPUE (SE)	Grand Isle Plankton net density (SE)	Grand Isle Light-trap CPUE (SE)	South Timbalier Plankton net density (SE)	South Timbalier Light-trap CPUE (SE)	Belle Pass Pushnet density (SE)	Belle Pass Light-trap CPUE (SE)
Gobiosoma bosc								46.88	0.59
(naked goby)								7.88	0.16
Microgobius spp.								4.17	0.04
(goby spp.)								1.30	0.03
Scombridae	RA								
Unidentified		1.42	0.01	0.26	0.05	0.23		0.01	
(mackerel)		0.72	0.01	0.15	0.03	0.17		†	
Acanthocybium solandri		0.03							
(wahoo)		0.03							
Auxis spp.		1.26	0.19	4.00	0.34		0.09		
(mackerel spp.)		0.33	0.05	1.25	0.07		0.05		
Euthynnus alletteratus		0.47	0.07	4.33	1.29	0.43	0.51		
(little tunny)		0.17	0.02	0.74	0.23	0.25	0.18		
Katsuwonus pelamis				0.03	0.03				
(skipjack tuna)				0.02	0.01				
Scomber japonicus					0.01				
(chub mackeral)					0.01				
Scomberomorus spp.								0.01	
(mackerel spp.)								†	
Scomberomorus cavalla		0.06	0.02	0.10	0.13	4.97	0.06		
(king mackerel)		0.05	0.01	0.04	0.04	2.91	0.02		
Scomberomorus maculatus		0.51	0.01	0.28	0.07	6.05	0.33	†	
(Spanish mackerel)		0.28	†	0.12	0.02	1.94	0.07	†	
Thunnus spp.		0.07	0.01		†				
(tuna spp.)		0.07	0.01		†				
Thunnus thynnus		0.11			†				
(bluefin tuna)		0.07			†				
Tetraodontiformes									
Balistidae	RA								
Unidentified				0.01	†				
(leatherjacket)				0.01	†				
Monacanthus hispidus								†	
(planehead filefish)								†	

comprised 18% and 32% of the plankton net and light-trap collections, respectively. Dominant groups included gobiids, scombrids, and carangids. At the mid-shelf platform (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 both plankton net and light-trap collections, as well as gobiids (plankton nets) and scombrids (light-traps). At inner shelf platform (ST54), these fishes comprised less than 1% of the plankton net collections and only 8% of the light-trap collections. Carangids (particularly *Chloroscombrus chrysurus*), gobiids, and scombrids dominated plankton net collections, while scombrids and blenniids dominated light-trap collections. At the Belle Pass jetties, reef-dependent and reef-associated fishes comprised approximately 15% and 2% of pushnet and light-trap collections. Samples by both gears were dominated by gobiids and blenniids, particularly *Gobiosoma bosc* and *Hypsoblennius hentz/ionthas.*

Similarity and Diversity of Larval and Juvenile Fish Assemblages Between Sites

Schoener's Index of Similarity values range from 0 (no similarity) to 1 (identical taxonomic compositions). Similarity values among the sites were relatively low (Table 2.8), with the highest similarity (0.45) occurring between the mid-shelf site (GI 94) and the inner shelf site (ST 54). The next highest value (0.35) was between outer shelf (GC 18) and inner shelf site (ST 54), followed by then mid-shelf site and outer shelf site (0.29). The jetty assemblage was most similar (0.25) to the inner shelf platform (ST 54) assemblage.

Table 2.8. Schoener's similarity indices for all sampling sites. Values range from 0-1 (no similarity-identical) and include taxa (at least to the level of genus) from all gears used at each site. Values represent indices calculated with the most dominant taxa from each site removed. (BP) Belle Pass, (ST) South Timbalier, (GI) Grand Isle, (GC) Green Canyon.

	GC 18	GI 94	ST 54	BP
GC 18	1	.	.	.
GI 94	0.29‡	1	.	.
ST 54	0.35‡	0.45	1	.
BP	0.15‡	0.09	0.25	1

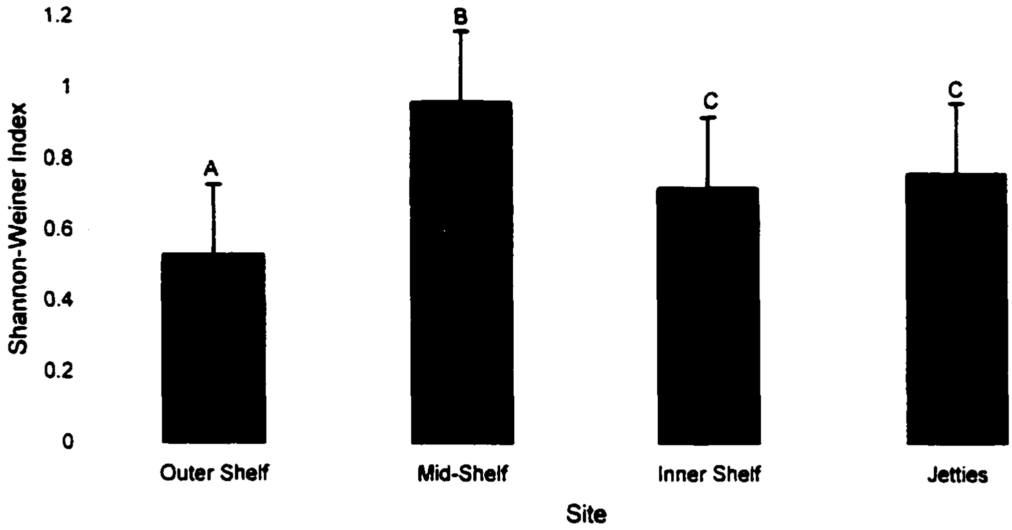
‡ indices computed with April-August samples only

Shannon-Weiner diversity results were similar along the transect of the three platforms and the jetty. There was no significant difference in the diversity of the net samples (passive plankton net or pushnet) among the sites (platforms or jetties; α=0.05; Figure 2.6). The light-trap samples at the outer shelf (GC 18) had significantly lower mean Shannon-Weiner diversity index values, while the mid-shelf platform (GI 94) had significantly higher mean diversity values than the other locations (Tukey's Studentized Range test, α=0.05; Figure 2.6). The diversity of light-trap collections at the two more coastal sites, inner shelf (ST 54) and jetties (Belle Pass), were intermediate and not significantly different from one another.

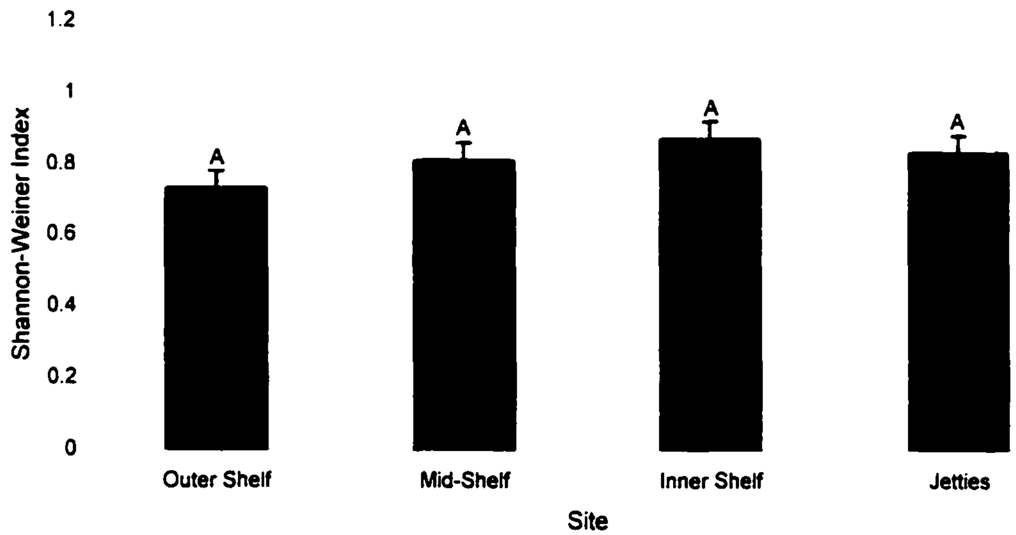
Environmental Variables and Larval and Juvenile Fish Abundances

At the outer shelf platform (GC 18), salinity and temperature were the most useful environmental parameters measured in describing trends in larval and juvenile fish abundances. For plankton net collections, densities of *Cynoscion arenarius*, *Scomberomorus maculatus*, and *Symphurus* spp. were negatively associated with the first environmental canonical variate, which was primarily influenced by salinity (Table 2.9). Densities of *Auxis* spp., *Caranx crysos*, *C. hippos/latus*, *Pristipomoides aquilonaris*, and *Sciaenops ocellatus* were positively associated with the second environmental canonical variate, which was marginally significant (p=0.068) and primarily influenced by temperature. Densities of *Citharichthys spilopterus* and *Mugil cephalus* were negatively associated with the second environmental variate. For the dominant taxa collected with light-traps, six taxa, primarily benthic species such as *Saurida brasiliensis*, *Microdesmus longipinnis*, *Syacium* spp., and *Symphurus* spp., were positively associated with the first environmental variate, which was negatively correlated with salinity and positively correlated with microzooplankton biomass (Table 2.10). Five taxa, comprised mostly of pelagic taxa (i.e., *Auxis* spp., *C. crysos*, *C. hippos/latus*, and *Eucinostomus* spp.) were positively associated with the second environmental variate, which was primarily explained by temperature.

At the mid-shelf platform (GI 94), temperature contributed substantially to the model in describing trends in larval and juvenile fish abundances. For plankton net collections, densities of *Euthynnus alletteratus* and *Symphurus* spp. were positively associated with the first environmental variate, which was positively correlated with temperature and negatively correlated with salinity, while



Light-traps



Plankton nets

Figure 2.6. Mean Shannon-Weiner diversity indices (with standard error bars) for light-trap collections and plankton net (outer, mid- and inner shelf platforms) or pushnet (Belle Pass jetties) collections from each sampling site. The same letter above each bar indicates no significant difference between the sites based on Tukey's Studentized Range tests (α=0.05). Different letters indicate significant differences.

Table 2.9. Results of a canonical correlation analysis on log-transformed plankton net densities (15 most dominant taxa) and environmental variables for Green Canyon 18. Loadings in bold under statistically significant canonical variates V1 and V2 explain at least 15% of the variation for that taxon. Loadings in bold under the environmental canonical variates W1 and W2 indicate the most influential environmental variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.750369	0.26739839	2.8134	0.0001
2	0.502430	0.61197053	1.3766	0.0680

Taxa	Correlations between plankton net densities and their canonical variates	
	V1	V2
Ariomma spp.	0.14	-0.01
Auxis spp.	0.09	**0.52**
Bregmaceros cantori	0.17	-0.12
Caranx crysos	0.23	**0.62**
Caranx hippos/latus	0.10	**0.62**
Citharichthys spilopterus	0.17	**-0.41**
Cyclothone braueri	0.18	-0.13
Cynoscion arenarius	**-0.70**	0.17
Lepophidium spp.	0.09	0.03
Mugil cephalus	0.21	**-0.44**
Peprilus burti	0.11	-0.20
Pristipomoides aquilonaris	0.19	**0.48**
Sciaenops ocellatus	0.06	**0.42**
Scomberomorus maculatus	**-0.74**	0.05
Symphurus spp.	**-0.71**	-0.06

Environmental Variables	Correlations between environmental variables and their canonical variates	
	W1	W2
Zooplankton Biomass	-0.37	0.16
Suspended Solids	0.06	-0.28
Salinity	**0.98**	-0.17
Temperature	-0.51	**0.85**

Table 2.10. Results of a canonical correlation analysis on log-transformed light-trap CPUEs (18 most dominant taxa) and environmental variables for Green Canyon 18. Loadings in bold under statistically significant canonical variates V1 and V2 explain at least 15% of the variation for that taxon. Loadings in bold under the environmental canonical variates W1 and W2 indicate the most influential environmental variables.

Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1 0.566445	0.50304207	3.1136	0.0001
2 0.413382	0.74070398	1.8532	0.0004

Taxa	Correlations between light-trap CPUEs and their canonical variates	
	V1	V2
Auxis spp.	-0.36	**0.57**
Bregmaceros cantori	-0.06	-0.02
Caranx crysos	-0.17	**0.65**
Caranx hippos/latus	-0.13	**0.40**
Cyclothone braueri	0.22	0.11
Cynoscion arenarius	0.27	0.20
Eucinostomus spp.	-0.15	**0.40**
Euthynnus alletteratus	**0.46**	0.34
Gobiesox strumosus	0.16	0.05
Holocentrus spp.	-0.35	**0.50**
Microdesmus longipinnis	**0.39**	0.19
Mugil cephalus	-0.12	-0.31
Peprilus burti	-0.12	-0.04
Pomacentrus spp.	**0.50**	0.24
Saurida brasiliensis	**0.46**	0.22
Syacium spp.	**0.41**	0.25
Symphurus spp.	**0.53**	0.28
Trachinocephalus myops	-0.21	0.24

Environmental Variables	Correlations between environmental variables and their canonical variates	
	W1	W2
Zooplankton Biomass	**0.60**	0.37
Suspended Solids	-0.10	-0.29
Salinity	**-0.87**	-0.42
Temperature	0.37	**0.91**

Synodus foetens was inversely correlated with this variate (Table 2.11). The second environmental variate was explained primarily by salinity, and was positively associated with the scombrids *Auxis* spp. and *E. alletteratus*. For dominant taxa collected with light-traps, abundances of the blenny *Parablennius marmoreus* and the lizardfishes *S. foetens* and *S. poeyi* were positively associated with the first environmental variate, which was positively correlated with salinity and negatively correlated with temperature (Table 2.12). A third lizardfish species, *Saurida brasiliensis*, and *E. alletteratus* were negatively associated with the first environmental variate. *Synodus foetens* was also negatively associated with the second environmental variate, which was correlated with low microzooplankton biomass. The third environmental canonical variate was only marginally significant (p=0.067) and was positively correlated with microzooplankton biomass. Abundances of *Caranx crysos*, *Pomacentrus* spp., *S. foetens*, and *S. poeyi* were positively associated with this environmental variate.

At then inner shelf platform (ST 54) the seasonal variables, temperature and salinity, defined the single significant environmental variate. For plankton net collections, densities of the pelagic species *Chloroscombrus chrysurus* and *Scomberomorus maculatus* were positively associated with the first environmental variate, which was marginally significant (p=0.0552) and positively influenced by salinity and temperature (Table 2.13). *Bregmaceros cantori* and *Etropus crossotus* were negatively associated with the first environmental variate. For light-trap collections, abundances of the carangids *Caranx crysos* and *Chloroscombrus chrysurus* were positively associated with the first environmental variate, which was positively correlated with temperature and salinity (Table 2.14). *Cynoscion arenarius* and *S. maculatus* were negatively associated with the first environmental variate. A second environmental canonical variate was marginally significant (p=0.0708) and was also influenced by salinity. Abundances of *Cynoscion arenarius* were positively associated with the second environmental variate and *Saurida brasiliensis* was negatively associated with the second environmental variate.

At the Belle Pass jetties, temperature, and to some extent salinity, were still influential environmental variables, but turbidity and dissolved oxygen were also important in the models. For pushnet collections, three common coastal taxa (*Dormitator maculatus*, *Gobiesox strumosus*, and *Hypsoblennius hentz/ionthas*) were negatively associated with the first canonical variate, which was explained primarily by temperature (Table 2.15). A second environmental variate was positively

Table 2.11. Results of a canonical correlation analysis on log-transformed plankton net densities (15 most dominant taxa) and environmental variables for Grand Isle 94. Loadings in bold under statistically significant canonical variates V1 and V2 explain at least 15% of the variation for that taxon. Loadings in bold under the environmental variates W1 and W2 indicate the most influential physical variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.588892	0.50402811	3.8641	0.0001
2	0.406611	0.77162236	2.0014	0.0002

Taxa	Correlations between plankton net densities and their canonical variates	
	V1	V2
Auxis spp.	0.06	**0.55**
Bregmaceros cantori	0.01	0.06
Caranx crysos	0.33	0.05
Chloroscombrus chrysurus	0.32	-0.28
Cynoscion arenarius	0.27	-0.18
Etropus crossotus	-0.19	0.12
Euthynnus alletteratus	**0.51**	**0.54**
Microdesmus lanceolatus	-0.20	0.34
Peprilus paru	0.24	0.05
Saurida brasiliensis	0.13	0.06
Sphraena guachancho	0.35	0.19
Syacium spp.	0.30	-0.09
Symphurus spp.	**0.74**	-0.19
Synodus foetens	**-0.55**	-0.35
Synodus poeyi	-0.18	0.03

Environmental Variables	Correlations between environmental variables and their canonical variates	
	W1	W2
Zooplankton Biomass	0.02	-0.38
Suspended Solids	-0.26	0.05
Salinity	-0.73	**0.68**
Temperature	**0.99**	0.01

Table 2.12. Results of a canonical correlation analysis on log-transformed light-trap CPUEs (16 most dominant taxa) and environmental variables for Grand Isle 94. Loadings in bold under statistically significant canonical variates V1, V2, and V3 explain at least 15% of the variation for that taxon. Loadings in bold under environmental variates W1, W2, and W3 indicate the most influential environmental variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.727366	0.36024110	8.2854	0.0001
2	0.407126	0.76494371	2.8369	0.0001
3	0.250076	0.91692543	1.4435	0.0647

Taxa	Correlations between light-trap CPUEs and their canonical variates		
	V1	V2	V3
Auxis spp.	0.34	0.36	0.02
Bregmaceros cantori	-0.20	-0.08	-0.05
Caranx crysos	-0.26	-0.09	**0.42**
Caranx hippos/latus	0.30	-0.21	-0.18
Chromis spp.	0.16	0.36	0.22
Euthynnus alletteratus	**-0.46**	-0.09	0.30
Hypsoblennius hentz/ionthas	0.22	0.30	0.35
Hypsoblennius invemar	0.26	0.23	0.27
Parablennius marmoreus	**0.73**	0.04	0.16
Pomacentrus spp.	-0.02	0.37	**0.46**
Rhomboplites aurorubens	-0.18	0.04	0.11
Saurida brasiliensis	**-0.43**	-0.35	0.09
Scartella/Hypleurochilus	0.30	0.25	0.18
Symphurus spp.	-0.26	0.04	0.19
Synodus foetens	**0.47**	**-0.59**	**0.43**
Synodus poeyi	**0.43**	0.02	**0.55**

Environmental Variables	Correlations between environmental variables and their canonical variates		
	W1	W2	W3
Zooplankton Biomass	-0.20	**-0.59**	**0.75**
Suspended Solids	0.30	0.03	0.17
Salinity	**0.90**	0.35	0.25
Temperature	**-0.94**	0.33	-0.08

Table 2.13. Results of a canonical correlation analysis on log-transformed plankton net densities (15 most dominant taxa) and environmental variables for South Timbalier 54. Loadings in bold under the statistically significant canonical variate V1 explain at least 15% of the variation for that taxon. Loadings in bold under environmental variate W1 indicate the most influential environmental variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.695653	0.29159946	1.3663	0.0552

Taxa	Correlations between plankton net densities and their canonical variates
	V1
Bregmaceros cantori	**-0.43**
Caranx hippos/latus	0.04
Chaetodipterus faber	-0.25
Chloroscombrus chrysurus	**0.72**
Cynoscion arenarius	0.30
Etropus crossotus	**-0.50**
Menticirrhus spp.	-0.18
Microdesmus lanceolatus	0.28
Ophidion nocomis/selenops	-0.22
Peprilus burti	-0.19
Peprilus paru	0.31
Scartella/Hypleurochilus	-0.19
Scomberomorus cavalla	0.19
Scomberomorus maculatus	**0.48**
Symphurus spp.	-0.01

Environmental Variables	Correlations between environmental variables and their canonical variates
	W1
Zooplankton Biomass	0.18
Suspended Solids	0.43
Salinity	**0.96**
Temperature	**0.74**

Table 2.14. Results of a canonical correlation analysis on log-transformed light-trap CPUEs (16 most dominant taxa) and environmental variables for South Timbalier 54. Loadings under statistically significant canonical variates V1 and V2 explain at least 15% of the variation for that taxon. Loadings in bold under environmental canonical variates W1 and W2 indicate the most influential environmental variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.667016	0.38618143	2.6350	0.0001
2	0.472763	0.69571078	1.3486	0.0708

Taxa	Correlations between light-trap CPUEs and their canonical variates	
	V1	V2
Caranx crysos	**0.48**	0.19
Chloroscombrus chrysurus	**0.39**	0.30
Cynoscion arenarius	**-0.47**	**0.45**
Etropus crossotus	-0.12	-0.22
Euthynnus alletteratus	0.18	0.01
Gobiesox strumosus	-0.32	0.36
Hypsoblennius hentz/ionthas	-0.27	0.01
Hypsoblennius invemar	-0.14	-0.26
Peprilus burti	-0.36	0.19
Saurida brasiliensis	-0.16	**-0.41**
Scartella/Hypleurochilus	-0.12	-0.17
Scomberomorus cavalla	0.21	-0.09
Scomberomorus maculatus	**-0.40**	-0.17
Sphoeroides parvus	-0.08	-0.13
Synodus foetens	-0.37	-0.23
Trachinocephalus myops	-0.12	-0.15

Environmental Variables	Correlations between environmental variables and their canonical variates	
	W1	W2
Zooplankton Biomass	0.32	0.14
Suspended Solids	0.23	-0.28
Salinity	**0.72**	**0.64**
Temperature	**0.99**	-0.10

Table 2.15. Results of a canonical correlation analysis on log-transformed pushnet densities (15 most dominant taxa) and environmental variables for Belle Pass. Loadings in bold under the statistically significant canonical variates V1, V2, and V3 explain at least 15% of the variation for that taxon. Loadings in bold under environmental variates W1, W2, and W3 indicate the most influential environmental variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.746141	0.12473748	3.3677	0.0001
2	0.709788	0.28140077	2.6115	0.0001
3	0.553340	0.56711076	1.5750	0.0201

Taxa	Correlations between pushnet densities and their canonical variates		
	V1	V2	V3
Bairdiella chrysoura	-0.13	0.31	-0.14
Citharichthys spp.	-0.01	**0.68**	0.07
Cynoscion arenarius	0.23	**0.75**	0.31
Cynoscion nebulosus	0.14	**0.46**	0.11
Dormitator maculatus	**-0.61**	0.23	-0.21
Gobiesox strumosus	**-0.75**	0.21	-0.18
Gobionellus oceanicus	0.25	0.29	0.01
Gobiosoma bosc	-0.31	**0.58**	0.05
Gobiosoma spp.	-0.29	-0.20	**-0.43**
Hypsoblennius hentz/ionthas	**-0.39**	-0.15	0.01
Membras martinica	-0.26	-0.32	**0.70**
Microgobius spp.	0.25	-0.34	-0.23
Sciaenops ocellatus	0.30	0.35	0.20
Symphurus spp.	-0.20	0.22	0.26
Synodus foetens	-0.18	0.36	-0.28

Environmental Variables	Correlations between environmental variables and their canonical variates		
	W1	W2	W3
Temperature	**0.91**	0.20	-0.13
Salinity	0.06	-0.06	**0.98**
Dissolved Oxygen	-0.04	**0.84**	-0.53
Turbidity	0.31	**-0.59**	-0.49

correlated with dissolved oxygen and negatively correlated with turbidity. Abundances of *Citharichthys* spp., *Cynoscion arenarius*, *C. nebulosus*, and *Gobiosoma bosc* were positively associated with the second canonical variate. Abundances of *Gobiosoma* spp. were negatively associated with the third environmental variate, which was positively correlated with salinity, while *Membras martinica* was positively associated with this variate. For light-trap collections, three taxa (i. e., *G. strumosus*, *H. hentz/ionthas*, and *Sphoeroides parvus*) were negatively associated with the first canonical variate, which was positively correlated with temperature, and to a lesser extent, turbidity (Table 2.16).

DISCUSSION

Reef Fishes Collected at the Offshore Oil and Gas Platforms and the Belle Pass Jetties

Overall, reef-dependent taxa (e.g., chaetodontids, pomacentrids, labrids, and scarids) were relatively rare (Table 2.7). Pomacentrids and chaetodontids were collected only at the shelf slope and mid-shelf sites, while labrids and scarids were also collected at the inshore sites. The 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 (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 more common and often times represented a significant component of the community assemblage at each site.

The relatively low abundance of reef fish larvae and juveniles compared to pelagic species at the outer shelf platform (GC 18) is in contrast to the adult community described by Gallaway (1981). However, the studies cited in Gallaway's (1981) synthesis were primarily visual (SCUBA diver) surveys interested in adult fishes associated with the natural and artificial structures, and not necessarily taxa in the surrounding water column. Pelagic species, therefore, may have been underestimated in those previous studies. Also, 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.

Table 2.16. Results of a canonical correlation analysis on log-transformed light-trap CPUEs (15 most dominant taxa) and environmental variables for Belle Pass. Loadings in bold under the statistically significant variate V1 explain at least 15% of the variation for that taxon. Loadings in bold under environmental canonical variate W1 indicate the most influential physical variables.

	Canonical Correlation	Likelihood Ratio	Approximate F	Pr > F
1	0.679900	0.33598275	1.56599	0.0032

Taxa	Correlations between light-trap CPUEs and their canonical variates
	V1
Bairdiella chrysoura	0.22
Chloroscombrus chrysurus	0.13
Citharichthys spp.	-0.14
Cynoscion arenarius	-0.20
Dormitator maculatus	-0.19
Gobiesox strumosus	**-0.83**
Gobionellus oceanicus	0.16
Gobiosoma bosc	-0.14
Gobiosoma spp.	-0.19
Hypsoblennius hentz/ionthas	**-0.68**
Membras martinica	0.22
Microdesmus longipinnis	0.08
Sphoeroides parvus	**-0.61**
Symphurus spp.	0.08
Synodus foetens	-0.07

Environmental Variables	Correlations between environmental variables and their canonical variates
	W1
Temperature	**0.76**
Salinity	0.18
Dissolved Oxygen	-0.24
Turbidity	**0.42**

While not a reef fish, the presence of preflexion *Sciaenops ocellatus* at outer platform site in September is noteworthy, since they are commonly found on the inner shelf and near coastal inlets (Ditty et al. 1988). Early larval stages have been collected as far as 17-34 km offshore (Lyczkowski-Shultz et al. 1988), suggesting either some offshore spawning may occur or that periodic offshore transport events may occur. Green Canyon 18 is located approximately 179 km offshore in 230 m of water and it is unlikely that local spawning is occurring at these depths. More likely, the presence of these larvae was related to hydrographic features in the area at the time of sampling. The July and August sampling trips which preceded the collection of *S. ocellatus* were characterized by intrusions of low salinity water. While the mean surface salinity was more typical of offshore waters by September (35 ppt), it is possible that the area was seeded with these larvae (or eggs) when inshore waters were advected offshore.

Overall, there was greater taxonomic richness among reef fish collected at the mid-shelf platform (GI 94) than the outer shelf platform (GC 18). By far the most dominant reef-associated fish taxa at GI 94 were blenniids, particularly *Parablennius marmoreus* 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 there small size, cryptic coloration, and tendency to hide in attached barnacle shells. Some blenniids have been found to be rather unusual compared to other common reef-associated taxa in that they have demersal eggs and pelagic, yet fairly competent larvae that appear to be able to feed immediately and are attracted to light (Thresher 1984). If the same early life history attributes are true for the blennies collected at the platform sites, then these traits may combine to form a mechanism by which these taxa are retained and concentrated around platform structures. Other reef taxa that hatch from demersal eggs and have demonstrated photopositive behavior include gobies and pomacentrids, although these larvae are not as competent upon hatching (Thresher 1984). At the mid-shelf platform, unidentified gobiids and pomacentrids, primarily *Chromis* spp. and *Pomacentrus* spp., ranked next in abundance. 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.

Few reef fish larvae and juveniles were collected at the inner shelf platform (ST 54). The low reef fish abundances are not surprising, particularly for the more tropical taxa such as haemulids, labrids, and scarids. The adults of many of these taxa are more typical of the outer shelf assemblages. Similarly with regards to reef fish larvae and juveniles, this trend of decreasing taxonomic richness towards the more inshore environments is supported somewhat by this study, particularly with regards to scarids. Even though an inner shelf platform would be downstream from potentially more offshore and along-shelf sources of larvae and recruits (greater density of platforms), perhaps the potentially less favorable inshore environmental conditions result in increased mortality (Leis 1991).

At the Belle Pass jetties, the presence of lutjanid juveniles (*Lutjanus griseus* and *L. synagris*) is noteworthy because it indicates that coastal, artificial structures even in relatively low salinity environments may play a role as nursery areas in the absence of other structurally-complex habitats, such as seagrass beds in more high-salinity, oligotrophic estuaries. Many species of reef-associated or reef-dependent fish do not settle directly onto reefs but utilize other coastal habitats as nursery grounds prior to moving to offshore reefs. While habitats such as high-salinity seagrass beds are important to many reef related species (Connolly 1994), other structurally-complex habitats have been identified as nurseries (Ferrell and Bell 1991; Bennett 1989; Ross and Moser 1995). Seagrass beds are often the most common form of shelter available in certain settlement areas, but experimental evidence suggests that presettlement larvae of a number of different species select any structurally-complex habitat at the time of settlement (Bell et al. 1987). Due to the overwhelming influence of the Mississippi River and its distributaries, Louisiana estuarine and coastal areas are generally low salinity (18-25 ppt at Belle Pass from April to September), turbid, and lacking in seagrass beds and naturally-occurring hard substrate habitats (except for oyster reefs). Therefore, the role of the artificial habitats such as jetties and breakwaters may be more important as islands of refuge for individuals that would otherwise be lost to unsuitable habitat and, therefore, elevated mortalities.

Taxonomic Similarity Among Sites

Since all sites sampled during this study were heavily dominated by a single taxon, only the similarity values calculated after the dominant taxa were removed are discussed. 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 mid-shelf platform (GI 94) and inner shelf platform (ST 54). This is not unexpected since sampling sites were purposely chosen to be in different depth zones across the shelf where adult faunal transitions had been documented (Gallaway et al. 1980; Gallaway 1981), and indeed similar larval/juvenile transitions occurred. The Belle Pass jetties, which were heavily influenced by the presence of estuarine and coastal pelagic taxa, was very different from the mid-shelf (GI 94) and outer shelf (GC 18) platforms, where mesopelagic and tropical taxa were influential. Similarity indices for the mid-shelf platform (GI 94) displayed the expected cross-shelf transitional pattern, with the highest similarity values being for the adjacent sites, the inner shelf (ST 54) and outer shelf site (GC 18), followed by the Belle Pass jetties. The highest similarity index for the outer shelf platform (GC 18), however, was with the inner shelf platform (ST 54), whereas one might have expected GC 18 to be most similar to GI 94 (mid-shelf platform). This somewhat unexpected result is probably due to the large number of reef taxa collected at the mid-shelf site (GI 94) that were unique to that site (Table 2.7). 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 mid-shelf platform (GI 94). Other taxa (ephippids and scarids) were collected at the outer shelf and inner shelf platforms (GC 18 and ST 54), but not at the mid-shelf platform (GI 94).

While using a similarity index to characterize assemblages helps to synthesize large amounts of information, the analyses are confounded by several problems which can make the results difficult to interpret. First of all, the index is highly influenced by large numbers of individuals of a single taxon and confidence intervals can be quite large (Ricklefs and Lau, 1980). This is why I ran analyses without the most dominant taxa from each site, which helped to identify trends that may have otherwise been overwhelmed in the complete data set. Secondly, in any comparison between two sites, samples were only used when seasonality overlapped in sampling efforts. In this way, the same species pool would theoretically be available for collection. However, at times this led to large disparities in sampling effort

between sites within a comparison. Finally, taxa utilized in the analyses were limited by the inability to identify many of the larval fishes collected over the course of the study. Since an attempt was made to analyze the taxonomic assemblage at the lowest level possible, large numbers of fish which could not be identified to genus were eliminated from the analyses. Overall, however, the index provides some idea of the similarity in community assemblages across the shelf.

Taxonomic Diversity Among Sites

The mean diversity indices based on plankton net collections taken at the platform sites and the pushnet collections taken at Belle Pass were not significantly different from each other, ranging from 0.73-0.83. They were, however, slightly higher than those for the light-trap collections, with the exception of GI 94. In general, observed statistical differences in Shannon-Weiner diversity indices between sites were limited to light-trap collections. The similarity between the light-trap diversity indices for the inner shelf platform (ST 54) and the Belle Pass jetties is not surprising, since both sites were dominated by large numbers of photopositive clupeiform fishes, which also lowered their diversity indices. Light-trap collections were significantly more diverse at the mid-shelf platform (GI 94), a result of being less dominated by clupeiform fishes than the inner shelf platform (ST 54) and the Belle Pass jetties, and of collecting more taxa, particularly reef fish species, than the outer shelf platform (GC 18). In general, taxonomic richness in light-traps was highest at the mid-shelf platform (GI 94), with 90 taxa identified to genus as compared to 65 taxa at the inner shelf (ST 54), the platform with the second highest number of light-trap 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 the inner shelf platform (ST 54) and the jetties, the two inshore sites. In contrast, species richness and abundance is generally relatively low on the outer shelf, due to the homogeneity of the bottom substrate (Bond 1996). 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. This homogeneity and the 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 the outer shelf platform (GC 18).

Environmental Variables and Larval and Juvenile Fish Abundances

Canonical correlation analyses were used to determine the relationship between dominant taxa collected at the sampling sites and environmental/biological parameters, i.e., temperature, salinity, turbidity, dissolved oxygen, and microzooplankton biomass. At all of the sampling sites, temperature and salinity appeared to explain most of the variation in larval abundances in the models. This is not surprising as these physical variables change seasonally, and to some extent spatially across the shelf. Occasionally, both temperature and salinity were important factors within a single environmental canonical variate, which is probably a reflection of seasonality, i.e., in the northern Gulf as temperatures increase during the late spring through the summer and early fall, salinities tend to increase as well, due to decreased Mississippi/Atchafalaya River runoff and increased evaporation/precipitation ratios.

Many of these relationships (based primarily on the seasonal variables temperature and salinity) were consistent with known information on the seasonal occurrences of the different species. For example at the outer shelf platform (GC 18), where samples were collected nearly year-round, *Mugil cephalus* was found to be negatively associated with temperature in plankton net samples, which is consistent with their peak periods of abundance (December-February) in the northern Gulf (Ditty et al. 1988). Larvae of *M. cephalus* are most commonly found over the outer to mid-shelf (Ditty and Shaw 1996), so their presence at the outer shelf sampling station is not surprising. Though the adults are common in shelf and coastal waters (Hoese and Moore 1977), *M. cephalus* was not collected at the mid- or inner shelf platforms. This is primarily a result of the limited sampling effort (April-August or September) at the other platforms, that did not encompass the spawning season (October through March; Leard et al. 1995), so the relative abundance of *M. cephalus* larvae at these platforms is unknown. Other species collected in plankton nets at the outer shelf platform were positively associated with temperature and represent taxa with peak larval abundances in the spring and summer months, such as *Auxis* spp. (May-September), *Caranx crysos* (June-August), and *C. hippos/latus* (April-August; Ditty et al. 1988). Relationships between seasonal variables (temperature and salinity) and larval peaks in abundance were observed at all sites. For example, positive relationships between abundances and temperature and

salinity were found for species with summer peaks in larval abundance, such as *Auxis* spp. (May-September) at the mid-shelf platform)GI 94) and *Chloroscombrus chrysurus* (June-September) and *Scomberomorus maculatus* (August-September) at the inner shelf platform (ST 54). Negative relationships for species with spring or winter peaks were found as well, such as previously mentioned *Mugil cephalus* at the outer shelf platform (GC 18) and *Gobiesox strumosus* (March-May) at the Belle Pass jetties.

While seasonality seems to be an important factor, trends in larval abundances could also reflect the environmental optima and preferences of some species. *Membras martinica*, for example, is found primarily in more saline areas along the coast, as well as offshore areas (Hoese and Moore 1977). At the Belle Pass jetties, pushnet densities for this species were positively associated with salinity. Larval and juvenile *Caranx crysos* prefer warmer, more saline waters (Patillo et al. 1997), and this species was often positively associated with temperature and salinity at the platforms.

Differences in the relationship between plankton net and light-trap collections may be a reflection of biases towards different life history stages, since plankton nets typically collect younger, less competent larvae, while light-traps collect larger larvae and juveniles. At the inner shelf platform (ST 54), for example, net collections of *Scomberomorus maculatus* were positively associated with temperature and salinity, while light-trap collections were negatively associated with these variables. This is consistent with the known early life history preferences for this species, as larval *S. maculatus* require relatively higher temperatures and salinities than juveniles, which are generally more eurythermal and euryhaline (Patillo et al. 1997).

Dissolved oxygen and turbidity were also important variables at the Belle Pass jetties for some species, but little is known about these requirements or preferences for the early life stages of many fishes. Some species which were very photopositive (i.e., *Gobiesox strumosus* and *Hypsoblennius hentz/ionthas*) were also negatively associated with turbidity in the light-trap samples, possibly because of decreased light-trap efficiency in highly turbid waters. Microzooplankton biomass was influential in the models at the outer and mid-shelf platforms (GC 18 and GI 94), but only in light-trap collections. Some of these light-trap taxa that were positively associated with zooplankton biomass included larval

forms such as *Euthynnus alletteratus*, *Saurida brasiliensis*, and *Synodus foetens*, which have well developed mouths and teeth at small sizes and are able to quickly feed on zooplankton.

While canonical correlation analyses were useful in characterizing the environmental correlates for most species, results for others were confounding. At the inner shelf platform (ST 54), for example, *Cynoscion arenarius* was negatively associated with the first environmental variate which related temperature and salinity, but positively associated with the second environmental variate which was positively correlated with salinity alone. In many instances, the models did not explain a large amount of the variation (15%) for many species. One possible reason for some of these discrepancies is that spawning seasons and periods of larval abundances for many species occurred throughout the entire sampling season (late spring-summer) for many species, particularly at the mid- and inner shelf platforms (GI 94 and ST 54) and the Belle Pass jetties. This is the case for species such as *Citharichthys* spp., *Citharichthys spilopterus*, *Cynoscion nebulosus* and others (Ditty et al. 1988). For other species, particularly small fishes with little economic value such as many of the lizardfishes (*Synodus foetens*, *S. poeyi*, *Saurida brasiliensis*) and blennies (*Hypsoblennius hentz/ionthas*, *H. invemar*, and *Scartella/Hypleurochilus*), little information is available on peak occurrences of these taxa across the shelf. In this respect, this study provides an important contribution to the life history information on these taxa across the shelf.

A major problem for managing reef resources is the incomplete understanding of the interactions between recruitment and habitat structure. Although habitat space may ultimately be limiting, many reef fish populations are not at the carrying capacity of their environment and changes in abundance may be controlled by settlement from the plankton or by early postsettlement mortality. Nothing has been published on the relationship between offshore petroleum platforms and the early life history stages of fishes anywhere in the world. These findings, along with those of the larger LSU program as a whole (Chapter 1), represent an important first contribution towards this aspect of artificial reef research.

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CHAPTER 3

COMPARISON OF PLANKTON NET AND LIGHT-TRAP METHODOLOGIES FOR SAMPLING LARVAL AND JUVENILE FISHES ASSOCIATED WITH OFFSHORE PETROLEUM PLATFORMS AND A COASTAL JETTY OFF LOUISIANA

INTRODUCTION

Most marine fishes, particularly structure-associated or reef-dependent fishes, have a pelagic early life history stage (Moser et al. 1984; Leis 1991). Previous studies have indicated that larval source, supply, recruitment, and settlement patterns can greatly influence the adult population dynamics of reef fish on both natural (Victor 1983, 1986; Sponaugle and Cowen 1996) and artificial reefs (Lukens 1981; Stephens et al. 1994). In response to the need for crucial information on reef fish early life history stages, several methods have been developed to collect larval and juvenile fishes in a variety of environments. Many reef fish juveniles at one time or another are associated with structurally-complex habitats, either while they reside in a nursery area (mangroves, seagrass meadows, oyster reefs) or once they settle onto the reef environment itself. While towed sampling gears are effective in open waters, these methods are usually not suitable for shallow or structurally complex habitats (Brogan 1994).

Different methodologies have been developed to collect fish early life stages in complex environments, including plankton pumps (Taggert and Legget 1984; Brander and Thompson 1989), visual censuses (Kingsford and Choat 1989), moored channel nets (Keener et al. 1988; Shenker et al. 1993), larval purse seines (Murphy and Clutter 1972; Choat et al. 1993), and diver-steered plankton tows (Marliave 1986; Brogan 1994). Other methods have used light sources to aggregate fish for collection and include lighted purse seines (Choat et al. 1993), light lift-nets (Dennis et al. 1991; Rooker et al. 1996) and light-traps of various designs (Doherty 1987; Thorrold 1992; Choat et al. 1993; Brogan 1994; Sponaugle and Cowen 1996; Hernandez and Lindquist 1999; Hickford and Schiel 1999; Reyns and Sponaugle 1999). All of these methods have different biases, advantages, and disadvantages, and should be chosen to best suit the environment being sampled and the questions being addressed.

To date, very few studies have investigated the ichthyoplankton assemblages associated with offshore oil and gas platforms in the northern Gulf of Mexico (Gulf) or any where else in the world, in part due to the difficulties in sampling within the complex, mostly vertical infrastructure of the platforms. Gallaway (1998) calculated that oil and gas platforms in the northern Gulf provided 11.7 km^2 (or <0.4%) of the total "reef" habitat. However, platforms represent vertical artificial substrate that extends from the bottom to the surface (photic zone), regardless of location and depth, which increases their significance (Parker et al., 1983). These and other artificial structures (e.g., jetties, breakwaters) could represent

significant habitats for reef fish, since the northern Gulf is dominated by a mud/silt/sand bottom with little vertical relief or hard-bottom habitat. In an attempt to characterize the across-shelf ichthyoplankton assemblages along a transect of artificial structures (three offshore oil and gas platforms and a coastal jetty) in the northern Gulf, a variety of gear types was used in an effort to sample the widest range of taxa, size classes, and developmental stages available. This paper reports the results of gear comparisons between a passive plankton net and light-trap used at the petroleum platforms. It also includes comparisons between a bow-mounted, plankton pushnet and light-trap (the same design) used at a coastal jetty. Previous studies have demonstrated that pushnets are effective in sampling larger juveniles and small fishes, particularly in coastal areas (Herke, 1969; Kriete and Loesch, 1980; Raynie and Shaw, 1994). In these comparisons, the taxa collected by the different gears, their similarity and diversity, as well as the size selectivities of the gears are examined. These findings will be useful to those designing similar sampling efforts for larval and juvenile fishes in the vicinity of complex structures or for those interested in collecting the full spectrum of sizes or developmental stages in their habitat surveys.

MATERIALS AND METHODS

Study Sites

Data collection and analyses focused on three oil and gas platforms in the northern Gulf and at a coastal rock jetty environment. The jetties provided a far-field, shallow, and low salinity non-platform site end-member that was also structurally complex and represented another artificial reef-type, hard-substrate habitat. Site selection for the three study platforms (west of the Mississippi River Delta) was based upon previous work (Gallaway et al. 198; Gallaway 1981; Continental Shelf Associates 1982) which reported that continental shelf nekton communities associated with natural and artificial reefs could be categorized by water depth in the northern Gulf. Three communities were characterized: a coastal assemblage (3-20 m depth), an offshore assemblage (20-60 m), and a bluewater/tropical assemblage (water depths >60 m). The platforms selected and the jetty site 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, extra samples during the first quarter and third quarter moon phases were collected during May, but due to inclement weather, full moon collections were cancelled. Exxon's South Timbalier (ST) 54G, which lies in approximately 20 m of water on the inner shelf (28°50'01"N, 90°25'00"W), was sampled twice monthly during new and full moon periods over a 2-3 night period in during April-September, 1997. The stone rubble jetties (2-3 m depth) at the terminus of Belle Pass, a major shipping channel near Fourchon, Louisiana (29°03'90"N, 90°13'80"W), were also sampled over a two night period in 1997 simultaneously with the sampling of ST 54.

Sampling Procedure

Sampling protocols are described in detail in Chapter 2. In general, passive plankton nets (60-cm diameter; 333μm mesh dyed green) were used to collect ichthyoplankton at the three platform sites, both at depth (15-23 m for 10-20 min, set and retrieved closed) and near surface (1-2 m for 10-15 min) within the platform structure with the intent of sampling roughly equivalent amounts of water at both depths.. Quatrefoil light-traps were deployed for 10 minutes at depth and near surface within the platform structure. An additional light-trap was floated downstream (approximately 20 m) from the platform for off-platform collections. Both the subsurface and off-platform light-traps were deployed with the light off until the sampling depth/location was reached, fished, and then retrieved with the light off. Light-trap samples were standardized to a catch-per-unit-effort (CPUE) of fish per 10 minutes. At Belle Pass, light-traps and a bow-mounted plankton pushnet (1 m x 1 m; 1000 μm mesh net dyed green; 3-5 min samples) were fished along the jetty walls. Plankton net and pushnet samples were standardized to the number of fish collected per 100 m^3 (density).

The quatrefoil light-trap (Figure 3.1) was modified from Floyd et al. (1984) and Secor et al. (1993). The main modifications are described as follows. The acrylic tubes in the main body of the trap were enlarged to 15.24 cm (6") outer diameter. The collection assembly at the bottom of the trap was replaced with short conical plankton-net (202 μm) and cod-end assembly. Four, vertical stainless steel threaded bars were added to the corners of the trap for additional support. The light source was a Brinkman Starfire II 12-volt halogen fishing light (250,000 candlepower). For surface samples, power was supplied through an umbilical cord by a 12-volt marine battery located on the lower deck of the

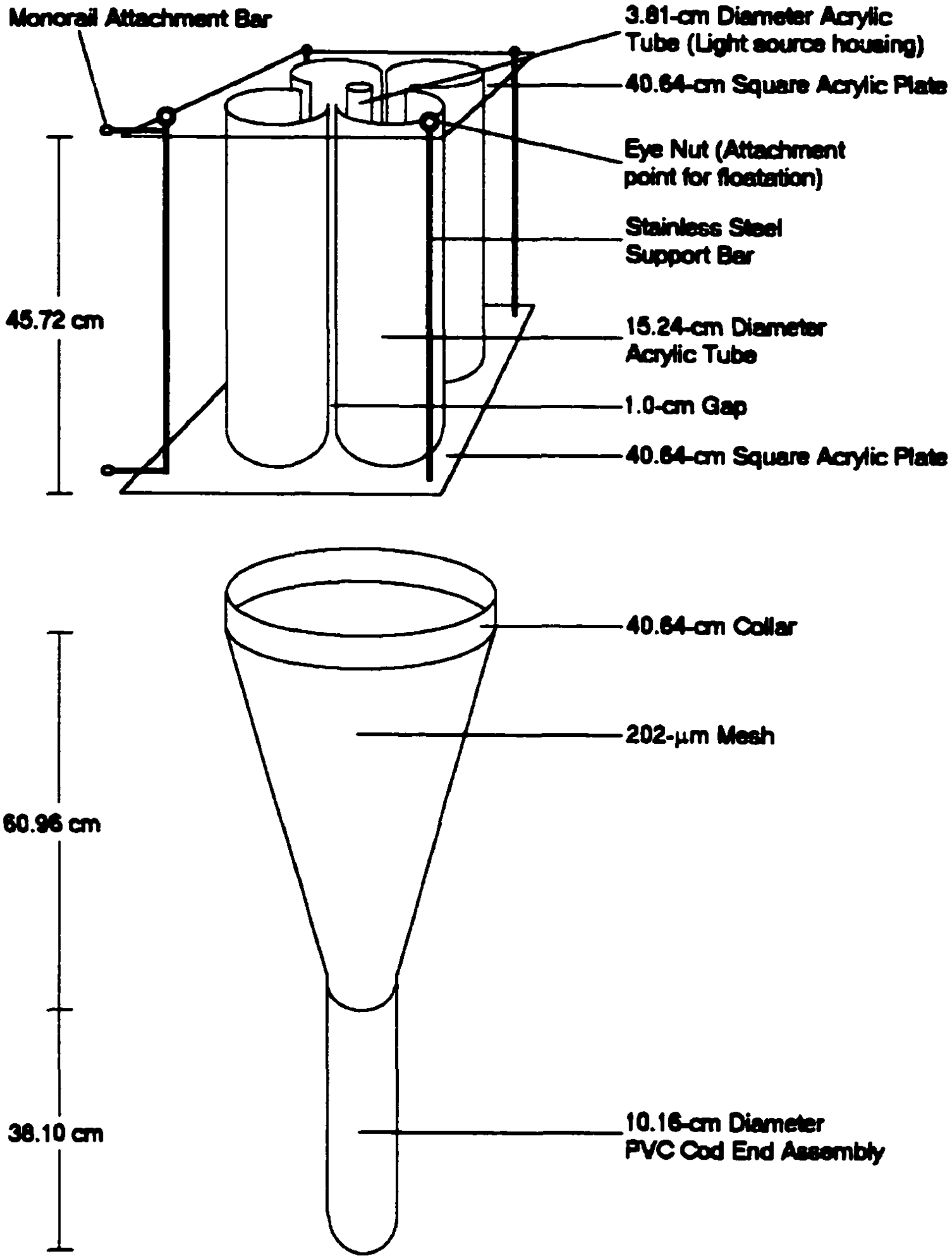


Figure 3.1. Specifications for the modified quatrefoil light-trap used in this study.

platform. For subsurface collections, either an umbilical cord connected to a 12-volt battery or a submersible battery pack was used. The battery pack was made by placing a 7.0 amp/h rechargeable sealed lead battery in a 1/4" thick PVC tube with a watertight connector on one end and a complimentary pig-tail on the end of the cable supplying power to the light.

Analyses of Data

Due to the very large numbers of clupeiform (Clupeidae and Engraulidae) fishes collected, particularly in light-trap samples, statistical analyses were run without these taxa, unless otherwise noted. Clupeiform fishes are seldom the taxa of interest in studies of hard substrate habitats (e.g., artificial reefs), and their abundances tend to overwhelm the trends of other taxa (Choat et al., 1993). All ANOVA, Tukey's Studentized Range Tests, and Student's t-tests were run with SAS version 6.12 (SAS, 1989).

Studentized t-tests (α=0.05) were used to compare overall plankton net densities between locations (subsurface and surface) within the outer (GC 18), mid- (GI 94), and inner (ST 54) shelf platforms. Light-trap CPUEs were compared between locations (subsurface, surface, and off-platform) within each of the platform sites using an ANOVA model with gear as a main effect. Tukey's Studentized Range tests were used to determine which light-trap collections were significantly different. Before testing, plankton net densities were log transformed ($\log_{10}(x+1)$) in an effort to conform to normality and homogeneity of variances. Analyses on light-trap CPUEs were run on ranked-transformed data.

Kolmogorov-Smirnov (K-S) length-frequency analyses (α=0.05) were performed for selected species from GC 18, GI 94, ST 54, and Belle Pass to determine if there were any significant differences between size distributions of fish collected with light-traps vs. plankton nets (Sokal and Rohlf, 1981). Taxa from each platform site and the Belle Pass jetties were chosen for these analyses if at least 10 individuals were collected by each gear type. All K-S analyses were performed using SYSTAT version 4 (SPSS, 1999).

Lunar periodicity (full vs. new moon) was examined for plankton net and light-trap samples collected at the mid- and inner shelf platforms, as well as the Belle Pass jetties, using Student's t-tests (α=0.05). An ANOVA model and Tukey's Studentized Range tests were used to analyze the densities

and CPUEs of samples collected in May of 1996 at the mid-shelf platform (third quarter, new, and full moon periods).

Schoener's Index of Niche Overlap (Schoener, 1970) was calculated for comparisons of ichthyoplankton collections within each platform structure (surface net and surface light-trap) and far-field collections (off-platform light-trap) in addition to total net vs. total light-trap collections. This same analysis (total net vs. total light-trap) was performed to compare the similarity of collections at the Belle Pass jetties. Only fish identified to at least the genus level were used in the analyses. Shannon-Weiner diversity indices (Magurran, 1988) were calculated for each sample collected at GC 18, GI 94, ST 54, and Belle Pass. Differences in diversity between gear types at each site 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 gear types were significantly different. Only fish identified at least to the level of genus were included in these analyses. Because the intent of the similarity and diversity indices was to characterize the taxonomic assemblages sampled by each gear type, clupeiform fishes were included for these analyses. Taxonomic richness (either at the family or genus/species level) is used in reference to the number of taxa collected.

RESULTS

Overall Abundances

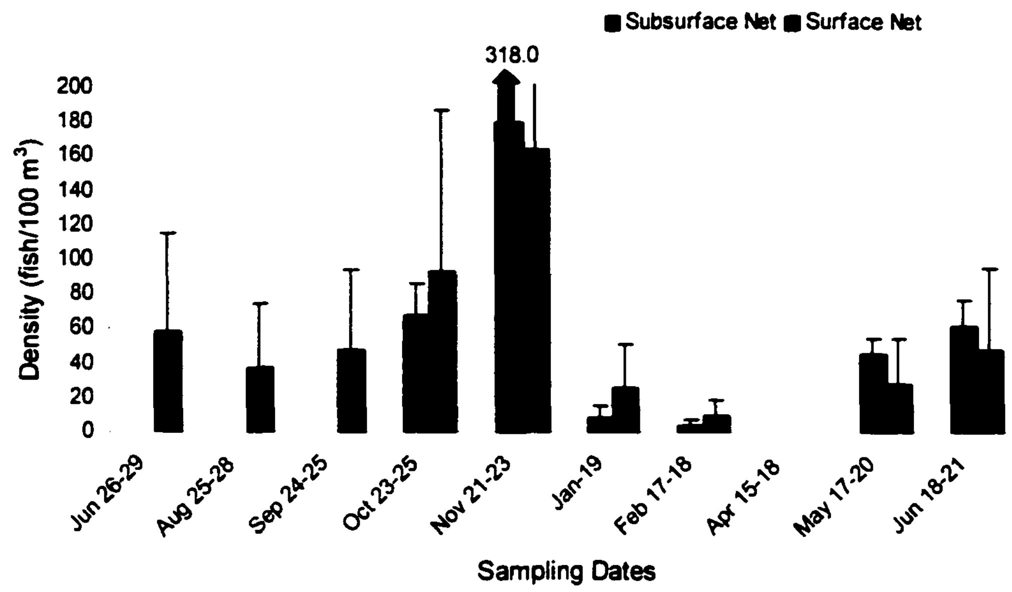
At the outer shelf platform (GC 18), plankton nets and light-traps collected 1,404 and 659 fish, respectively (excluding clupeiforms), with a mean total density of 74.6 fish/100m^3 and a mean total CPUE of 2.1 fish/10 min (Table 3.1). Plankton nets collected fish from more families than light-traps, 15 of which were exclusively from plankton nets. Light-traps collected seven families which were not collected in plankton nets. Plankton nets collected fish from 56 taxa (identified at least to genus level), 25 of which were not collected with light-traps; whereas light-traps collected fish from 47 taxa, with 14 being unique to light-trap collections. Mean plankton net densities ranged from 3.3-318.0 fish/100 m^3, while light-trap CPUEs ranged from 0-12.2 fish /10 min (Figure 3.2). *Sciaenops ocellatus*, *Caranx hippos/latus*, and *Mugil cephalus* were among the most common non-clupeiform fishes in the plankton net collections (Table 3.2). Coastal pelagic taxa such as *Auxis* spp., *Caranx crysos*, and *C. hippos/latus* were common in the surface and off-platform light-trap collections.

Table 3.1. Number of samples, total individuals, families, and taxa (excluding clupeiforms) collected at each site with a passive plankton net, light-trap, and plankton pushnet. Mean total densities (nets) or CPUEs (light-traps) are also provided for each gear at each site. For each site, values in parentheses indicate the number of families or taxa (at least to genus level) unique to that gear type.

Gear Type	Number of samples	Number of fish	Mean Total Density and CPUE	Number of families	Number of taxa
Green Canyon 18					
Passive Plankton Net	125	1,404	74.6 fish/100m^3	43 (15)	56 (25)
Light-trap	319	659	2.06 fish/10 min	35 (7)	47 (14)
Grand Isle 94					
Passive Plankton Net	329	3,076	69.6 fish/100m^3	38 (6)	75 (26)
Light-trap	474	12,474	26.2 fish/10 min	35 (3)	78 (27)
South Timbalier 54					
Passive Plankton Net	89	1,689	166.0 fish/100m^3	32 (8)	50 (16)
Light-trap	194	1,193	0.6 fish/10 min	32 (8)	56 (24)
Belle Pass Jetties					
Plankton Pushnet	149	33,147	136.7 fish/100m^3	39 (20)	77 (44)
Light-trap	148	849	4.6 fish/10 min	19 (0)	34 (3)

At the mid-shelf platform (GI 94), plankton nets collected 3,076 fish while light-traps collected 12,474 fish, with a mean total density of 69.6 fish/100 m^3 and a mean total CPUE of 26.2 fish/10 min (Table 3.1). Plankton nets collected individuals from more families than light-traps. However, light-traps collected more taxa (genus level) than plankton nets. Twice as many unique families were collected by plankton nets, while the number of unique taxa collected by each gear type was nearly identical. Mean plankton net densities ranged from 16.6-201.0 fish/100 m^3, while light-trap mean CPUEs ranged from 1.2-197.1 fish/10 min (Figure 3.3). Benthic taxa such as *Symphurus* spp. and *Bregmaceros cantori* were common in plankton net collections, as well as coastal pelagic species such as *Auxis* spp. and *Euthynnus alletteratus* (Table 3.2). Among the most common fishes collected in light-traps were synodontids (primarily *Synodus foetens* and *S. poeyi*) and blenniids (primarily *Hypsoblennius invemar* and *Parablennius marmoreus*).

At the inner shelf platform (ST 54), plankton nets and light-traps collected 1,689 and 1,193 fish, respectively, with a mean total density of 166.0 fish/100 m^3 and a mean total CPUE of 0.6 fish/10 min (Table 3.1). Due to problems with the deploying the subsurface net at this site (Table 2.1), the plankton



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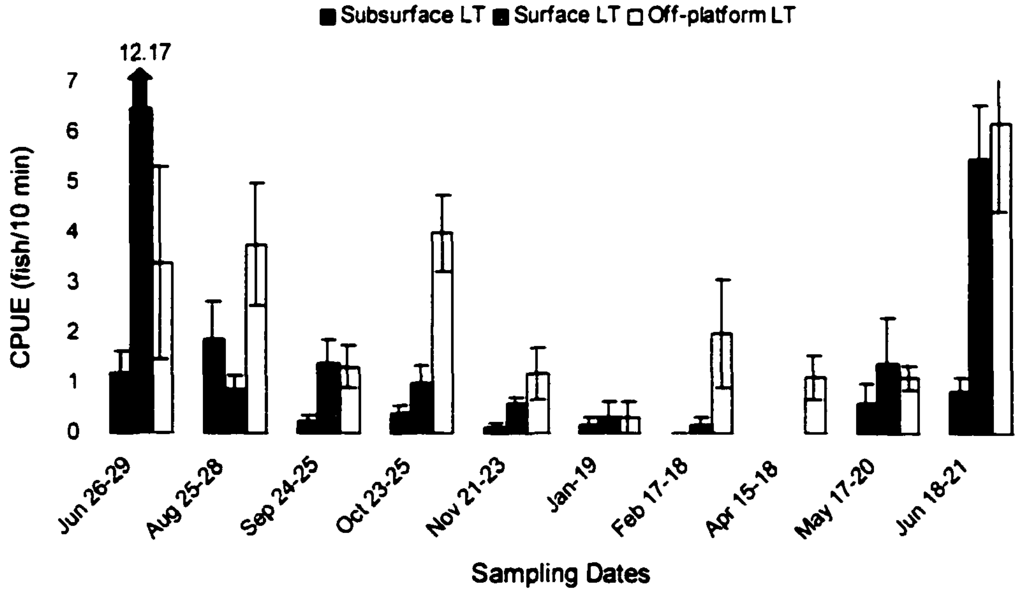

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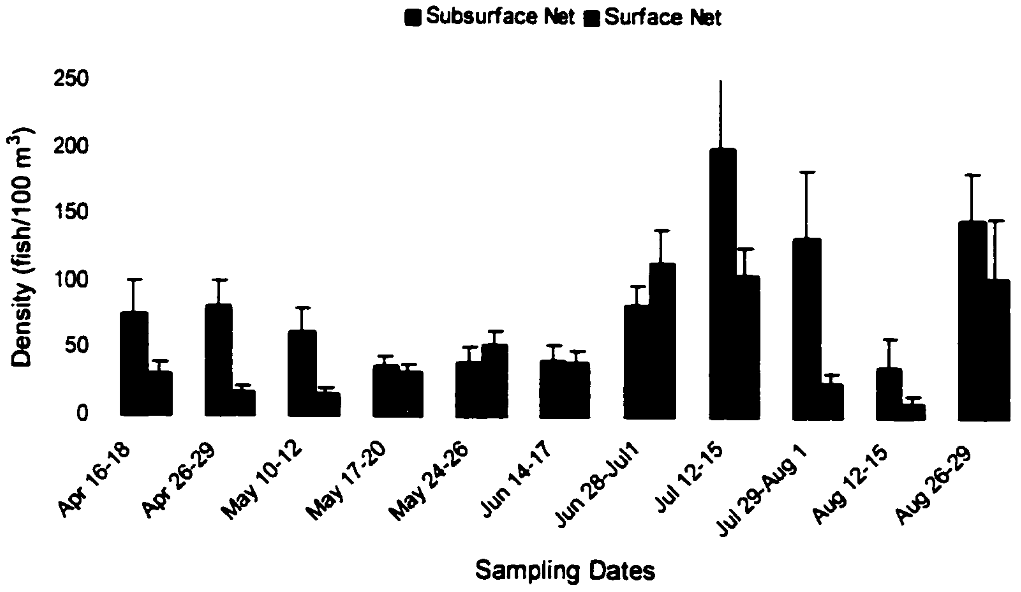
Figure 3.2. Mean plankton net densities (a) and light-trap CPUEs (b) with standard errors for each sampling trip at Green Canyon 18 (1995-96). Arrows above bars point toward the off-scale mean for that gear. No subsurface plankton net samples were taken during June 26-29, August 25-28, September 24-25, and April 15-18. No surface net, surface light-trap, or subsurface light-trap samples were taken during April 15-18. No fish were present in subsurface light-trap samples (n=10) during February 17-18.

Table 3.2. Size ranges (SL in mm) and percent of the total catch by gear for dominant taxa (>1%) collected by at least one gear type. Note the preponderance of recently-spawned larvae, late stage postlarvae, or juveniles collected with both gears. Also note the overlap in sampling efforts for GC 18 and GI 94, and ST 54 and Belle Pass.

	Light-trap		Plankton net	
Taxon	Size Range	%	Size Range	%
	Green Canyon 18 (July 1995-June 1996)			
Cyclothone braueri	3.2-7.2	5.8	4.0-13.0	1.8
Saurida brasiliensis	3.2-9.8	5.8		
Trachinocephalus myops	16.2-35.0	1.8		
Bregmaceros cantori	1.5-6.7	2.0	1.3-6.8	4.5
Gobiesox stromosus	2.6-3.2	2.0		
Holocentrus spp.	6.0-37.5	4.0		
Caranx crysos	5.0-65.0	12.0	2.5-16.5	3.3
Caranx hippos/latus	3.0-54.0	6.4	2.0-32.0	10.9
Chloroscombrus chrysurus			1.9-7.0	1.6
Elagatis bipinnulata			2.0-3.5	1.3
Pristipomoides aquilonaris			2.3-40.0	3.9
Eucinostomus spp.	6.5-11.2	3.3		
Cynoscion arenarius	2.5-4.5	1.1	2.0-4.4	6.9
Micropogonias undulatus	3.2-4.5	1.1		
Sciaenops ocellatus			1.8-3.9	12.3
Pomacentrus spp.	9.0-19.3	4.7		
Mugil cephalus	2.4-21.5	3.8	2.2-5.0	9.0
Microdesmus lanceolatus			2.0-11.0	1.5
Microdesmus longipinnis	2.4-4.9	1.8		
Auxis spp.	3.3-59.0	13.3	2.2-10.5	7.6
Euthynnus alletteratus	6.2-87.0	5.1	3.0-12.0	2.5
Scomberomorus cavalla	3.0-4.5	1.3		
Scomberomorus maculatus			2.0-10.1	2.1
Ariomma spp.			2.1-2.5	7.8
Peprilus burti	1.7-4.2	2.0	1.4-3.3	1.2
Citharichthys spilopterus			3.0-8.0	2.1
Syacium spp.	3.5-6.5	2.7		
Symphurus spp.	2.2-8.0	5.3	2.8-9.0	6.9
	Grand Isle 94 (April-August 1996)			
Saurida brasiliensis	4.5-55.0	7.9	2.7-22.5	6.2
Synodus foetens	6.0-43.0	30.6	4.2-22.5	1.8
Synodus poeyi	5.3-45.0	15.6	2.0-16.5	1.2
Bregmaceros cantori	2.0-29.0	3.0	2.0-15.5	16.6
Caranx crysos			2.5-15.0	2.1
Chloroscombrus chrysurus			2.1-16.5	1.5
Lutjanus spp.			3.0-5.5	1.0
Cynoscion arenarius			1.9-5.2	2.2
Sphyraena guachancho			2.6-7.3	2.7
Hypsoblennius hentz/ionthas	4.3-12.0	2.5		
Hypsoblennius invemar	3.5-14.5	13.8		
Parablennius marmoreus	4.4-23.7	12.3		

Table 3.2. (continued)

	Light-trap		Net	
Taxon	Size Range	%	Size Range	%
Scartella/Hypleurochilus	3.6-12.5	1.7		
Microdesmus lanceolatus			2.4-25.0	2.2
Auxis spp.	4.0-36.0	1.4	2.5-10.3	10.3
Euthynnus alletteratus	3.1-60.0	5.3	2.7-8.7	10.7
Etropus crossotus			2.5-9.0	2.6
Syacium spp.			2.1-8.5	3.0
Symphurus spp.			2.0-12.8	22.5
South Timbalier 54 (April-September 1997)				
Saurida brasiliensis	26.4-43.0	1.2		
Synodus foetens	9.0-44.5	38.9		
Bregmaceros cantori			2.2-11.7	2.1
Caranx crysos	6.5-24.5	2.0		
Caranx hippos/latus	5.5-35.0	3.8		
Chloroscombrus chrysurus	2.5-25.0	1.5	2.0-18.4	17.4
Cynoscion arenarius	2.0-7.0	7.0	1.9-7.8	53.3
Menticirrhus spp.			2.4-5.0	1.9
Hypsoblennius hentz/ionthas	3.4-12.5	4.4		
Hypsoblennius invemar	5.7-13.8	3.6		
Scartella/Hypleurochilus	2.0-14.3	5.0		
Microdesmus lanceolatus			3.2-20.8	1.3
Microdesmus spp.			2.0-3.3	1.3
Auxis spp.	4.9-25.0	1.7		
Euthynnus alletteratus	7.0-22.5	9.1		
Scomberomorus cavalla	3.5-20.0	1.1	2.4-4.2	2.9
Scomberomorus maculatus	2.5-40.5	6.0	1.9-10.2	4.4
Peprilus burti	3.5-22.0	1.9	2.1-12.0	1.0
Peprilus alepidotus	2.5-24.7	1.3	1.8-5.0	1.6
Etropus crossotus	2.8-12.7	1.1	3.0-13.1	2.1
Symphurus spp.			2.0-14.5	2.3
Sphoeroides spp.	6.7-16.0	1.6		
Belle Pass (April-September 1997)				
Synodus foetens	20.0-36.0	2.7		
Gobiesox strumosus	7.5-10.1	8.7	4.1-10.6	1.1
Membras martinica	6.1-87.0	24.1		
Chloroscombrus chrysurus	9.7-38.0	1.0		
Bairdiella chrysoura	2.9-5.1	2.2	2.4-125.0	2.1
Cynoscion arenarius	3.2-8.2	10.8	2.5-41.0	27.5
Hypsoblennius hentz/ionthas	8.3-12.0	19.1	5.1-13.5	1.7
Dormitator maculatus	7.2-10.7	2.2		
Gobionellus oceanicus	11.0-13.5	2.0	7.5-35.0	6.9
Gobiosoma bosc	7.7-9.6	10.9	6.5-17.0	37.3
Gobiosoma spp.	4.2-7.6	5.0	4.7-8.1	1.3
Microgobius spp.			4.7-10.1	3.7
Citharichthys spp.	7.9-11.6	1.5	5.2-13.0	5.2
Symphurus spp.			7.3-42.0	4.5
Sphoeroides parvus	9.1-12.5	3.1		



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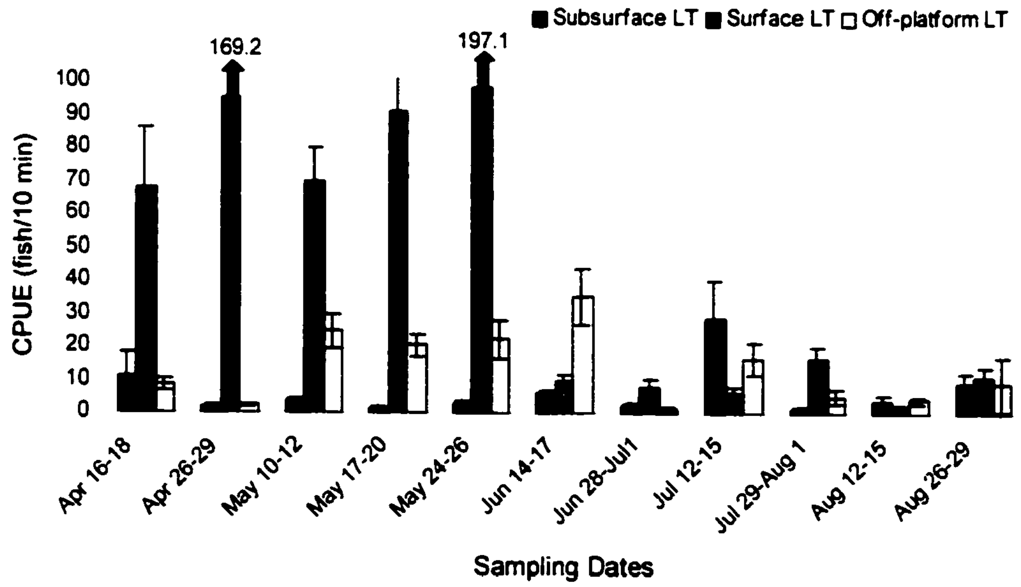


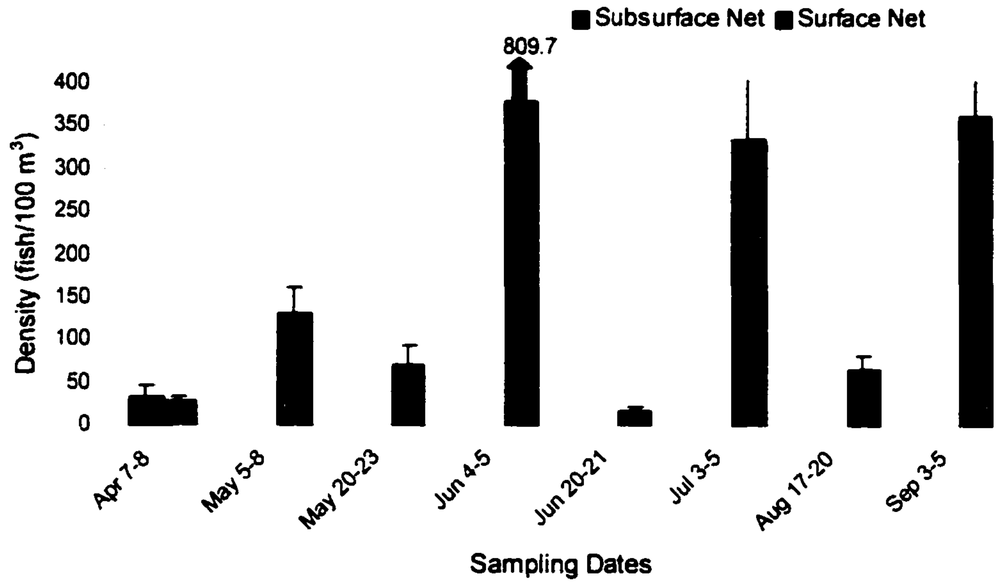
Figure 3.3. Mean plankton net densities (a) and light-trap CPUEs (b) with standard errors for each sampling trip at Grand Isle 94 (1996). Arrows above bars point toward the off-scale mean for that gear.

net catch is almost exclusively from the surface. Plankton nets and light-traps collected fish from an equal number of families, but light-traps collected fish from more taxa, including unique taxa, than plankton nets (Table 3.2). Mean plankton net densities ranged from 15.7-809.7 fish/100 m^3, while mean CPUEs ranged from 0-18 fish/10 min (Figure 3.4). *Cynoscion arenarius* and *Chloroscombrus chrysurus* were the most dominant taxa in plankton net samples (Table 3.2). Light-trap collections were dominated by *Synodus foetens* and scombrids, particularly *Euthynnus alletteratus* and *Scomberomorus maculatus*.

At the Belle Pass jetties, the pushnet and light-trap collected 33,147 and 849 fish, respectively, with a mean total density of 136.7 fish/100m^3 and a mean total CPUE of 4.6 fish/10 min (Table 3.1). The pushnet collected fish from approximately twice as many families as the light-trap, including 20 unique families. The same trend was evident in the number of taxa collected by each gear type. No families were unique to light-traps and only three unique taxa were collected with light-traps. Mean pushnet densities ranged from 18.7-288.7 fish/100 m^3, while mean CPUEs ranged from 0-9.7 fish/10 min (Figure 3.5). Pushnet samples were dominated by gobiids (primarily *Gobiosoma bosc*), and the sciaenid, *Cynoscion arenarius* (Table 3.2). Dominant taxa in light-trap collections included *Membras martinica*, *Hypsoblennius hentz/ionthas*, *Gobiosoma bosc*, and *Cynoscion arenarius*.

Within Site Comparisons of Sampling Gears

No significant differences were detected in mean total plankton net densities between surface and subsurface collections at the outer shelf (GC 18) and mid-shelf (GI 94) platforms (Tukey's Studentized Range Test, α=0.05), although subsurface densities were generally higher (Figure 3.6). At the inner shelf platform (ST 54), surface nets had significantly higher mean total densities than subsurface nets, though the sampling effort was unbalanced (Table 2.1). In contrast, light-trap collections from surface waters (surface and off-platform light-traps) had significantly greater total CPUEs than subsurface light-traps at all three platforms (Figure 3.6). At the outer shelf site (GC 18), overall means by depth and location ranged from 0.7-3.2 fish/10 min, with means from surface and off-platform locations being significantly greater than the subsurface mean (Tukey's Studentized Range Test, α=0.05). At the mid-shelf platform (GI 94) overall light-trap CPUEs were the greatest of the three platform sites and ranged from 6.5-58.2 fish/10 min with significant differences detected between all light-trap depths/locations. At the inner shelf platform (ST 54), overall mean CPUEs ranged from 3.8-7.2



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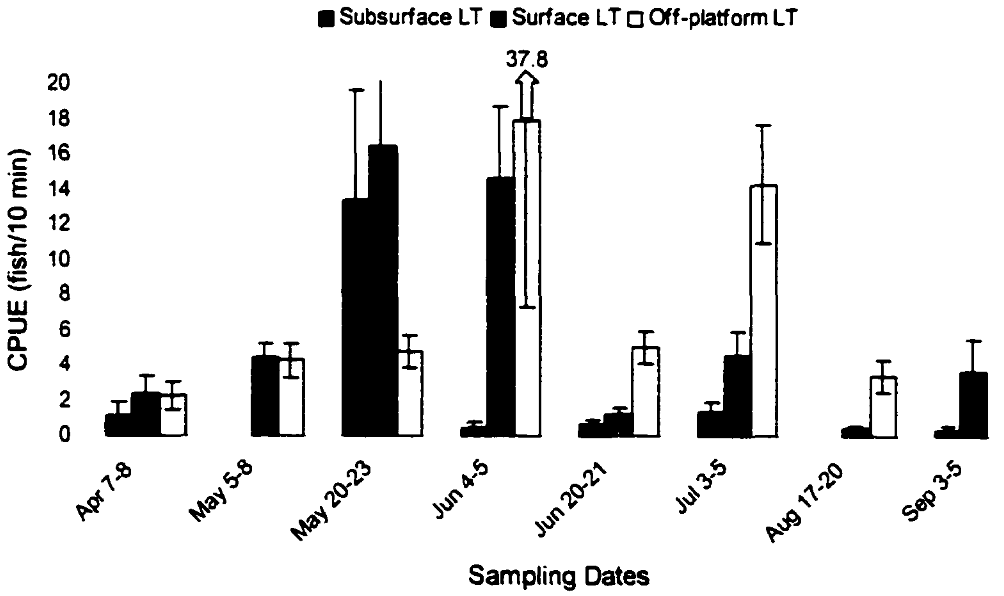

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Figure 3.4. Mean plankton net densities (a) and light-trap CPUEs (b) with standard errors for each sampling trip at South Timbalier 54 (1997). Arrows above bars point toward the off-scale mean for that gear. Subsurface net samples were only taken during April 7-8. No subsurface light-traps were taken during May 5-8. No off-platform light-trap samples were taken during September 3-5. No fish were present in subsurface light-trap samples (n=4) during August 17-20.

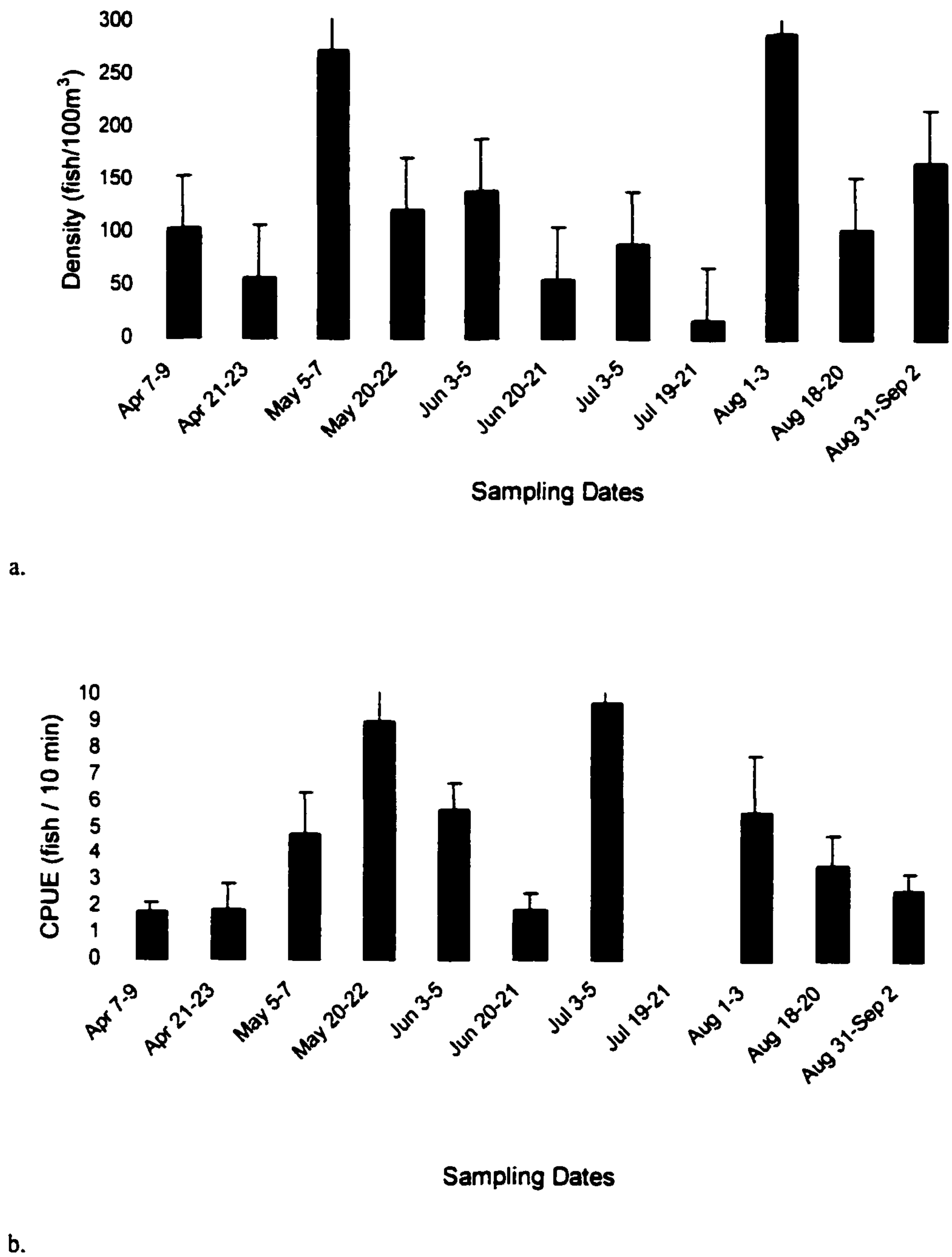
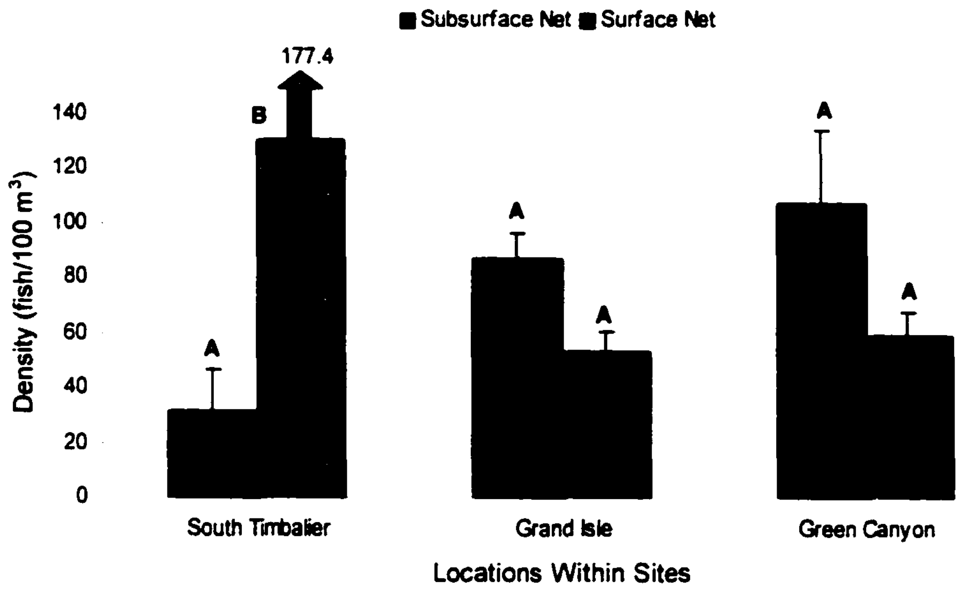
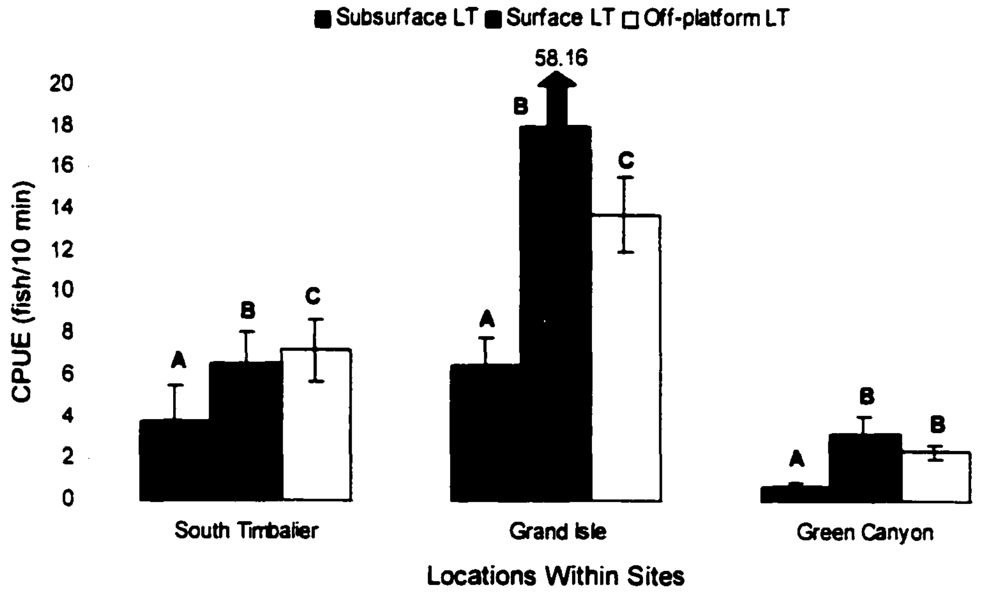


Figure 3.5. Mean pushnet densities (a) and light-trap CPUEs (b) with standard errors for each sampling trip at Belle Pass (1997). No fish were present in light-trap samples during July 19-21.



a.



b.

Figure 3.6. Mean plankton net densities (a) and light-trap CPUEs (b) with standard error bars for depths/locations within each platform site. Arrows above bars point toward the off-scale mean for that gear. For mean densities within each location, the same letter above each bar indicates no significant difference between depths based on t-tests on log-transformed data (α=0.05). For mean CPUEs within each location, the same letter above each bar indicates no significant difference between depths/locations based on Tukey's Studentized Range test on ranked data (α=0.05). Different letters designate significant differences.

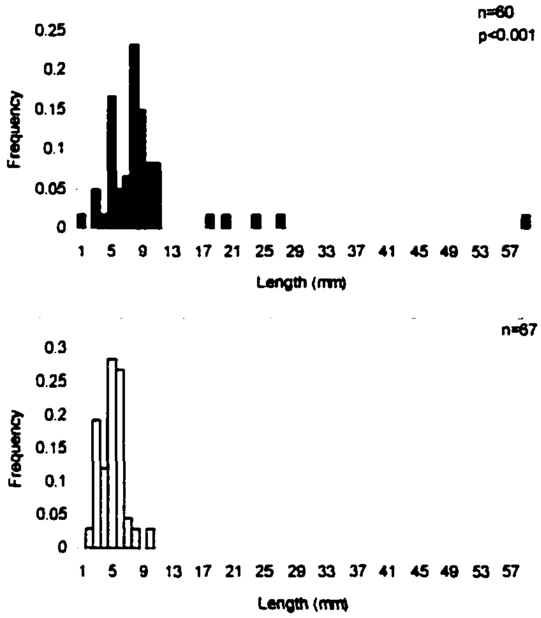
fish/10 min with the off-platform collections being the greatest followed by the mid-platform surface then by subsurface collections.

Length-Frequency Analyses

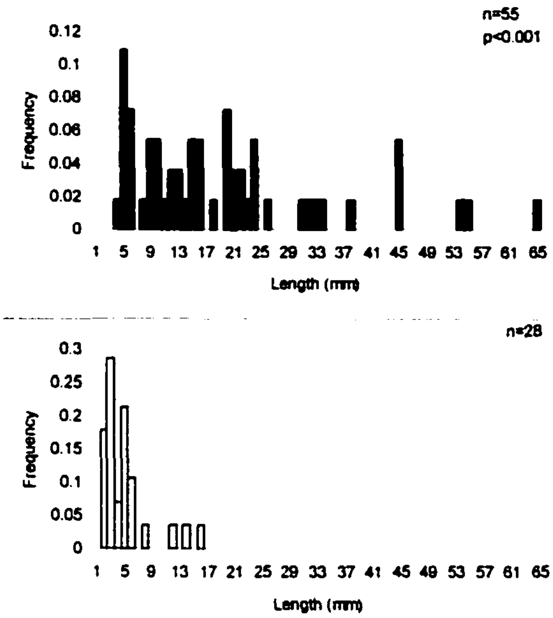
Six taxa from the outer shelf site (GC 18) met the required criteria for K-S analyses involving the differences in size frequency distributions between sampling gears (i.e., at least 10 specimens collected by each gear). In all instances, differences in size-frequency distributions for the two gear types were found to be statistically significant (K-S tests, $p \leq 0.05$; Figure 3.7). In general, there was some size overlap in all gear comparisons, although the degree of overlap and shapes of the size distributions differed among species. For *Auxis* spp., *Caranx crysos*, and *Mugil cephalus*, the plankton net samples caught predominantly smaller individuals, while the light-trap samples generally encompassed these smaller sizes as well as larger larvae and juveniles. For *C. hippos/latus* and *Euthynnus alletteratus* there was less overlap at the smaller sizes and modal size classes for the light-trap samples were generally larger. Only for *Symphurus* spp. was the modal length of light-trap samples smaller than that for net collections ($p \leq 0.05$).

At the mid-shelf site (GI 94), 10 of the 11 taxa analyzed for differences in size distributions (plankton net vs. light-trap) were highly significant (K-S tests, $p \leq 0.001$; Figure 3.8). Size distributions for *Bregmaceros cantori*, *Scomberomorus cavalla*, and *Trichiurus lepturus* appeared to substantially overlap at the smaller sizes, but in each instance the light-trap samples encompassed a significantly broader range of size classes. For *Auxis spp.*, *Caranx crysos*, *Synodus foetens* and *S. poeyi* there was some overlap in size distributions, with the plankton net capturing smaller larvae, while modal sizes for light-trap samples were always larger. Although significantly different, size distributions for *Rhomboplites aurorubens* exhibited a similar bimodal distribution for each gear type. For *Scomberomorus maculatus* there was no overlap at all in the sizes of larvae captured with the two gears. With only one taxon (*Saurida brasiliensis*) were plankton nets able to better catch small sizes, but also larger size classes as well. Only one dominant taxa, *Symphurus* spp., did not exhibit a significant difference in size distribution between gears ($p=0.385$).

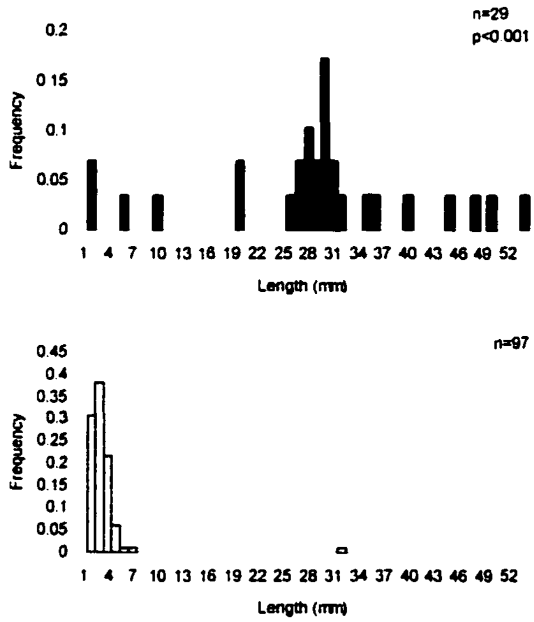
At the inner shelf site (ST 54) differences between the two gear types' size distributions for 5 of the 7 taxa analyzed were highly significant (K-S tests, $p \leq 0.01$; Figure 3.9). In general, light-trap size-



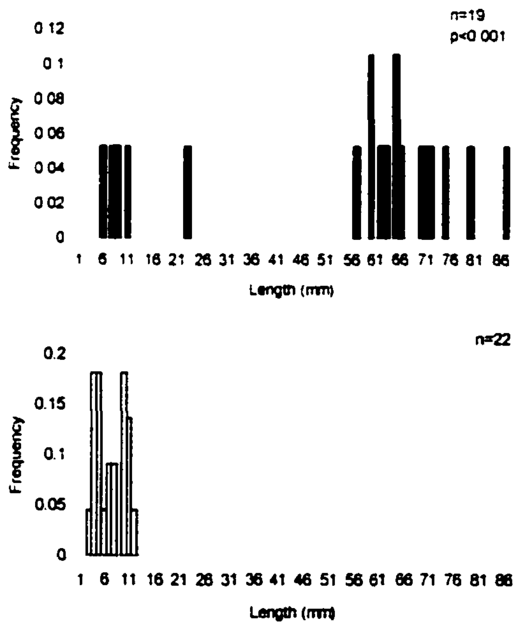
Auxis spp.



Caranx crysos

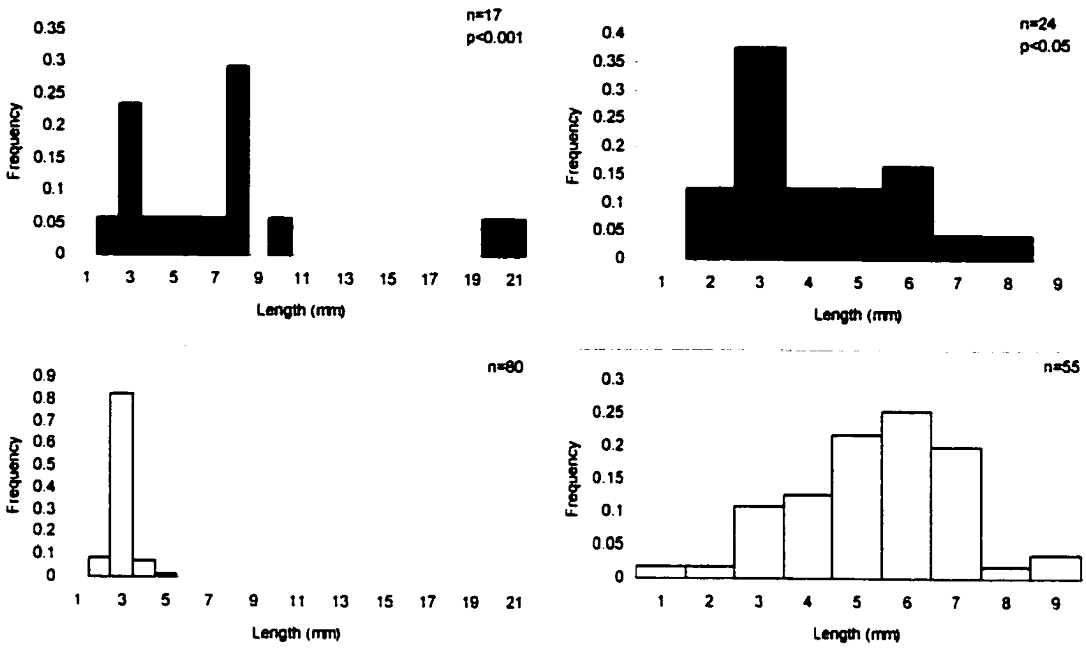


Caranx hippos/latus



Euthynnus alleterattus

Figure 3.7. Size distributions of fish collected with light-traps (shaded bars) and plankton nets (open bars) at the Green Canyon site (1995-1996). Fish length-frequency distributions were analyzed with Kolmogorov-Smirnov tests (p-values are represented in the upper panel of each gear pairing along with each sample size).



Mugil cephalus *Symphurus* spp.

Figure 3.7 (continued)

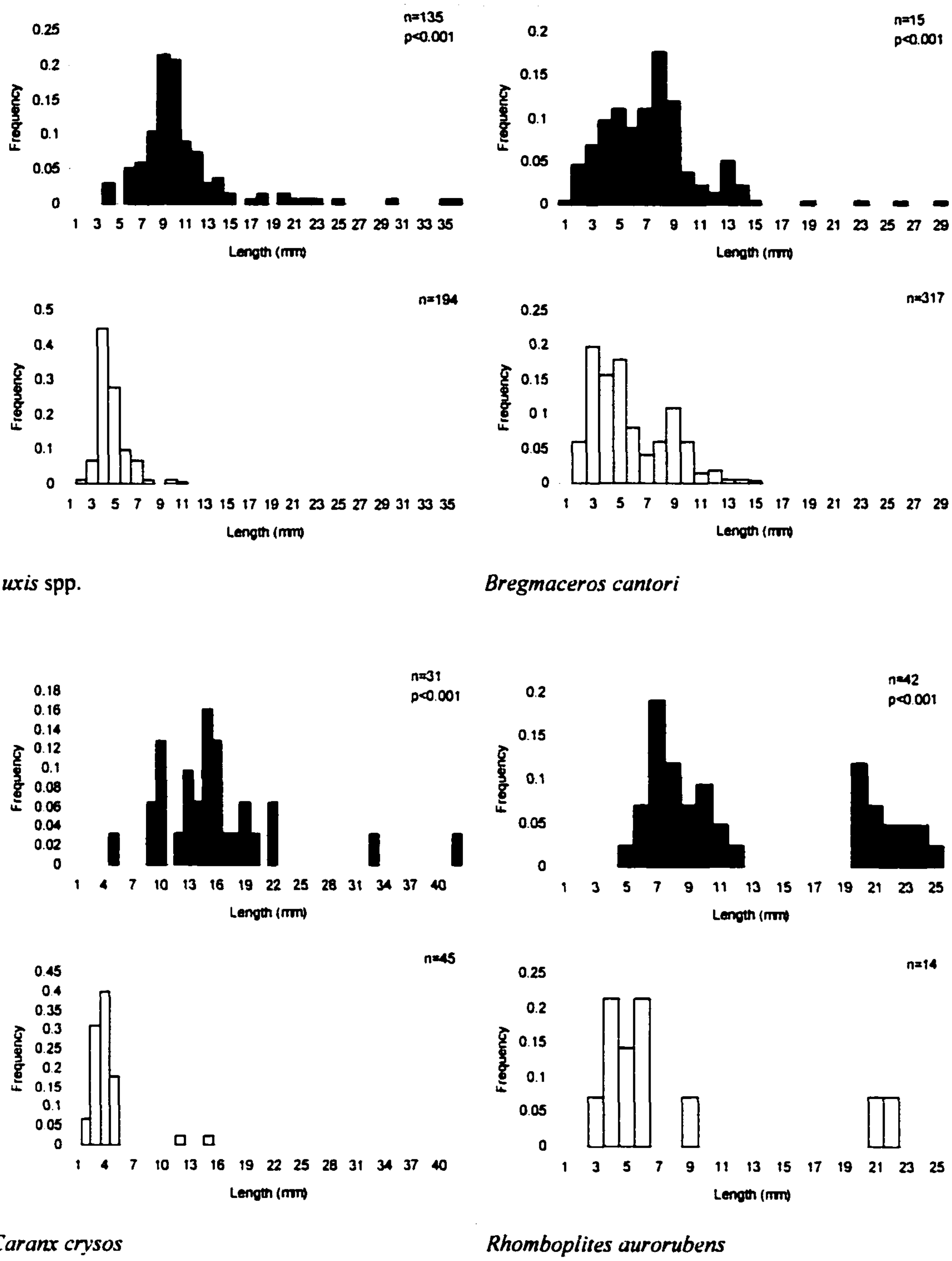
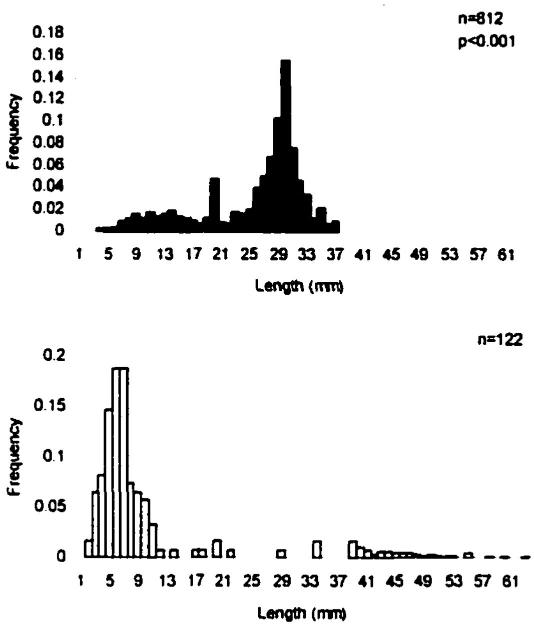
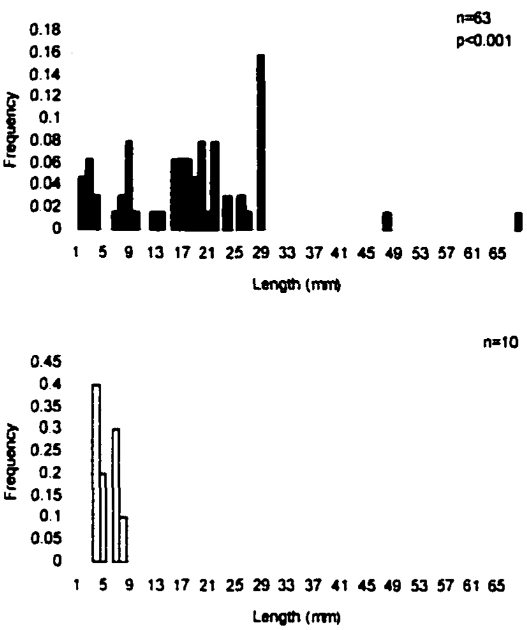


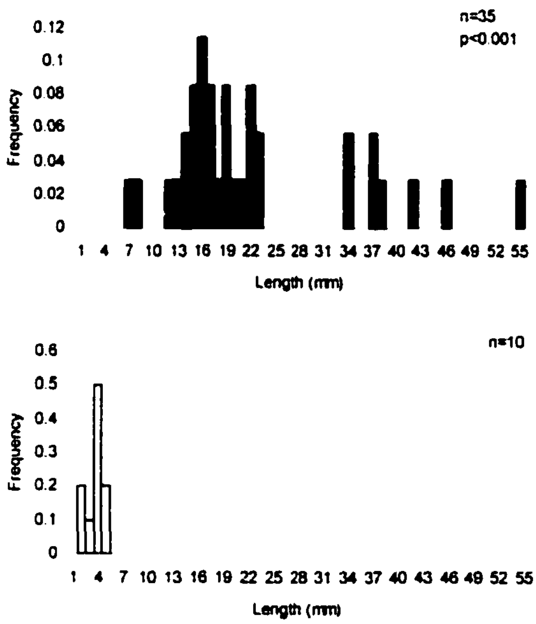
Figure 3.8. Size distributions of fish collected with light-traps (shaded bars) and plankton nets (open bars) at the Grand Isle site (1996). Fish length-frequency distributions were analyzed with Kolmogorov-Smirnov tests (p-values are represented in the upper panel of each gear pairing along with each sample size).



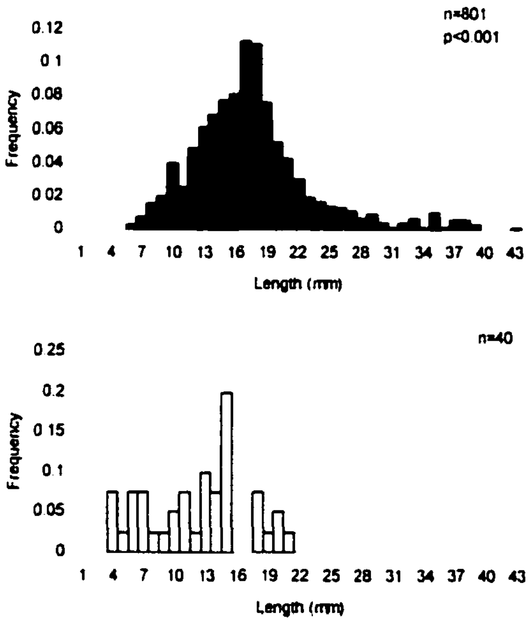
Saurida brasiliensis



Scomberomorus cavalla

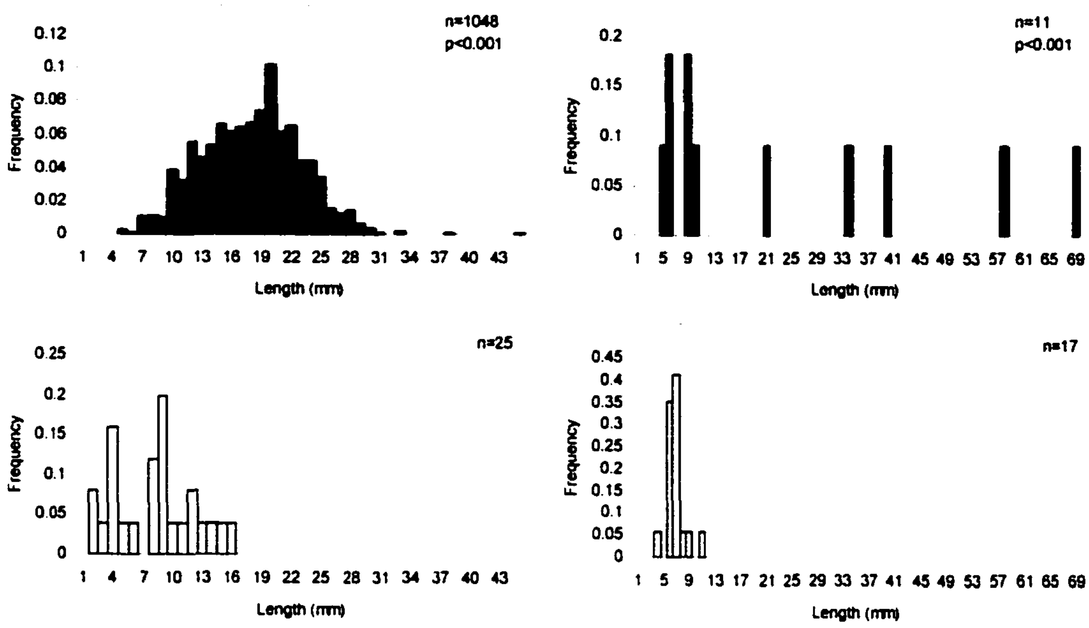


Scomberomorus maculatus



Synodus foetens

Figure 3.8 (continued)



Synodus poeyi

Trichiurus lepturus

Figure 3.8 (continued)

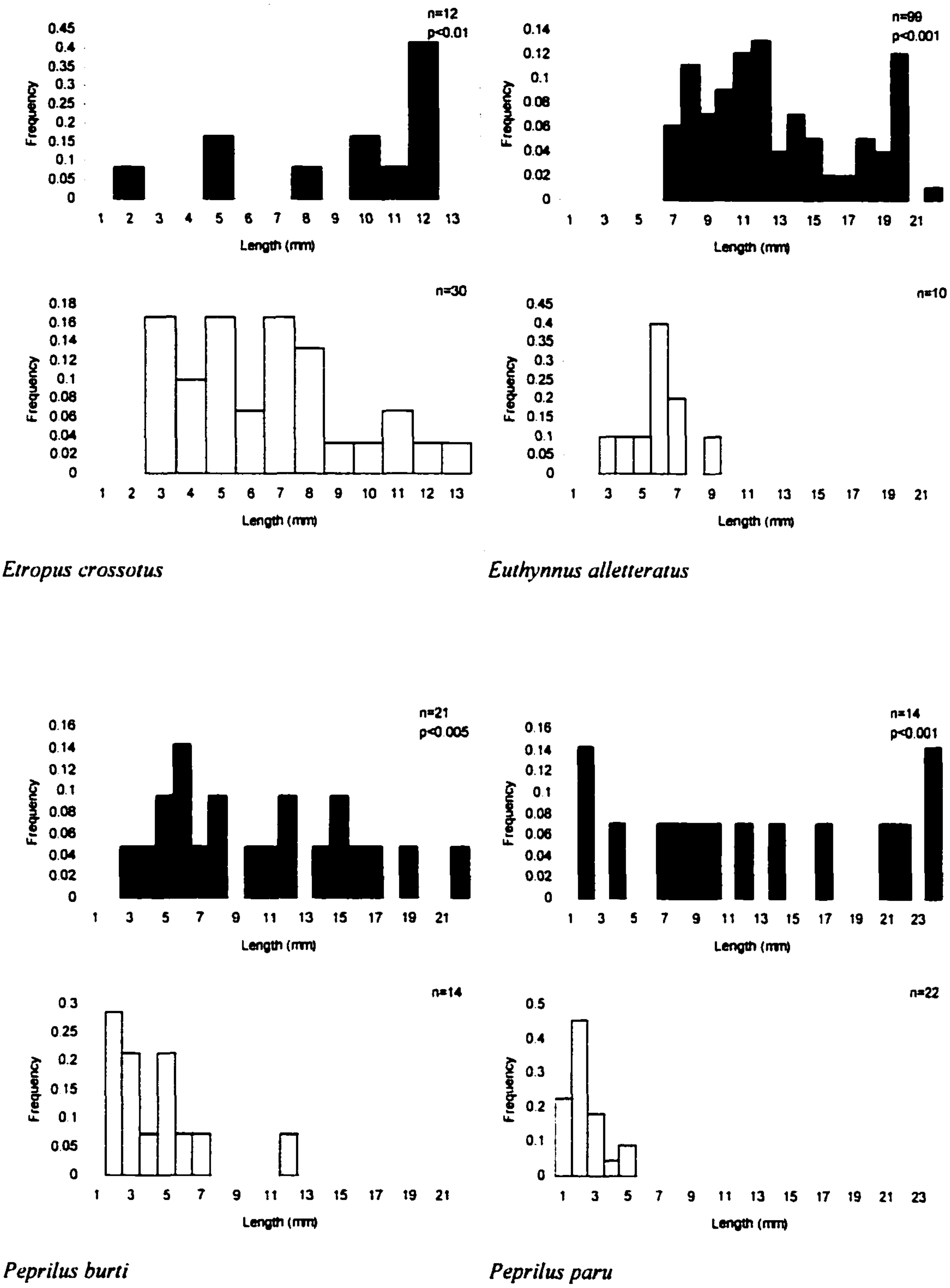
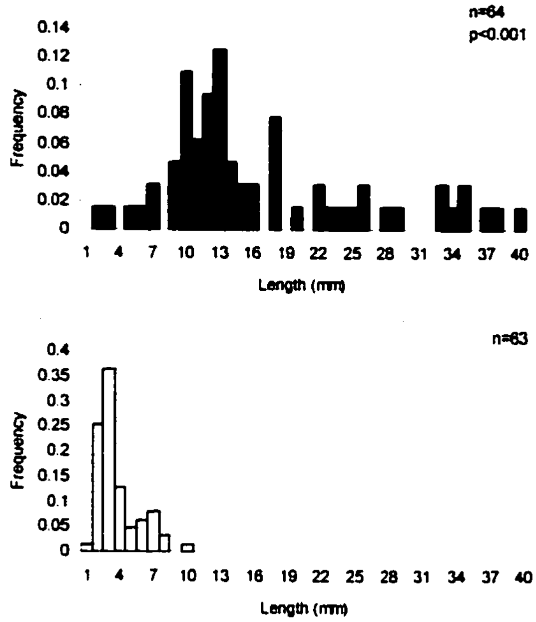


Figure 3.9. Size distributions of fish collected with light-traps (shaded bars) and plankton nets (open bars) at the South Timbalier site (1997). Fish length-frequency distributions were analyzed with Kolmogorov-Smirnov tests (p-values are represented in the upper panel of each gear pairing along with each sample size).



Scomberomorus maculatus

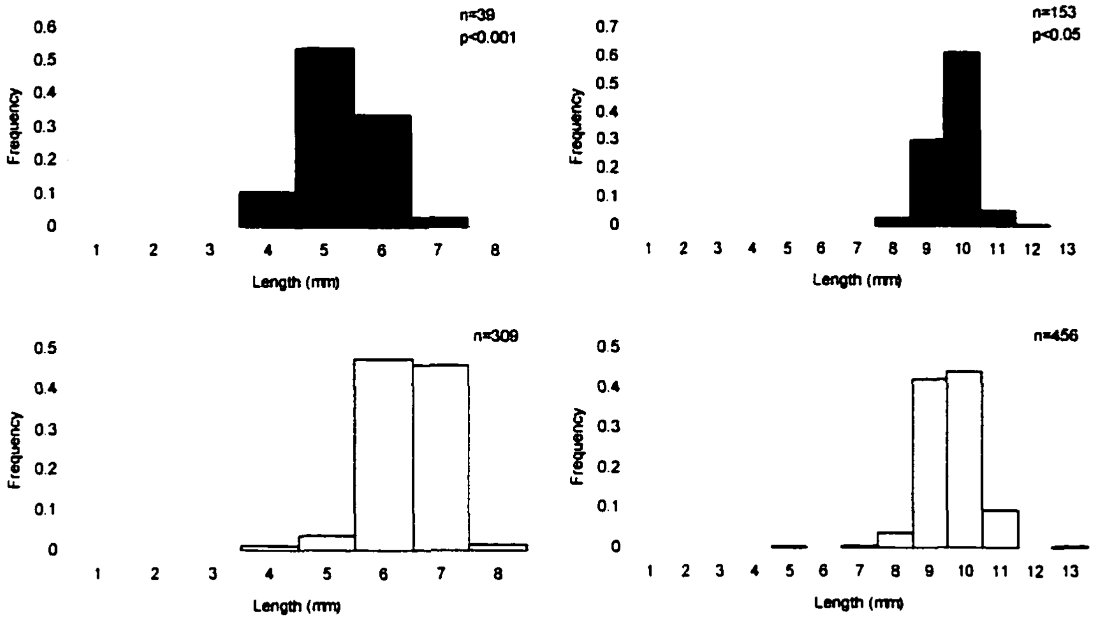
Figure 3.9 (continued)

frequency distributions for *Peprilus burti*, *P. paru*, and *Scomberomorus maculatus* encompassed that of the plankton net distributions, but also included larger sizes. Little overlap in size distributions was observed for *Euthynnus alletteratus*, with light-trap collections being much larger. Distributions of *Etropus crossotus* broadly overlapped, although plankton nets collected a wider range of smaller and larger size classes. Two dominant species, *Bregmaceros cantori* and *Chloroscombrus chrysurus* did not exhibit a significant difference in size distributions between the two gear types ($p=0.998$ and $p=0.133$, respectively).

In contrast to the platform sites, size distributions for pushnet vs. light-trap collections at the Belle Pass jetties were significantly different (K-S tests, $p<0.05$) for only 3 of the 11 taxa analyzed (Figure 3.10). There was a broad overlap in the size distributions for *Gobiosoma* spp. and *Hypsoblennius hentz/ionthas*, but in each case the pushnet samples collected larger sized individuals with greater frequency. In contrast, the light-trap size distribution for *Membras martinica* had an intermediate dominant mode.

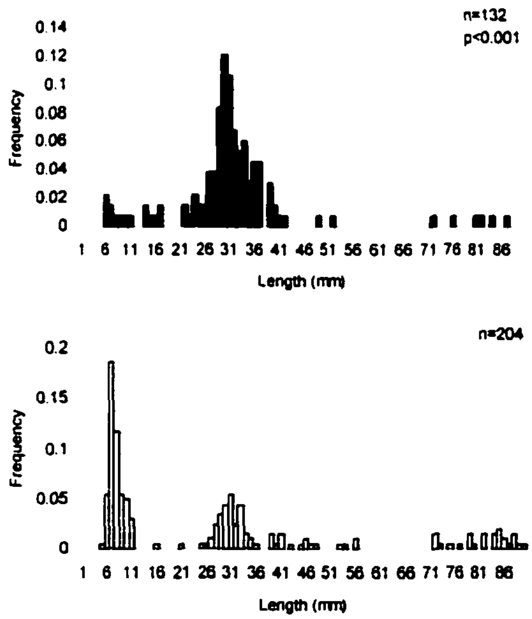
Lunar Periodicity

At the mid-shelf platform (GI 94) during new moon phases, mean total CPUEs for light-traps were significantly higher than during full moons (Student's t-test, $p\leq0.0001$; Figure 3.11), while mean plankton net densities had the opposite trend ($p\leq0.01$). The special lunar study conducted at GI 94 which compared three lunar phases (first quarter, new, and third quarter moon phases sampled in May 1996), however, yielded no significant differences in mean total light-trap CPUEs or mean total plankton net densities between the three phases (Tukey's Studentized Range test, $p\leq0.05$; Figure 3.12). At the inner shelf platform (ST 54) there were no significant difference in total CPUEs between new and full moon phases ($p=0.5635$; Figure 3.13), however, mean total density during new moon phases was significantly higher than full moons ($p\leq0.05$). Both results are in contrast to the findings at GI 94. At the Belle Pass jetties, mean total CPUEs and pushnet total densities were significantly higher during new moon periods (Student's t-tests, $p<0.0003$ and $p<0.0001$, respectively; Figure 3.14). Therefore, when significant lunar differences were found, four out of five instances had greater new moon catches.



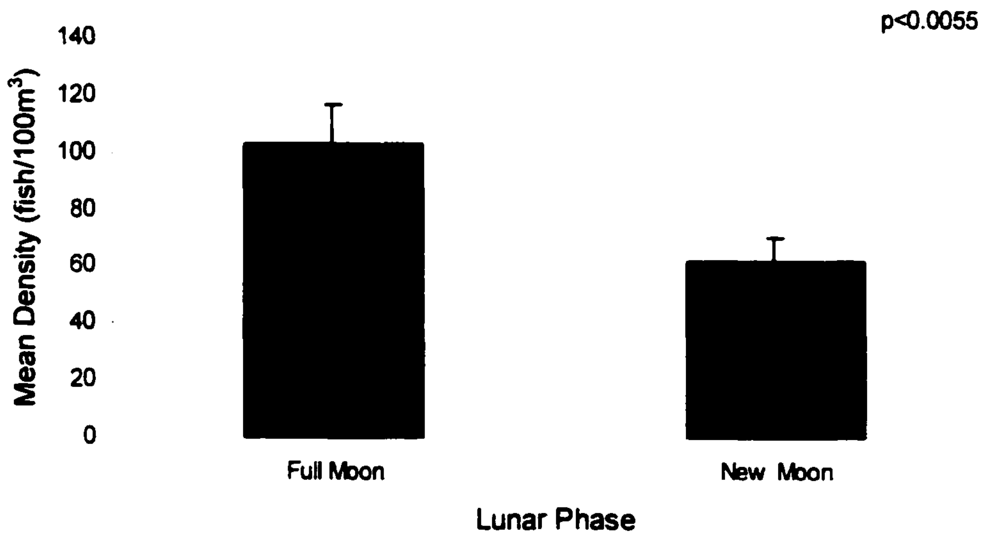
Gobiosoma spp.

Hypsoblennius hentz/ionthas

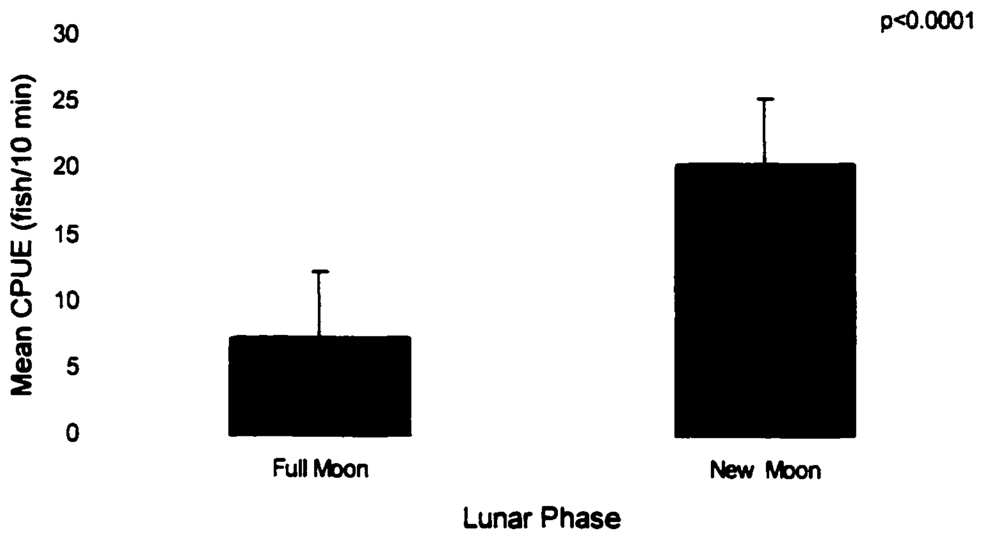


Membras martinica

Figure 3.10. Size distributions of fish collected with light-traps (shaded bars) and a pushnet (open bars) at the Belle Pass site (1997). Fish length frequency distributions were analyzed with Kolmogorov-Smirnov tests (p-values are represented in the upper panel of each gear pairing along with each sample size).

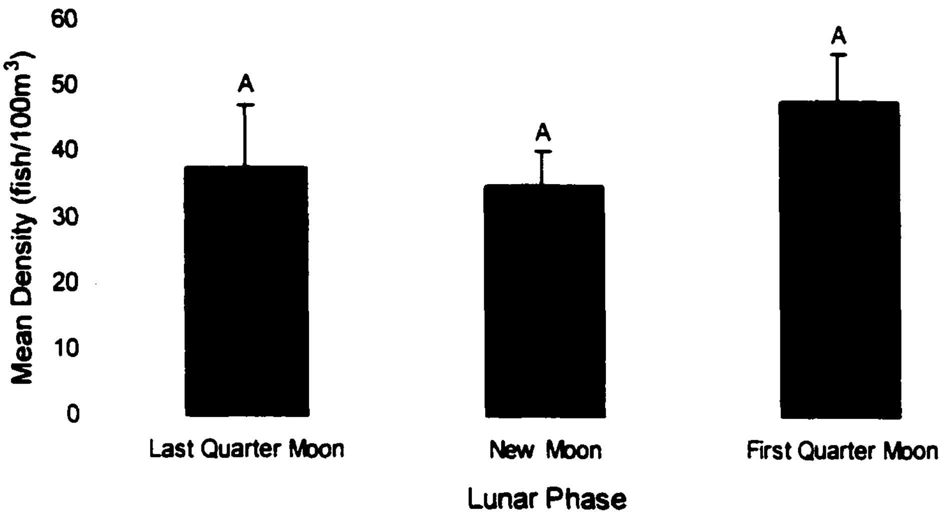


a.

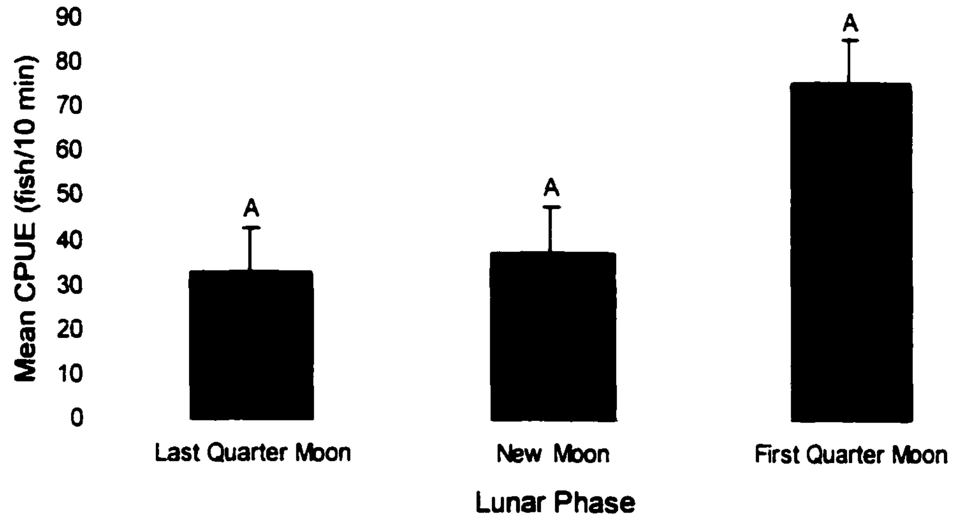


b.

Figure 3.11. Mean plankton net density (a) and light-trap CPUE (b) with standard error bars for each lunar phase sampled at Grand Isle 94 (Apr-Sep 1996). The p-values indicate statistical significance from t-tests.



a.



b.

Figure 3.12. Mean plankton net density (a) and light-trap CPUE (b) with standard error bars for each lunar phase sampled in May 1996 at Grand Isle 94. The same letter above each bar indicates no significant difference between the lunar phases based on Tukey's Studentized Range tests on ranked data (α=0.05).

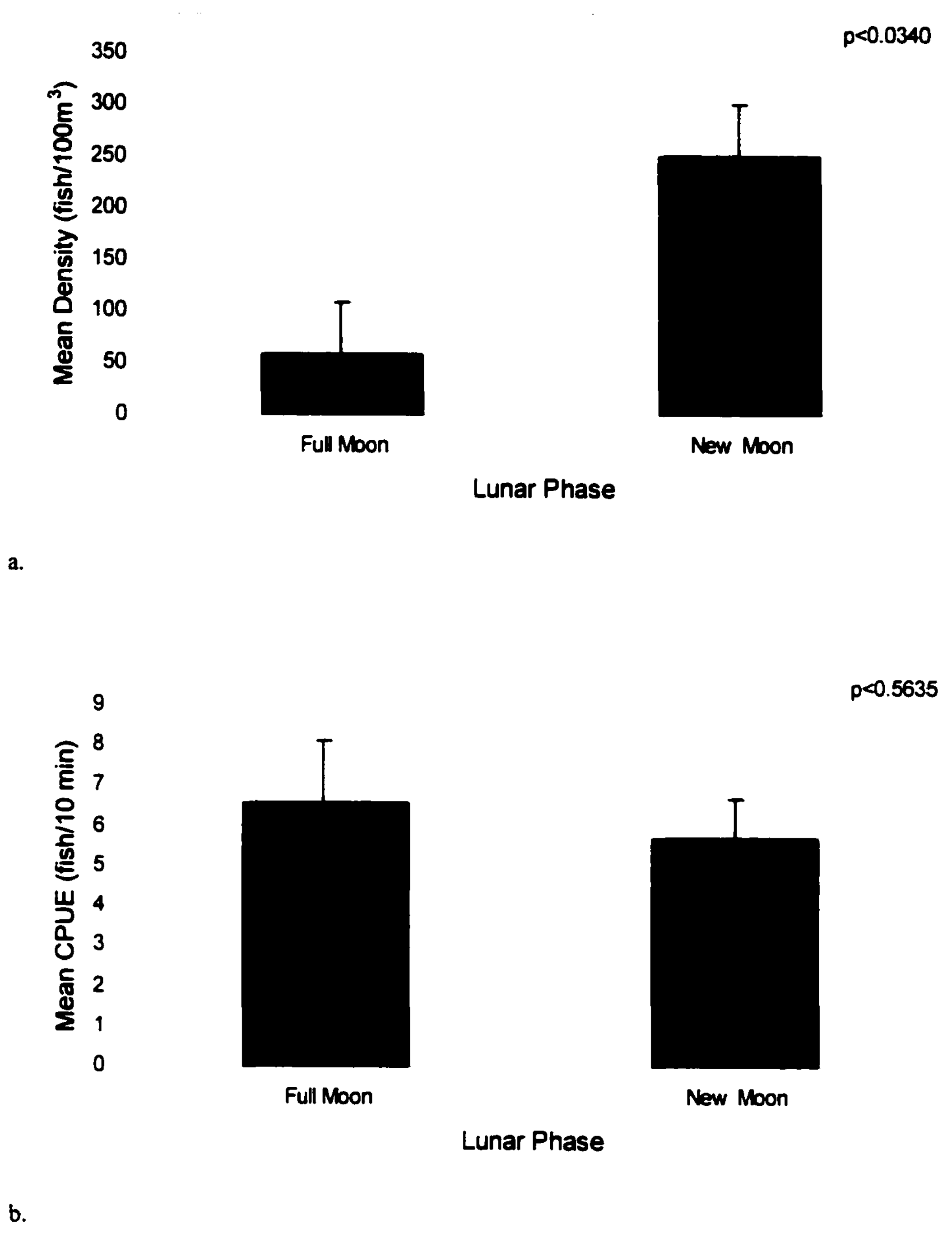
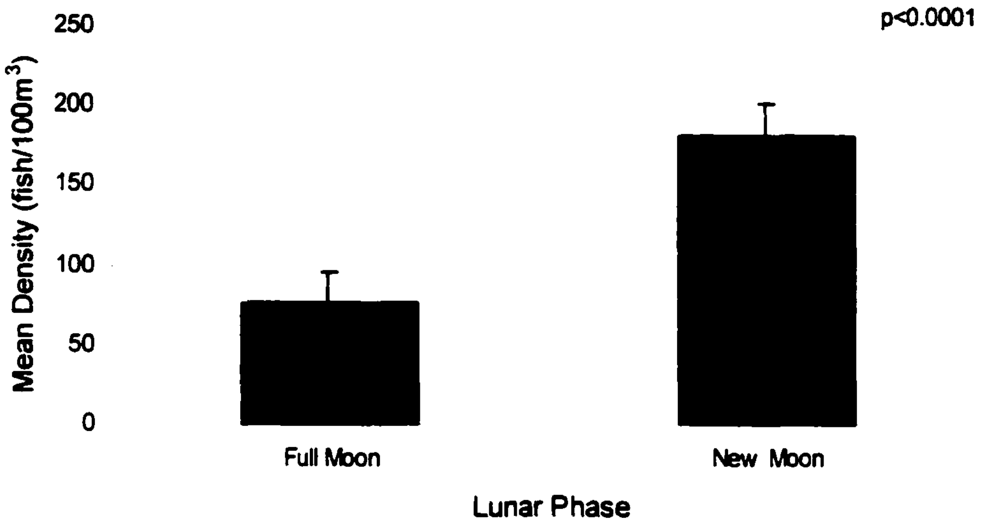
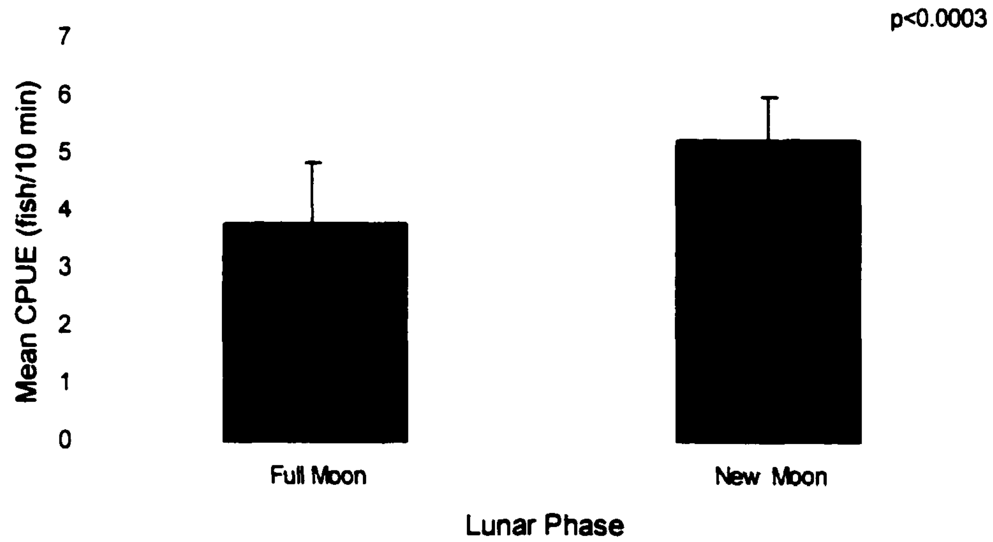


Figure 3.13. Mean plankton net density (a) and light-trap CPUE (b) with standard error bars for each lunar phase sampled at South Timbalier 54 (Apr-Sep 1997). The p-values represent statistical significance from t-tests.



a.



b.

Figure 3.14. Mean pushnet density (a) and light-trap CPUE (b) with standard error bars for each lunar phase sampled at Belle Pass (Apr-Sep 1997). The p-values represent statistical significance from t-tests.

Similarity and Diversity of Ichthyoplankton Assemblages Within Sites

Within site comparisons of gears and surface sampling locations indicated that off-platform and surface light-trap collections were more similar to each other (Schoener's Index of Similarity values range from 0.45-0.76) than each was to surface plankton net collections (0.27-0.71), although the disparity between the index gear comparisons is smaller at ST 54 (0.59-0.71; Table 3.3). Overall, total light-trap collections were relatively different from total plankton net samples at the outer shelf (GC 18) and mid-shelf (GI 94) platforms (0.38 and 0.32, respectively), but were much more similar at the inner shelf platform (ST 54) and Belle Pass jetties (0.63 and 0.61, respectively).

Table 3.3. Schoener's Index of Niche Overlap values for different surface gear and location comparisons. (OL) off-platform light-trap, (SL) surface light-trap, (SN) surface net, (TL) total light-traps, (TN) total nets

	OL vs SL	OL vs SN	SL vs SN	TL vs TN
Green Canyon 18	0.53	0.32	0.31	0.38
Grand Isle 94	0.45	0.37	0.27	0.32
South Timbalier 54	0.76	0.71	0.59	0.63
Belle Pass			0.61	0.61‡

‡Calculation is the same as with SL vs. SN since only a surface pushnet and surface light-trap were used.

There was little difference in the Shannon-Weiner diversity index values from gear and depth/location samples collected at the outer shelf (GC 18) and inner shelf (ST 54) platforms (Figure 3.15). In both instances, only subsurface light-trap samples had significantly lower diversity values than the other gear and depth/location combinations (α=0.05). No clear pattern in diversity was discernable at the GI 94 site other than surface net collections were significantly different from light-trap collections and that off platform light-trap collections were different from net collections regardless of depth. At the Belle Pass jetties, pushnet samples were significantly more diverse than the light-trap samples.

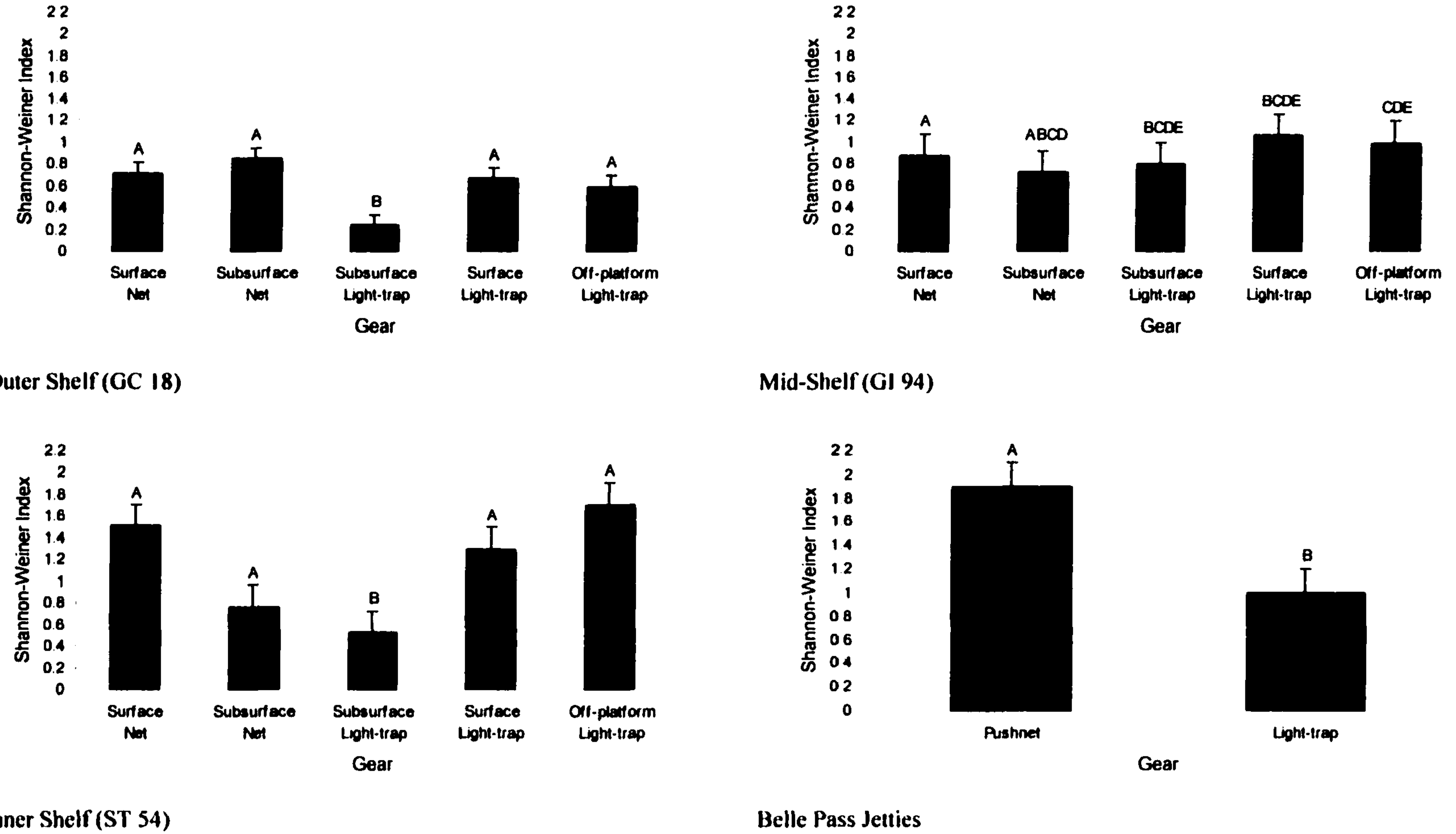


Figure 3.15. Mean Shannon-Weiner diversity indices (with standard error bars) for each gear type and sampling location for each site. The same letter above each bar indicates no significant difference between the gear types based on Tukey's Studentized Range tests (α=0.05). Different letters indicate significant differences.

DISCUSSION

Gear Selectivity

The most obvious trend observed during this study was the overwhelming presence of engraulids and clupeids at all sites, even on the shelf slope site (Chapter 2). Light-trap and plankton net collections (total catch) were dominated by clupeiform fishes at the outer (59%), mid- (66%), and inner shelf (97%) platforms, and the Belle Pass jetties (74%). The dominance of these taxa is not unexpected, particularly considering the abundances of these fishes in the northern Gulf and the sampling gears utilized. Clupeiform fishes are often among the most abundant in plankton surveys of the northern Gulf and are present year-round in shelf waters (Ditty, 1986; Ditty et al., 1988; Finucane et al., 1979). Light-traps are selective sampling devices and previous studies have demonstrated that often the catches are dominated by a single taxonomic group (Brogan, 1994; Choat et al., 1993; Sponaugle and Cowen, 1996; Thorrold, 1992). Clupeiform fishes have been shown to be particularly photopositive and have dominated the total catches in several studies utilizing light-aggregating collection techniques (Brogan, 1994; Choat et al., 1993; Dennis et al., 1989; Rooker et al., 1996). The pushnet used in this study actively collects fish and was relatively large (1m x 1m). It has also been shown to be an effective collector of clupeiforms in previous studies (Herke, 1969; Kriete and Loesch, 1980; Raynie and Shaw, 1994). While the light-trap collects fish based on taxon-specific, photopositive behaviors and the pushnet actively strains the water mass it samples, the plankton nets in the platform study collected fish passively with tidal currents. Even so, it was also very effective in sampling these fishes. This catchability was undoubtedly aided by the nocturnal sampling design.

Even with these sampling efficiency enhancements, these three sampling techniques clearly displayed gear selectivity as evident by differences in taxonomic richness between gear types. Passive plankton nets collected fish from more unique families than light-traps at the outer shelf (GC 18: 15 vs. 7) and mid-shelf (GI 94: 6 vs. 3) platforms, but not at the inner shelf platform (ST 54, eight unique families to each gear). At the Belle Pass jetties, the pushnet collected individuals from 20 unique families, as well as fish from all families sampled by light-traps. Previous studies comparing light-traps and plankton nets in marine waters have found similar results (i.e., light-traps collected fewer families than plankton tows) with only a few instances where light-traps collected unique families. Brogan (1994)

collected 16 unique families with a diver-steered pushnet and only 4 unique families with light-traps, and the latter 4 families, when combined, comprised a very small proportion (<0.08%) of his total light-trap catch. Likewise, more unique families were collected with a neuston net (10) than with light-traps (4) when fished simultaneously in Onslow Bay, North Carolina, and the unique light-trap families comprised only 10% of the total light-trap catch (Hernandez and Lindquist 1999). Their results are similar to those in this study, where unique light-trap families usually made up less than 1% of the total catch at each platform site. However, whereas the previously cited studies each collected only four unique families with light-traps, seven (GC 18) and eight (ST 54) unique families were collected with light-traps in this study. Neither Choat et al. (1993) nor Hickford and Schiel (1999) reported any families in light-trap samples that were not present in plankton net samples.

In addition, the large numbers of unique taxa (identified at least to genus level) collected by light-traps (Table 3.1) was also surprising, since this gear is usually considered to be very taxon-specific and therefore, limited in its sampling scope. At the genus level, light-traps collected more unique taxa than plankton nets at the mid- (27 vs. 26) and inner shelf platforms (24 vs. 16), but not at the outer shelf platform (14 vs. 25). At Belle Pass, however, the light-traps collected far fewer unique taxa (3) than did the pushnet (44). Such large numbers of unique taxa have not been previously reported for light-traps in gear comparison studies. Two studies have reported data at the genus level and found either that all taxa collected by light-traps were collected by nets (Hickford and Schiel, 1999), or that there were more unique taxa in the net collections than light-trap collections (Hernandez and Lindquist, 1999). In this study, light-traps proved very useful in sampling available taxa that were not collected by plankton nets.

Trends in taxon selectivity by gear were supported in the similarity indices between the gear types within a given site (Table 3.3). At the outer shelf (GC 18) and mid-shelf (GI 94) platforms, there was greater similarity between the light-trap samples, regardless of location, than there was between the surface light-trap collections (either off platform or central location) and the surface net collections. Again, this indicates the behavioral or developmental responses of different fish taxa influence their susceptibility to different sampling gears (Hernandez and Lindquist, 1999). The trend was not as evident at the inner shelf platform (ST 54), but this is not surprising as 97% of the total catch by both gears was comprised of clupeiform fishes, which are very susceptible to both gear types (Schoener's Similarity

Index for total light-trap vs. total net collections = 0.63). There was also a relatively high similarity index value (0.61) for the pushnet vs. light-trap comparison at Belle Pass, even though the pushnet had collected many unique taxa. Again, this site was dominated by clupeiform fishes (74% of total catch), and light-traps are effective in sampling these fishes, resulting in a higher than expected similarity value. In addition, the pushnet's unique taxa were relatively rare and, therefore, had a limited influence in the calculation of the similarity index.

The presence of rare and unique taxa in plankton pushnet collections at the jetties did increase the diversity of the assemblage, however (Figure 3.15). In contrast, few differences were observed between the passive plankton net and light-trap collections at the platforms. Several studies have investigated differences in taxonomic richness between different gear types, although few, if any, have reported diversity data. Choat et al. (1993) collected individuals from more families with a bongo net (63 families), a lighted-seine net (37 families), neuston net (31 families), Tucker trawl (29 families), and purse seine (25 families) than with a light-trap (20 families) in a gear comparison study within Australia's Great Barrier Reef. In the Gulf of California, Brogan (1994) collected more reef fish larvae and juveniles from different families with a diver-steered plankton net (43 families) than with a light-trap (31 families). Hernandez and Lindquist (1999) collected more fish larvae and juveniles from different families with a neuston net (24 families) than with either of the two light-trap designs employed (18 and 21 families) in a study in Onslow Bay, North Carolina. In each of these studies, the authors concluded that the taxonomic assemblage collected in their respective studies was very method-dependent, and the same appears to be true in the present study.

The results of this study further illustrate the benefits that multiple gear types can bring to ichthyoplankton studies by sampling a more complete range of size classes, ages, and developmental stages (Brogan, 1994; Choat et al., 1993; Hernandez and Lindquist, 1999). Of the 24 length-frequency comparisons between passive plankton nets and light-traps, 21 exhibited statistically significant differences (Figures 3.7-3.9). In the instances where no significant differences were found, the distributions either overlapped substantially (*Symphurus* spp., Figure 3.8 and *Bregmaceros cantori*, Figure 3.9) or suffered from too few individuals in the larger size classes for a significant statistical difference to be found (*Chloroscombrus chrysurus*, Figure 3.9). In general, the light-trap was more

effective in sampling larger size classes of the same species at each location, depth, or site. In some cases, the light-trap collections did not encompass a significant portion of the plankton net's smaller sizes, but clearly excelled at capturing the larger sizes. This was the case with *Caranx crysos* and *Scomberomorus maculatus* (Figure 3.8) and for *Euthynnus alletteratus* (Figures 3.7 and 3.9). In other instances, the light-trap collections appeared to significantly overlap the smaller sizes of the net collections, but also augmented the size-frequency distribution with much larger sizes, or in some cases, even additional modes, as was the case for *C. crysos* (Figure 3.7) and *S. cavalla* (Figure 3.8).

By using multiple gears and methodologies, the presence of a number of taxa with a full range of life history stages, ranging from recently-spawned larvae to juveniles, was confirmed. For example, at the outer shelf platform (GC 18) the plankton net collected *Euthynnus alletteratus* within a smaller size range (3.0-12.0 mm) than the light-trap (6.2-87.0 mm). If plankton net collections were not supplemented with light-trap catches, larger juveniles at this site would have been overlooked.

The advantages of plankton pushnets (see introduction) proved useful in sampling the edges of the jetty environment which is structurally complex. The boat and pushnet were maneuvered very close to the shallow slope of the rock wall with relative ease. In general, net avoidance is reduced with pushnets compared to towed nets, because the net fishes in advance of the boat, its shadow and its propeller wash (Raynie and Shaw, 1994). The large mesh size (1000 μm) and net opening (1 m x 1 m) minimizes the pressure wave in front of the net and minimizes net clogging, enhancing the ability to collect larger larvae and postsettlement juveniles. As a result, many of the size distributions sampled with the pushnet and light-trap at Belle Pass overlapped considerably (Figure 3.10). Only 3 of the 11 species analyzed exhibited significant size differences between the gear types. In one instance, the pushnet collections clearly had a larger size mode than the light-trap (Figure 3.10, *Gobiosoma* spp.). While the same size classes were targeted with the pushnet, its usefulness was in sampling different taxa. The number of families (39) and taxa identified to the genus level (77) were approximately double that of the light-traps (19 and 34, respectively), which generated a taxon diversity for the pushnet collections that was significantly higher than that for the light-trap (Figure 3.15). Once again, multiple gear types allowed for the collection of a more complete representation of the ichthyoplankton and juvenile fish assemblages at the jetty site as well.

Lunar Periodicity

Lunar periodicities were investigated because there are many hypotheses on lunar reproductive patterns pertaining to propagule dispersal and predation rates that occur both at the beginning (spawning) and end (settlement) of the planktonic phase (Robertson 1991). Many reef fish appear to time their spawning events with different lunar cycles (Thresher 1984). Higher rates of fish settlement often occur during darker, new moon periods than full moon periods (Victor 1986; Rooker et al. 1996), presumably a response to mortality associated with visual predators. These patterns of spawning, transport, recruitment, and settlement in association with the local physical oceanographic regime, often result in variable larval supply and settlement patterns with distinct lunar periodicities. Since the sampling transect is downstream of the Mississippi River plume and extends from an outer shelf platform to a coastal jetty, baroclinic pressure gradients, wind-driven currents, and tides are important transport considerations. It should be noted, however, that in the northern Gulf of Mexico tides are dominantly diurnal and their range in tidal height is not often in synchrony with the phase of the moon (i.e., new and full moon maximum tide ranges vs. first quarter and third quarter minimums), but rather the tidal range is in synchrony with the tropical and equatorial phases of the moon's elevation (i.e., Tropic of Cancer and/or Capricorn crossing maximum tidal ranges vs. equatorial crossing minimums; McLellan 1965).

In addition, the effects of ambient light on gear selectivity were investigated. Since light-traps rely on the illumination of the surrounding water mass to attract fish, the contrast in trap-generated illumination should be greater (and theoretically more efficient) when there is less ambient light, such as during a new moon phase (all larval and postlarval supply/availability issues being equal).

Few studies utilizing light-aggregating devices have addressed gear efficiency within the framework of lunar periodicities in fish spawning, larval supply (transport) and settlement. Gregory and Powles (1985) observed higher catches during new moon phases in a freshwater system but didn't report a statistical difference. Rooker et al. (1996) used a nightlight lift-net in nearshore habitats in Puerto Rico and reported that new moon abundances of larval fish were four times higher than the next most abundant phase (last quarter) during the summer months, and suggested that ambient light intensities might have played a factor in gear efficiency. The competitive interaction of lunar vs. light-trap illumination may have played a role in the collection of fish at Belle Pass, where significantly higher CPUEs were observed

during new moons (Figure 3.14). Jetty pushnet collections also had significantly more fish during new moons, possibly due to decreased visual avoidance under lower ambient light conditions. It is difficult, however, to separate the effects of ambient illumination and gear performance from the supply and/or settlement patterns of the fishes, so lunar periodicity may still play a role in the occurrence of fishes at this site.

In addition, the situation at petroleum platforms may be equally difficult to discern, since platforms have many bright lights throughout the structure to illuminate the work areas at night and to aid ship navigation, which may in effect be attracting fish to the structure (i.e., fishing a light-trap within a giant "light-trap"). This issue was at least partially addressed by sampling away from the structure (i.e., 20 m downstream), but even these off-platform light-trap collections could still be within the "halo influence" of the platform's light field. Still, when significant differences in mean total densities and mean total CPUEs were found between new vs. full moon phases, four out of five instances had greater new moon catches (Figure 3.11). The analysis of the May samples at GI 94 taken over three lunar phases was disappointing, however, since it showed very little difference between the lunar phases for both gears (Figure 3.12). Although these platform results on lunar periodicity are less than conclusive, there may be several explanations for the lack of a consistently strong pattern. First of all, the previously mentioned potential competitive interference of the platform's large ambient light-field may have partially masked any lunar effect that would otherwise be present. Secondly, some of the species may be responding differently to lunar cues. For example, some peak recruitment events for tropical and coastal fishes have also been linked to full moon periods (Johannes, 1978; Robertson et al., 1988). In addition the light-traps generally caught more larger sized (and presumably older, more competent) larvae, whereas plankton net collections were dominated by smaller sized larvae which could have been displaying different behavioral capabilities. Finally, it is possible that the abundances of these fish are related to more localized factors such as water mass supply, particularly at the mid- and inner shelf sites where the coastal current regime can dynamically affect salinity, temperature, and food patchiness, and where the geographical concentration of upstream platforms, which may represent potential spawning sites, is greatest when compared to the relative isolated shelf slope site.

In summary, the combination of the light-trap and the passive plankton nets were effective in collecting fish larvae and juveniles within the complex infrastructure of the oil and gas platforms sampled in the northcentral Gulf of Mexico. Surprisingly, the light-trap collected individuals from a wide range of taxa, including many unique taxa that were not collected with the plankton net. As in previous studies, the light-trap generally collected larger individuals (postflexion larvae and juveniles) than the plankton net, but also performed very well at the smaller sizes. Pushnet collections from the jetties were more taxonomically rich and diverse than light-trap collections, and the pushnet was equally effective in capturing large individuals as the light-trap. The use of multiple gear types in ichthyoplankton studies needs to become more common, since they can provide the researcher with a more complete view of larval and juvenile fish assemblages. For example, the combination of sampling gears at the platforms allowed for the collection of a wider range of taxa, size classes, and developmental life stages than either gear would have provided individually. This enabled us to confirm the presence of both recently-spawned larvae, larger or near-settlement size postlarvae, and juveniles at the sampling sites.

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CHAPTER 4

THE VERTICAL AND WITHIN-PLATFORM SPATIAL DISTRIBUTION OF LARVAL AND JUVENILE FISHES COLLECTED AT OFFSHORE OIL AND GAS PLATFORMS OFF LOUISIANA

INTRODUCTION

The introduction and proliferation of offshore oil and gas structures in the northern Gulf of Mexico (Gulf) has undoubtedly affected the marine ecosystem. The fish aggregation value of these platforms is well-recognized (CDOP 1985) and previous studies have shown differences in the adult assemblages with depth and distance from the platforms (Stanley and Wilson 1997; Hastings et al. 1976; Stanley and Wilson 2000; Love et al. 1999; Shinn 1974). While the adult assemblages around petroleum platforms (i.e., artificial reefs) are fairly well known, little is known about the early life stages of ecologically-, commercially- and recreationally-important fishes that may be associated with the infrastructure of petroleum platforms (Chapter 2).

Very few baseline ecological ichthyoplankton studies within oil fields have been published (Finucane et al. 1979a; Finucane et al., 1979b; Bedinger et al. 1980), and none have been published that focus upon platform infrastructure. The National Marine Fisheries Service's (NMFS) and Gulf State's Southeastern Area Monitoring and Assessment Program's (SEAMAP) Gulf-wide fisheries surveys, and Minerals Management Service sponsored oceanographic surveys have historically not sampled in the immediate vicinity of oil and gas platforms because of the conservative navigation/safety requirements of their ships. Thus, fisheries-independent assessment of the abundance of fish life stages within and immediately around these platforms and the role they might play as essential fisheries habitat has not been adequately addressed.

Samples were collected within and immediately downstream of three oil and gas platforms in the northcentral Gulf west of the Mississippi River Delta with passive plankton nets and light-traps to address possible relationships between offshore petroleum platforms and larval, postlarval and juvenile fishes. Fish were collected both at depth and near the surface within the platform infrastructure (plankton nets and light-traps), and near the surface immediately downstream of the platform structure (light-traps) in order to comprehensively sample the platform environment and provide spatial and vertical distribution data. More typical, continental shelf ichthyoplankton surveys have demonstrated that for many taxa the larval, postlarval and juvenile fishes may occupy specific depth strata (Ditty 1986, Cha et al. 1994, Ditty et al. 1988, Powell and Robins 1998, Kelley et al. 1993).

MATERIALS AND METHODS

Data collection and analyses focused on three oil and gas platforms in the northern Gulf, which were chosen to represent a previous characterization of the adult fish community zonation. Three communities were characterized: a coastal assemblage (3-20 m depth); an offshore assemblage (20-60 m depth); and a bluewater/tropical assemblage (>60 m). Mobil's Green Canyon (GC) 18, which lies in about 230 m of water on the outer shelf (27°56'37"N, 91°01'45"W), was sampled monthly during new moon phases over a 2-3 night period from July 1995 to 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 from April to August 1996. In addition during May 1996, extra samples during the first quarter and third quarter moon phases were collected, but due to inclement weather, scheduled full moon collections were cancelled. Exxon's South Timbalier (ST) 54G, which lies in approximately 20 m of water on the inner shelf (28°50'01"N, 90°25'00"W), was sampled twice monthly during new and full moon periods over a 2-3 night period from April to September, 1997.

Sampling protocols are described in detail elsewhere (Chapter 2). In general, passive plankton nets (60-cm diameter; 333 μm mesh dyed green) were used to collect ichthyoplankton at the three platform sites, both at depth (15-23 m for 10-20 min, set and retrieved closed) and near surface (1-2 m for 10-15 min) within the platform structure with the intent of sampling roughly equivalent amounts of water at both depths. Plankton net samples were standardized to number of fish per 100 m^3 (density). Modified quatrefoil light-traps (Floyd et al. 1984; Secor et al. 1993) were deployed for 10 minutes at depth and near surface within the platform structure, and in addition were also floated downstream (approximately 20 m) from the platform for off-platform collections. Both the subsurface and off-platform light-traps were deployed with the light off until the sampling depth/location was reached, fished, and then retrieved with the light off. Light-trap samples were standardized to a catch-per-unit-effort (CPUE) of fish per 10 min.

Due to the very large numbers of clupeiform fishes collected, particularly in light-trap samples, the analyses described were run without these taxa (except where noted), since these fish are seldom the taxa of interest in studies of hard substrate habitats and their abundances tend to overwhelm the trends of

other taxa (Choat et al. 1993). All ANOVA, Tukey's Studentized Range Tests, and Student's t-tests were run with SAS version 6.12 (SAS 1989).

Studentized t-tests (α=0.05) were used to compare overall plankton net densities between locations (subsurface and surface) within the GC 18 (shelf break), GI 94 (mid-shelf), and ST 54 (inner shelf) sites. Light-trap CPUEs were compared between locations (subsurface, surface, and off-platform) within each of the platform sites using an ANOVA model with location as a main effect. Tukey's Studentized Range tests were used to determine which light-trap collections were significantly different. A similar testing approach was used with the plankton net collections whose densities were log transformed ($\log_{10}(x+1)$) in an effort to conform to normality and homogeneity of variances. Analyses on light-trap CPUEs were run on ranked-transformed data. The same analyses were also run on some of dominant taxa (top three taxa identified at least to the level of genus for each gear location/depth) collected at each of the platforms.

Schoener's index of niche overlap (Schoener 1970) was calculated for comparisons of fish collections within the platform structure (surface net and surface light-trap) and far-field collections (off-platform light-trap) and total net collections vs. total light-trap collections. Shannon-Weiner diversity indices (Magurran 1988) were calculated for each sample collected at shelf break, mid-shelf and inner shelf platforms. Differences in diversity between gear types at each platform were analyzed with ANOVA models using gear as a main effect. Post-ANOVA tests (Tukey's Studentized Range, α=0.05) were used to determine which gear types where significantly different. Only fish identified to at least the genus level were included in these analyses. Clupeiform fishes were included in the similarity and diversity indices, since the intent was to characterize the taxonomic assemblages sampled by each gear type. Taxonomic richness (either at the family or genus/species level) is used in reference to the number of taxa collected.

RESULTS

At the shelf break platform (GC 18), many of the dominant taxa were collected by both gear types and in different sampling locations within and downstream of the platform (Table 4.1). For example, *Mugil cephalus* had the highest average density for both subsurface (32.1 fish/100m^3) and surface nets (8.3 fish/100m^3), and was relatively dominant in off-platform light-trap samples (0.14

Table 4.1. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for the top 10 taxonomic groups of fish collected at the shelf break platform (GC 18) with standard error (SE) and rank by each gear type and location. For ranks, tied values received the mean of the corresponding ranks.

	Subsurface Net		Subsurface Light-trap		Surface Net		Surface Light-trap		Off-platform Light-trap	
Taxa	Rank	Density (SE)	Rank	CPUE (SE)	Rank	Density (SE)	Rank	CPUE (SE)	Rank	CPUE (SE)
Mugil cephalus	1	32.1 (15.62)			1	8.27 (4.58)			5.5	0.14 (0.06)
Scaridae (unidentified)	2	16.31 (5.64)			5	3.01 (1.35)				
Gobiidae (unidentified)	3	11.08 (3.87)	1	0.09 (0.04)	2	4.63 (1.78)	1	0.44 (0.40)	11.5	0.05 (0.02)
Citharichthys spilopterus	4	4.85 (1.98)								
Caranx hippos/latus	5	4.45 (1.62)			7	1.89 (0.65)	10	0.08 (0.03)	2	0.22 (0.06)
Cyclothone braueri	6	3.05 (1.55)					4	0.23 (0.21)		
Ophichthidae (unidentified)	7	2.87 (1.27)								
Bregmaceros cantori	8	2.42 (1.21)	4	0.03 (0.02)	8	1.80 (0.88)			11.5	0.05 (0.02)
Pristipomoides aquilonaris	9	1.95 (0.88)								
Serranidae (unidentified)	10	1.86 (1.28)								
Blenniidae (unidentified)			2.5	0.06 (0.03)			6	0.17 (0.15)		
Symphurus spp.			2.5	0.06 (0.05)	4	3.03 (1.16)	8	0.10 (0.04)	9	0.07 (0.03)
Saurida brasiliensis			5.5	0.03 (0.02)			5	0.20 (0.14)		
Myctophidae (unidentified)			5.5	0.03 (0.02)					4	0.17 (0.06)
Lestidium atlanticum			10	0.02 (0.01)						
Lestrolepis intermedia			10	0.02 (0.02)						
Lepophidium spp.			10	0.02 (0.01)						
Micropogonias undulatus			10	0.02 (0.01)						
Pomacentrus spp.			10	0.02 (0.01)			7	0.14 (0.08)		
Auxis spp.			10	0.02 (0.01)			2	0.40 (0.13)	5.5	0.14 (0.04)
Peprilus burti			10	0.02 (0.01)						
Sciaenops ocellatus					3	4.11 (1.92)				
Caranx crysos					6	2.75 (1.30)	3	0.24 (0.08)	1	0.30 (0.10)
Scombridae (unidentified)					9	1.75 (1.01)				
Cynoscion arenarius					10	1.51 (0.66)				
Gobiesox strumosus							10	0.08 (0.08)		
Syacium spp.							10	0.08 (0.05)	3	0.18 (0.08)
Euthynnus alletteratus										
Holocentrus spp.									7	0.11 (0.05)
Eucinostomus spp.									8	0.10 (0.07)
Pomatomus saltatrix									11.5	0.05 (0.03)
Peprilus burti									11.5	0.05 (0.03)

fish/10 min). Other taxa, including *Bregmaceros cantori, Caranx hippos/latus*, and unidentified gobies and scarids were also relatively dominant throughout the sampling depths/locations. However, there were some observable vertical and spatial differences in plankton net densities and light-trap CPUEs between the dominant, non-clupeiform taxa collected within and near the platform structure. Several deepwater (*Lestidium atlanticum, Lestrolepis intermedia*, and *Lepophidium* spp.), demersal (*Citharichthys spilopterus, Micropogonias undulatus*, and ophicthids) and reef-associated (*Pristipomoides aquilonaris* and serranids) taxa were more prevalent in subsurface collections (net or light-trap) than in surface collections. Several pelagic taxa, including *Pomatomus saltatrix, Eucinostomus* spp., *Caranx crysos, Euthynnus alletteratus* and unidentified scombrids were more prominent in surface collections. Other taxa collected in surface light-traps exhibited spatial differences. For example, gobies dominated surface light-trap collections within the platform, but were not relatively common in off-platform samples. A similar trend was observed for *Cyclothone braueri* and blennies. Conversely, myctophids, *Mugil cephalus, Holocentrus* spp., and *Bremaceros cantori* were relatively common in off-platform, surface light-trap collections, but not very common in collections within the platform.

At the mid-shelf platform (GI 94), some taxa were commonly found in both subsurface and surface collections and both within and off-platform (Table 4.2). Some lizardfishes (*Saurida brasiliensis* and *Synodus foetens*), for example, were relatively common in subsurface plankton net samples and in subsurface, surface and off-platform light-trap samples. They were, however, not a dominant taxa in surface plankton net collections. The lizardfish *Synodus poeyi* and the blennies *Parablennius marmoreus* and *Hypsoblennius invemar* were not dominant in plankton net samples, but were relatively common in light-trap samples both within and off the platform structure. There were some apparent spatial and vertical differences in abundances between taxa. Some taxa were primarily sampled in deeper waters, including *Syacium* spp., *Peprilus paru* and *Etropus crossotus* in subsurface plankton nets and *Rhomboplites aurorubens* in subsurface light-traps. Other taxa were dominant in surface collections, such as *Auxis* spp. (all gears) and unidentified blennies, *Sphyraena guachancho* and *Chloroscombrus chrysurus* (surface net). In light-trap collections, the blenny complexes *Scartella/Hypleurochilus* and *Hypsoblennius hentz/ionthas* were dominant in surface light-trap collections within the platform, but not in off-platform samples. Conversely, *Upeneus parvus, Pomacentrus* spp. and *Scomberomorus cavalla*

Table 4.2. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for the top 10 taxonomic groups of fish collected at the mid-shelf platform (GI 94) with standard error (SE) and rank by each gear type and location. For ranks, tied values received the mean of the corresponding ranks.

	Subsurface Net		Subsurface Light-trap		Surface Net		Surface Light-trap		Off-platform Light-trap	
Taxa	Rank	Density (SE)	Rank	CPUE (SE)	Rank	Density (SE)	Rank	CPUE (SE)	Rank	CPUE (SE)
Symphurus spp.	1	17.00 (3.82)			1	6.79 (1.18)				
Bregmaceros cantori	2	16.67 (3.00)	1	2.18 (1.02)	8	1.59 (0.42)				
Gobiidae (unidentified)	3	10.73 (1.76)	4	0.21 (0.06)	3	5.75 (0.80)				
Saurida brasiliensis	4	4.8 (1.3)	2	1.97 (0.42)			5	3.35 (0.51)	5	0.50 (0.14)
Euthynnus alletteratus	5	4.10 (1.06)	10	0.08 (0.03)	5	4.55 (1.05)	8	0.92 (0.17)	2	2.83 (0.62)
Syacium spp.	6	3.78 (1.14)								
Peprilus paru	7	2.79 (1.72)								
Synodus foetens	8	2.12 (0.77)	5	0.20 (0.06)			1	22.11 (5.24)	10	0.20 (0.05)
Synodontidae (unidentified)	9	2.11 (0.56)	8	0.10 (0.03)			9	0.90 (0.39)		
Etropus crossotus	10	1.79 (0.54)								
Synodus poeyi			3	0.34 (0.09)			2	9.98 (1.78)	4	1.13 (0.28)
Rhomboplites aurorubens			6	0.20 (0.06)						
Parablennius marmoreus			7	0.19 (0.04)			3	7.20 (1.06)	3	1.62 (0.35)
Hypsoblennius invemar			9	0.08 (0.03)			4	6.33 (1.77)	1	3.58 (0.67)
Caranx crysos					9	1.14 (0.41)				
Cynoscion arenarius					6	3.12 (1.11)				
Auxis spp.					2	6.61 (2.32)	10	0.76 (0.19)	9	0.24 (0.06)
Blenniidae (unidentified)					4	4.73 (3.95)				
Sphyraena guachancho					7	1.83 (0.60)				
Chloroscombrus chrysurus					10	1.00 (0.34)				
Hypsoblennius hentz/ionthas							6	1.76 (0.57)		
Scartella/Hypleurochilus							7	1.14 (0.24)		
Upeneus parvus									6	0.38 (0.09)
Pomacentrus spp.									7	0.30 (0.14)
Scomberomorus cavalla									8	0.27 (0.11)

were relatively common in off-platform samples, but not dominant in surface samples within the platform structure.

At the inner shelf platform (ST 54), *Cynoscion arenarius* were commonly collected at all locations/depths and in all gear types (Table 4.3). Other relatively ubiquitous taxa included gobies, blennies and *Synodus foetens*. Similar to the shelf break and mid-shelf platforms, vertical distribution trends were observed, but differences between within platform and off-platform surface collections were less pronounced. Many of the dominant taxa collected at depth, including myctophids, *Ariomma* spp. and *Scorpaena* spp. (in subsurface nets), *Trichiurus lepturus* and *Bregmaceros cantori* (in both within platform gears), and *Rhomboplites aurorubens*, *Saurida brasiliensis* and *Peprilus paru* (in subsurface light-traps), were not common in surface collections. Many of the taxa commonly collected away from the platform with light-traps were also collected within the platform, either in plankton nets or light-traps. Exceptions include *Auxis* spp. and *Caranx crysos*, which were dominant in off-platform light-trap samples and not within the platform structure. *Scomberomorus maculatus* was dominant in all surface collections.

At all platforms, there were many instances where some taxa were collected with only one gear type at a specific depth/location (Table 4.4). In general, subsurface gears within platforms collected the fewest unique taxa within each site. When subsurface nets and light-traps collected unique taxa, they were primarily deep water or demersal fishes as adults, such as *Paralepis atlantica*, *Lestrolepis intermedia*, and *Chlorophthalmus agassizi* at the shelf break platform (GC 18), *Robia legula*, *Engyophrys senta* and *Lestreas* spp. at the mid-shelf platform (GI 94), and *Ophidion robinsi* and *Rhomboplites aurorubens* at the inner shelf platform (ST 54). Surface plankton nets and light-traps within the platform structure collected a wide variety of unique taxa, including pelagic, deep water, demersal and reef-associated types. Off-platform light-traps collected primarily taxa which are pelagic as adults, such as flyingfishes (*Cypselurus* spp., GC 18 and ST 54), jacks (*Trachinotus carolinus*, GI 94; *Selar crumenopthalmus* and *Trachinotus carolinus*, ST 54), and mackerels (*Scomber japonicus* and *Thunnus* spp., GI 94), among others. Interestingly, goatfishes were present as unique taxa in off-platform light-trap samples at all sites (*Upeneus parvus*, GC 18 and ST 54; *Mullus auratus* and *Pseudopeneus maculatus*, GI 94). Also, *Abudefduf saxatilis*, a reef-dependent species, was collected only in off-

Table 4.3. Total plankton net density (fish/100 m^3) and light-trap CPUE (fish/10 min) for the top 10 taxonomic groups of fish collected at the inner shelf platform (ST 54) with standard error (SE) and rank by each gear type and location. For ranks, tied values received the mean of the corresponding ranks.

	Subsurface Net		Subsurface Light-trap		Surface Net		Surface Light-trap		Off-platform Light-trap	
Taxa	Rank	Density (SE)	Rank	CPUE (SE)	Rank	Density (SE)	Rank	CPUE (SE)	Rank	CPUE (SE)
Cynoscion arenarius	1	7.99 (3.21)	4	0.10 (0.04)	1	42.16 (8.56)	3	0.42 (0.11)	4	0.56 (0.13)
Myctophidae (unidentified)	2	4.09 (3.52)								
Gobiidae (unidentified)	3	1.41 (0.96)	8	0.06 (0.03)	3	29.9 (12.71)			10	0.23 (0.08)
Blenniidae (unidentified)	4	1.10 (1.10)			10	2.47 (0.90)	9	0.09 (0.03)		
Etropus crossotus	5	0.89 (0.89)			5	7.59 (2.94)				
Trichiurus lepturus	6.5	0.52 (0.52)	2	0.18 (0.07)						
Ariomma spp.	6.5	0.52 (0.52)								
Bregmaceros cantori	9	0.26 (0.26)	6	0.06 (0.03)						
Synodus foetens	9	0.3 (0.3)	1	2.88 (1.55)			1	3.16 (1.25)	7	0.27 (0.10)
Scorpaena spp.	9	0.26 (0.26)								
Rhomboplites aurorubens			3	0.12 (0.07)						
Saurida brasiliensis			5	0.06 (0.03)						
Scartella/Hypleurochilus			7	0.06 (0.03)			2	0.49 (0.26)		
Scomberomorus cavalla			9	0.04 (0.03)	7	5.39 (3.15)				
Peprilus paru			10	0.04 (0.03)						
Symphurus spp.					4	8.84 (3.84)				
Caranx hippos/latus					9	2.70 (2.44)			3	0.61 (0.25)
Euthynnus alletteratus							4	0.37 (0.23)	1	1.08 (0.47)
Chloroscombrus chrysurus					2	30.0 (11.03)	10	0.09 (0.04)		
Hypsoblennius invemar							8	0.11 (0.05)	6	0.48 (0.19)
Hypsoblennius hentz/ionthas							5	0.21 (0.08)	5	0.48 (0.22)
Scomberomorus maculatus					6	6.56 (2.09)	6	0.18 (0.06)	2	0.81 (0.18)
Ophidion nocomis/selenops					8	3.09 (1.77)				
Peprilus burti							7	0.14 (0.05)		
Auxis spp.									8	0.26 (0.17)
Caranx crysos									9	0.24 (0.08)

Table 4.4. Unique taxa (identified at least to genus) collected by gear and location for each platform.

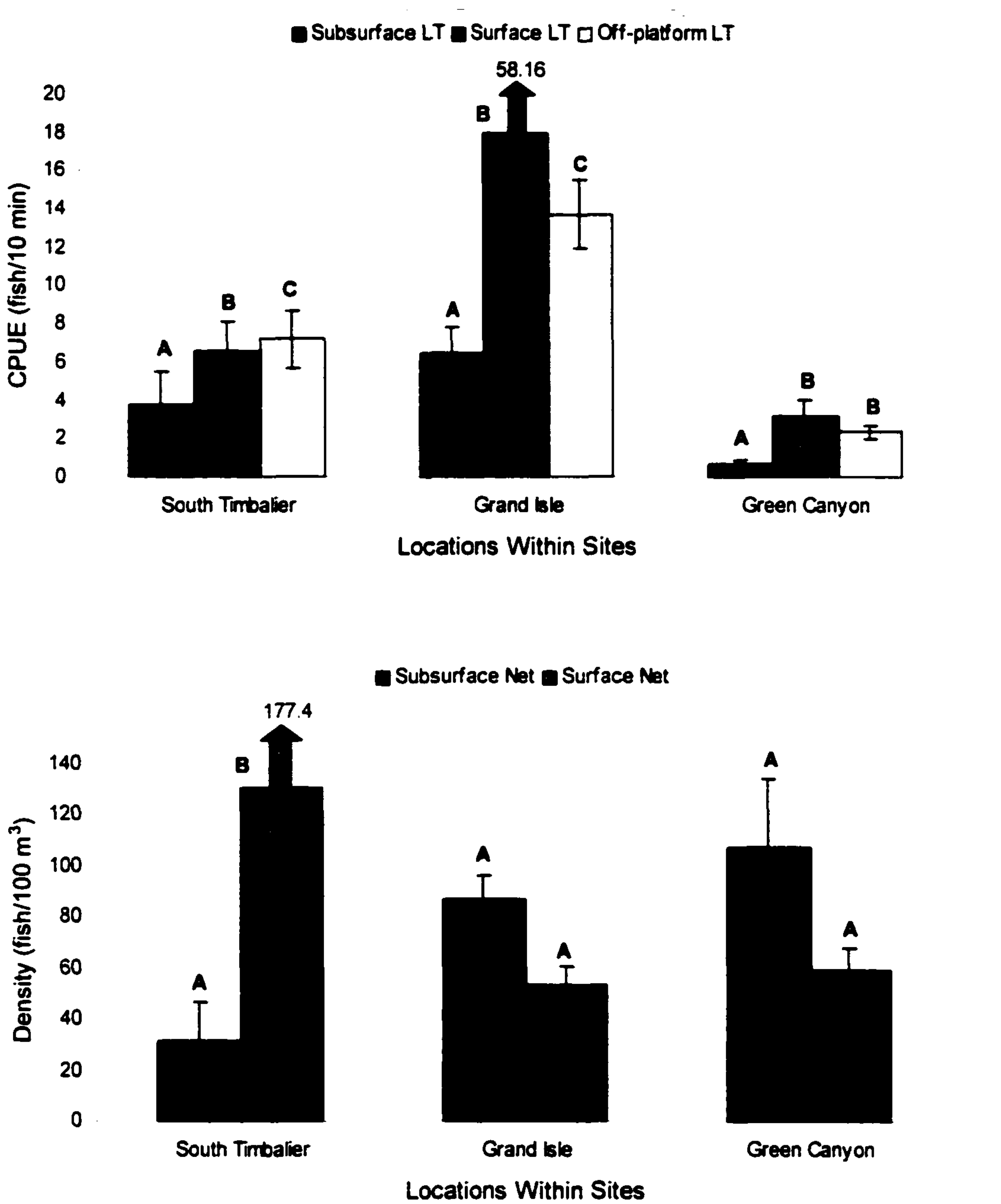
Gear/Location	Shelf Break (GC 18)	Mid-Shelf (GI 94)	Inner Shelf (ST 54)
Subsurface Net	*Elops saurus*	*Lepophidium* spp.	
	Sphoeroides spp.	*Ophidion selenops*	
	Chlorophthalmus agassizi	*Robia legula*	
		Priacanthus spp.	
		Gempylus spp.	
		Engyophrys senta	
Subsurface Light-trap	*Paralepis atlantica*	*Lestroleas* spp.	*Ophidion robinsi*
	Lestrolepis intermedia	*Bollmannia communis*	*Rhomboplites aurorubens*
Surface Net	*Scopelarchoides* spp.	*Lepophidium staurgphor*	*Cyclothone braueri*
	Melamphaes spp.	*Caranx* spp.	*Ophidion* spp.
	Chaetodipterus faber	*Oligoplites saurus*	*Cypselurus* spp.
	Prionotus spp.	*Seriola* spp.	*Syngnathus* spp.
	Rhomboplites aurorubens	*Stellifer lanceolatus*	*Syngnathus louisianae*
	Apogon spp.	*Opistognathus* spp.	*Selene* spp.
	Paradiplogramus bairdi	*Opistognathus lonchurus*	*Oligoplites saurus*
	Selene vomer	*Microdesmus* spp.	*Lutjanus* spp.
	Foetorepus agassizi	*Ophioblennius atlanticus*	*Calamus* spp.
	Scorpaena spp.	*Achirus lineatus*	*Larimus fasciatus*
	Coryphaena equisetis	*Microdesmus longipinnis*	*Stellifer lanceolatus*
	Tetragonurus atlanticus	*Ophicthus gomesi*	*Gymnachirus* spp.
			Chaetodipterus faber
			Syacium spp.
			Dormitator maculatus
			Trinectes maculatus
			Microdesmus lanceolatus
Surface Light-trap	*Myrophis punctatus*	*Hoplunnis macrurus*	*Albula vulpes*
	Gobiesox strumosus	*Saurida normani*	*Membras martinica*
	Cypselurus cyanopterus	*Vinciguerria nimbaria*	*Seriola* spp.
	Parexocoetus brachypterus	*Saurida suspicio*	*Sphyraena borealis*
	Priacanthus spp.	*Saurida normani/brasiliensis*	*Sphoeroides* spp.
	Lutjanus apodus/vivanus	*Calamus* spp.	
	Lutjanus campechanus	*Cypselurus cyanopterus*	
		Seriola fasciata	
		Trachinotus falcatus/goodei	
		Upeneus parvus	
		Abudefduf taurus	
		Synodus synodus	
		Sphyraena borealis	
		Thunnus thynnus	
		Ariomma regulus	
		Bothus spp.	
Off-platform Light-trap	*Cypselurus furcatus/heterurus*	*Trachinotus carolinus*	*Saurida suspicio*
		Coryphaena equisetis	*Lepophidium staurophor*
	Pomatomus saltatrix	*Mullus auratus*	*Cypselurus cyanopterus*
	Upeneus parvus	*Pseudopeneus maculatus*	*Cypselurus furcatus*
	Monolene sessilicauda	*Abudefduf saxatilis*	*Priacanthus* spp.
		Scomber japonicus	*Selar crumenopthalmus*
		Thunnus spp.	*Trachinotus carolinus*
			Upeneus parvus
			Abudefduf saxatilis
			Pomacentrus spp.
			Mugil cephalus
			Cyclopsetta fimbriata

platform samples at GI 94 and ST 54. In most instances, however, these unique taxa were not among the dominant taxa collected at each site. Exceptions include *Lestrolepis intermedia* (subsurface light-trap), *Gobiesox strumosus* (surface light-trap) and *Pomatomus saltatrix* (off-platform light-trap) at the shelf break site (GC 18; Table 4.1) and *Rhomboplites aurorubens* (subsurface light-trap) at the inner shelf site (ST 54; Table 4.3).

In general within the light-trap collections, surface and off-platform light-traps had the highest mean total CPUEs at all three platforms (Figure 4.1). At the shelf break platform (GC 18), mean CPUEs were lower than the other sites. Mean CPUEs for surface (3.2 fish/10 min) and off-platform (2.4 fish/10 min) light-traps were not statistically different from each other, but both were significantly higher than the mean CPUE for subsurface light-trap collections (0.7 fish/10 min; Tukey's Studentized Range test, α=0.05). At the mid-shelf (GI 94) and inner shelf (ST 54) sites, significant differences were detected between all three gear depths/locations. Overall, light-trap CPUEs were highest at the mid-shelf site (GI 94). At this platform, mean CPUE for surface light-traps (58.2 fish/min) was significantly higher than both the off-platform (13.8 fish/10 min) and subsurface (6.5 fish/10 min) mean CPUEs. At the inner shelf platform (ST 54), the mean CPUE for off-platform light-trap samples (7.2 fish/min) were significantly higher than those for the surface (6.6 fish/min) and subsurface (3.8 fish/min) light-trap collections.

No significant differences were detected in mean total plankton net densities between the two depths at the shelf break (GC 18) and mid-shelf (GI 94) sites (t-tests, α=0.05; Figure 4.1), although subsurface densities were generally higher. Mean densities by depth were similar at these sites and ranged from 58.9-107.7 fish/100 m^3 at GC 18 and from 53.4-86.6 fish/100 m^3 at GI 94. This general trend was reversed at the inner shelf platform (ST 54), where surface nets had a significantly higher mean total density (177.4 fish/100 m^3) than subsurface nets (31.6 fish/100 m^3). However, due to complications in deploying subsurface plankton nets at ST 54 (Table 2.1), relatively few subsurface samples (n=7) were available for comparison with surface samples (n=82).

Significant trends were also observed within dominant species in mean CPUEs and densities between the different sampling depths and locations within sites. At the shelf break platform (GC 18), three taxa met the criterion for light-trap depth/location comparisons and four taxa met the criterion for



a.

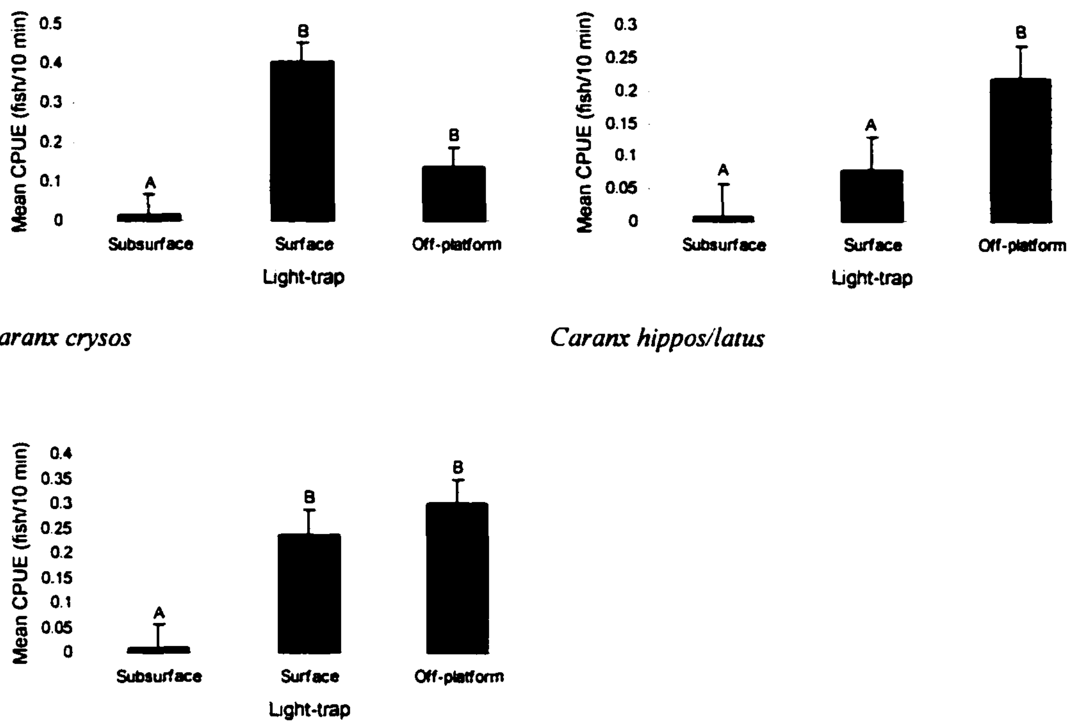
b.

Figure 4.1. Mean light-trap CPUEs (a) and plankton net densities (b) with standard error bars for data without clupeiform fishes for depths/locations within each platform site. Arrows above bars point toward the mean for that location/depth which is off the axis. Within each site, the same letter above each bar indicates no significant difference between the gear types based on Tukey's Studentized Range test on ranked data (α=0.05). Different letters designate significant differences.

plankton net depth comparisons. *Caranx crysos* and *Auxis* spp. appeared to behave similarly, since they were collected in significantly higher CPUEs from surface waters (both within the platform structure and off-platform) than from subsurface waters (Tukey's Studentized Range tests, $\alpha=0.05$; Figure 4.2). While *C. hippos/latus* displayed significantly higher CPUEs in off-platform collections than at either depth within the platform. In general, differences in mean plankton net densities at GC 18 for some dominant taxa were higher in subsurface collections than surface collections (Figure 4.3): *Citharichthys spilopterus* (Student's t-test, p=0.006); *Symphurus* spp. (p=0.046); *Mugil cephalus* (p=0.081); and *Caranx hippos/latus* (p=0.260).

At the mid-shelf platform (GI 94), three taxa met the criterion for light-trap depth/location comparisons and two taxa met the criterion for plankton net depth comparisons. Two of the dominant species collected with light-traps appeared to be surface oriented (Figure 4.4). Mean CPUEs for *Hypsoblennius invemar* and *Euthynnus alletteratus* were significantly higher in surface and off-platform light-trap samples than in subsurface light-trap samples (Tukey's Studentized Range tests, $\alpha=0.05$). Mean CPUEs for *Synodus foetens* were significantly higher in the surface light-trap samples within the platform. Mean plankton net densities were significantly higher in the subsurface samples for *Bregmaceros cantori* and to a much lesser extent for *Symphurus* spp. (Figure 4.5).

At the inner shelf platform (ST 54), two taxa met the criterion for light-trap depth/location comparisons, while four taxa met the criterion for plankton net depth comparisons. For *Synodus foetens*, the mean surface light-trap CPUE was significantly higher than that for off-platform samples, but not the subsurface samples, and there was no significant differences between subsurface and off-platform mean CPUEs (Tukey's Studentized Range test, $\alpha=0.05$; Figure 4.6). A different pattern was observed for *Euthynnus alletteratus*, where the mean off-platform light-trap CPUE was significantly higher than the subsurface light-trap CPUE, but was not significantly different from the mean surface light-trap CPUE ($\alpha=0.05$). The mean subsurface net density was significantly higher than the surface net density for *Ariomma* spp. (Figure 4.7; $p<0.030$). Conversely, the mean surface net densities were higher for *Cynoscion arenarius*, *Chloroscombrus chrysurus* and *Etropus crossotus*, although no significant differences were detected.



Auxis spp.

Figure 4.2. Mean total CPUEs (with standard error bars) for dominant species collected with light-traps at the shelf break platform (GC 18). The same letter above each bar indicates no significant difference between the gear locations based on Tukey's Studentized Range tests on ranked data (α=0.05). Different letters indicate significant differences.

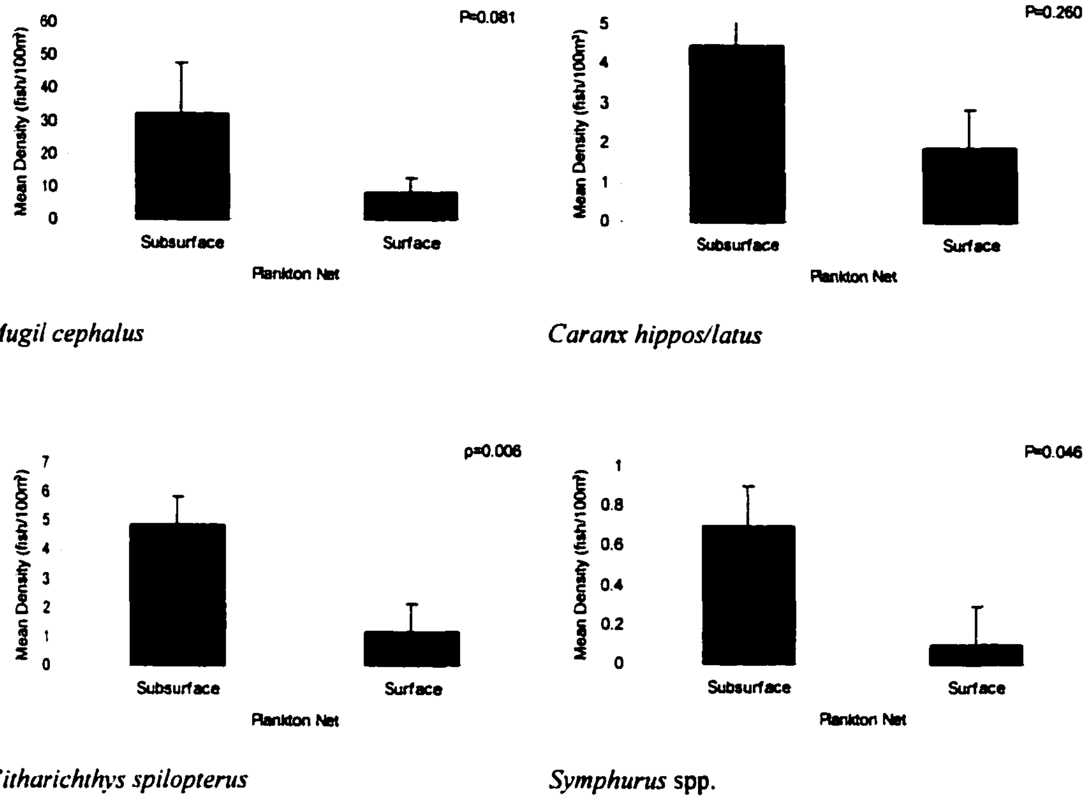


Figure 4.3. Mean total densities (with standard error bars) for dominant species collected with plankton nets at shelf break platform (GC 18). The p-values indicate statistical significance from t-tests on log-transformed data.

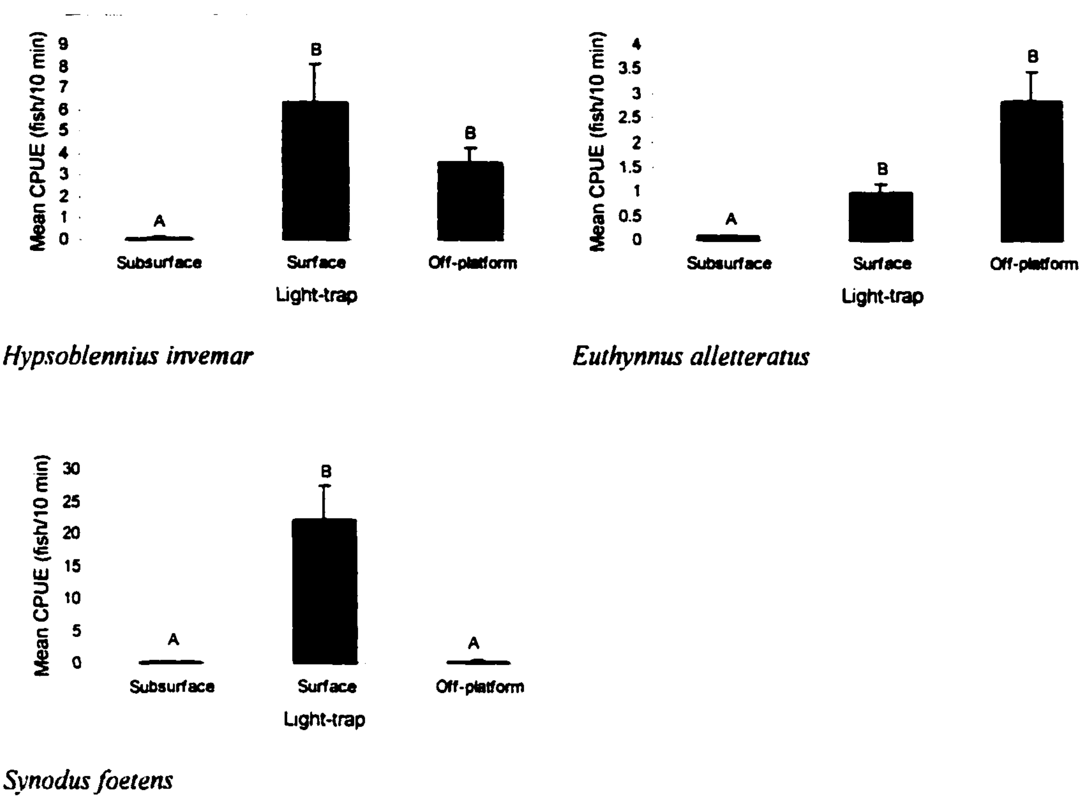
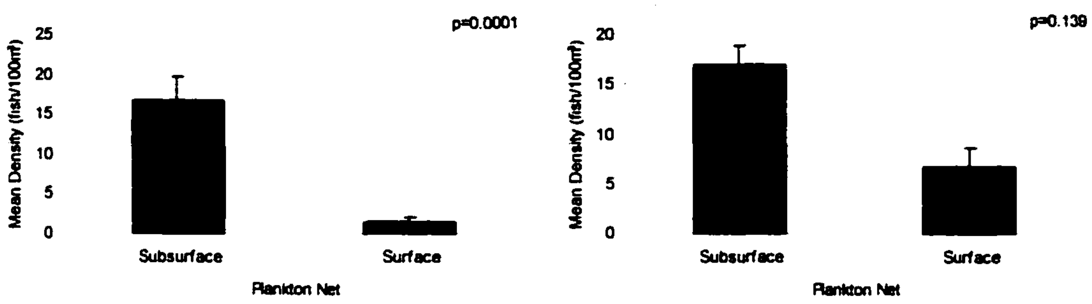
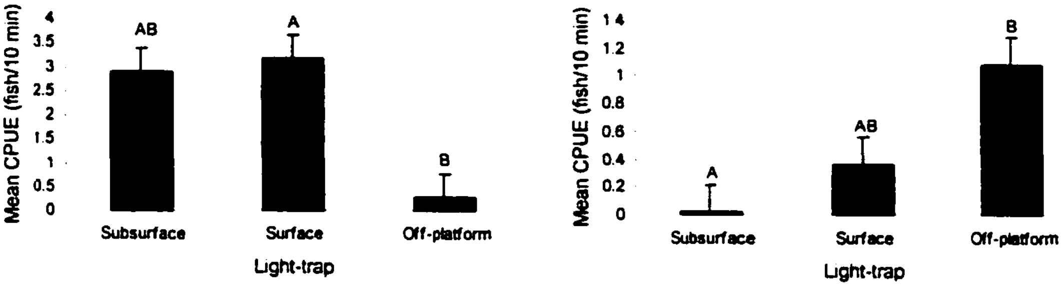


Figure 4.4. Mean total CPUEs (with standard error bars) for dominant species collected with light-traps at the mid-shelf platform (GI 94). The same letter above each bar indicates no significant difference between the gear locations based on Tukey's Studentized Range tests on ranked data (α=0.05). Different letters indicate significant differences.



Bregmaceros cantori *Symphurus* spp.

Figure 4.5. Mean total densities (with standard error bars) for dominant species collected with plankton nets at the mid-shelf platform (GI 94). The p-values indicate statistical significance from t-tests on log-transformed data.



Synodus foetens *Euthynnus alletteratus*

Figure 4.6. Mean total CPUEs (with standard error bars) for dominant species collected with light-traps at the inner shelf platform (ST 54). The same letter above each bar indicates no significant difference between the gear locations based on Tukey's Studentized Range tests on ranked data ($\alpha=0.05$). Different letters indicate significant differences.

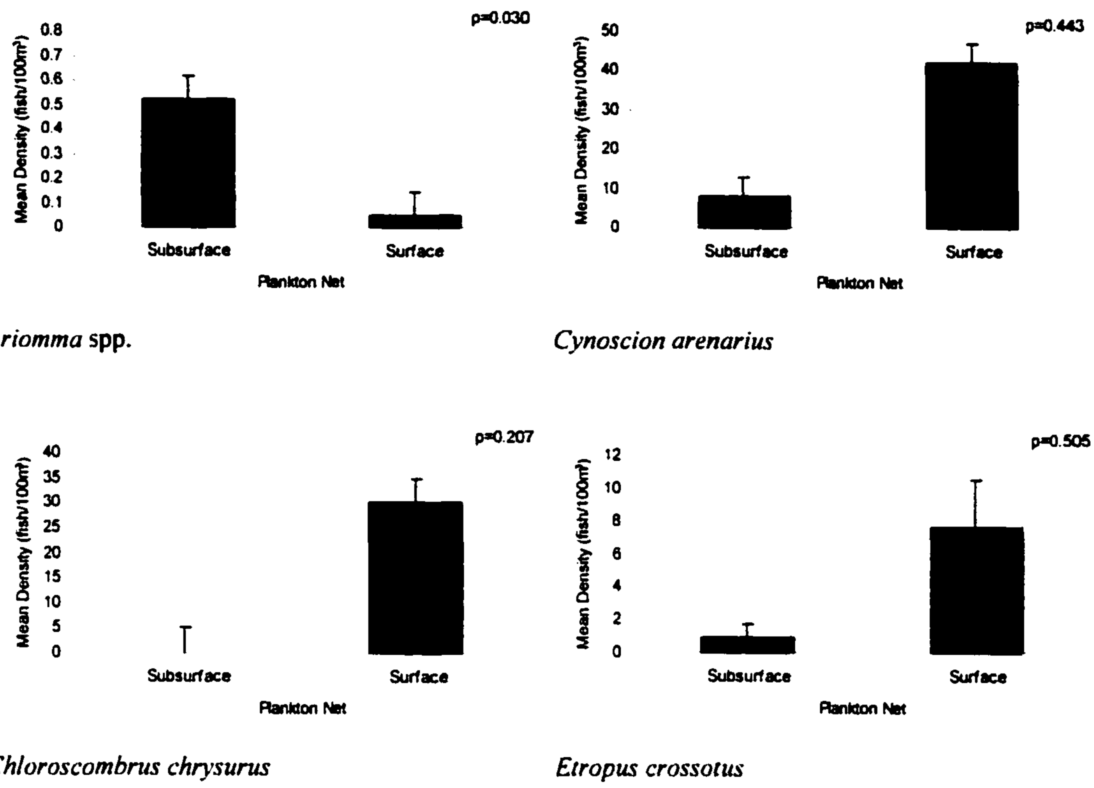


Figure 4.7. Mean total densities (with standard error bars) for dominant species collected with plankton nets at the inner shelf platform (ST 54). The p-values indicate statistical significance from t-tests on log-transformed data.

Within site comparisons of gears and surface sampling locations indicated that off-platform and surface light-trap collections were more similar to each other (0.45-0.76) than each was to surface plankton net collections (0.27-0.71), although the disparity between the index gear comparisons is smaller at ST 54 (0.59-0.71; Table 4.5). Overall, total light-trap collections were relatively different from total plankton net samples at GC 18 and GI 94 (0.38 and 0.32, respectively), but much more similar at ST 54 (0.63).

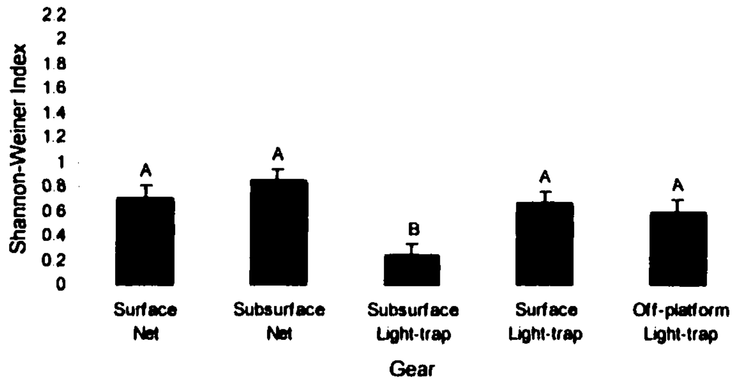
Table 4.5. Schoener's similarity indices for different surface gear and location comparisons. (OL) off-platform light-trap, (SL) surface light-trap, (SN) surface net, (TL) total light-traps, (TN) total nets.

	OL vs SL	OL vs SN	SL vs SN	TL vs TN
Outer Shelf (GC 18)	0.53	0.32	0.31	0.38
Mid-Shelf (GI 94)	0.45	0.37	0.27	0.32
Inner Shelf (ST 54)	0.76	0.71	0.59	0.63

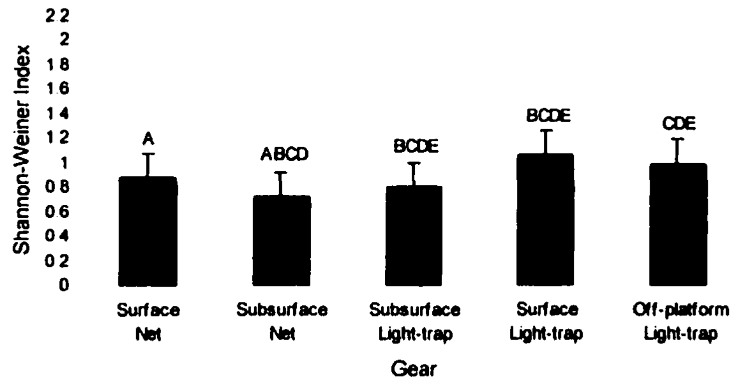
There was little difference in the Shannon-Weiner diversity index values for gear and depth/location samples collected at GC 18 and ST 54 (Figure 4.8). In both instances, only subsurface light-trap samples had significantly lower diversity values than the other gear and depth/location combinations (α=0.05). No clear pattern in diversity was discernable at the mid-shelf site (GI 94) other than surface net collections were significantly different from light-trap collections, and that off platform light-trap collections were different from net collections regardless of depth.

DISCUSSION

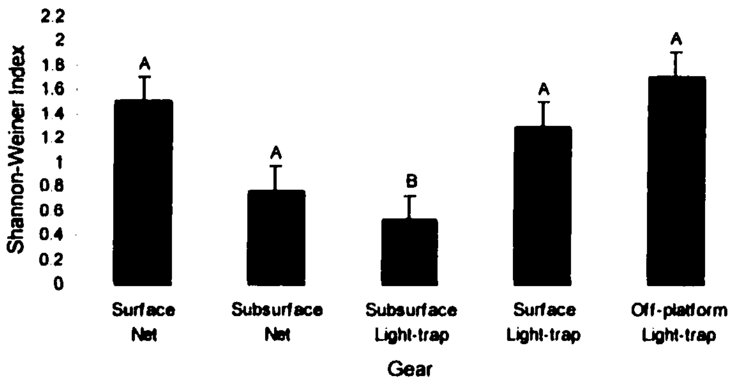
I am aware of only one study (Finucane et al. 1979b) that investigated the ichthyoplankton community found in proximity to oil and gas platforms. This Texas continental shelf study was limited, however, in that fish larvae and juveniles were collected with double oblique bongo net tows (water column) and neuston net tows (surface) at a navigationally-safe distance from the platform structures (30-90 m). Also, all of the sites with structure were within a 5 km radius from each other, and all sites, including the controls, were in 17 m of water, not allowing for any comparisons of different community regimes across depth zones or large geographic areas. The sampling in the oil field study was also



Outer Shelf (GC 18)



Mid-Shelf (GI 94)



Inner Shelf (ST 54)

Figure 4.8. Mean Shannon-Weiner diversity indices (with standard error bars) for each gear type and sampling location for each site. The same letter above each bar indicates no significant difference between the gear types based on Tukey's Studentized Range tests (α=0.05). Different letters indicate significant differences.

limited to only three, 2-day cruises. While statistical comparisons were limited, the authors did note some differences in the taxonomic compositions collected by the different gear types, and concluded that the neuston net generally collected fish larvae that preferred surface/near surface waters, while the bongo tows collected some larvae that were unique to subsurface waters.

If one is to assume that their bongo net collections reflected a subsurface ichthyoplankton assemblage and the neuston collection reflected a surface assemblage, then a few general comparisons can be made between this study and that of Finucane et al. (1979b). For example, those authors noted that bothids, gadids and gerreids were absent in bongo (subsurface) tows, while gobiids, myctophids and sparids were not present in neuston (surface) tows. Of the dominant bothid taxa collected in this study, *Citharichthys spilopterus* and *Etropus crossotus* were dominant only in subsurface waters at the outer shelf (GC 18) and mid-shelf (GI 94) platforms, respectively. However, *E. crossotus* were relatively dominant in both subsurface and surface plankton nets at the inner shelf platform (ST 54) and *Syacium* spp. were collected primarily in surface light-traps at the outer shelf platform (GC 18). Unlike the previous study, gerreids (*Eucinostomus* spp.) were collected in surface waters (off-platform light-trap) at GC 18. Gadids, myctophids and sparids were not dominant taxa in any of the platform collections.

It is difficult to determine, however, if any differences in taxonomic compositions observed in Finucane et al. (1979b) and this study are a result of a possible gear bias, or if they represent real differences in vertical preferences between taxa. The platforms represent vertical and structurally-complex habitats (i.e., vertical extension of the benthos and/or an artificial reef). In addition, larval synodontids and gobiids, for example, exhibit strong photopositive responses and are often collected in light-aggregation devices (Choat et al. 1993; Brogan 1994; Hickford and Schiel 1999; Hernandez and Lindquist 1999; Chapter 2). This behavioral response may result in the aggregation of some larval fishes in a depth stratum where they otherwise might not be found. Finacune et al. (1979b), for example, found synodontids and gobiids to be common in subsurface waters. Synodontids were relatively common at depth in both plankton nets and light-traps at the mid-shelf (GI 94) and inner shelf (ST 54) platforms. At all three platforms, however, they were relatively common in surface waters in light-trap collections, but not in plankton nets. A similar trend was observed for gobiids. It is likely, therefore, that the depth

distributions of some taxa may be influenced by either the platform's vertical benthos or the presence of light (e.g., light-traps and/or platform's light-field).

A number of studies have addressed the vertical distribution of larval and juvenile fishes in a variety of open ocean and coastal habitats (Ditty 1986; Ditty et al. 1988, Able et al. 1998; Leis 1991; Cha et al. 1994; Thorrold et al. 1994; Katsuragawa and Matsuura 1990). In general, these studies used towed nets (e.g., MOCHNESS, oblique bongo) and addressed larval fish vertical assemblages at a much larger scale (surface down to 200 m depth) than sampled at the platforms (surface down to 15-23 m depth). The observations of vertical distribution patterns in this study differs from others in that sampling occurred: 1) at a relatively small vertical scale (within 25 m of surface); 2) around a structurally-complex, hard-substrate habitat; and 3) with passive plankton nets and light-traps fished exclusively at night.

The depth of subsurface sampling was limited, in part, by the depth of the first cross-member support structures within each platform which inhibited the sampling gear from going deeper and to which the guidelines were attached (Chapter 2). In general, the entire sampling depth range is within just the first depth interval or near surface stratum sampled by other large-scale ichthyoplankton studies. However, even with this sampling limitation, there were statistical differences in the vertical structure of the larval and juvenile fishes collected within and near the platforms. Many studies have shown that larval fishes are concentrated in the upper levels of the water column and are generally above the thermocline or mixed layer (Ahlstrom 1959; Cha et al. 1994; Kendall and Naplin 1981; Loeb 1979). Ditty et al. (1988), in a review of ichthyoplankton surveys of the northern Gulf, found that most (>75%) of the dominant taxa were collected in the upper water column (<50 m depth). Studies in other marine systems have found similar results. For example, larval fishes collected at 25 m depth intervals with MOCHNESS in the Florida Keys were predominantly in the first (31.5%) and second (33.1%) strata (Cha et al. 1994).

Despite the limited vertical scale in this study, there were some similarities between this study and previous surveys. In particular, some mesopelagic and demersal taxa were predominantly collected in subsurface gears. Several species were collected only at depth, such as *Chlorophthalmus agassizi*, *Paralepis atlantica*, and *Lestrolepis intermedia* at GC 18 (outer shelf), *Robia legula*, *Ophidion selenops*, and *Priacanthus* spp. at GI 94 (mid-shelf), and *Ophidion robinsi* and *Rhomboplites aurorubens* at ST 54

(inner shelf). This is not unexpected since it has been suggested that mesopelagic and mid-oceanic larval fishes may be present in deeper waters as an early adaptation to their later, adult life (Ahlstrom 1959; Loeb 1979). Katsuragawa and Matsuura (1990), for example, reported much higher catches of myctophids, gonostomatids, paralepids and other mesopelagic taxa in oblique bongo tows than in neuston tows. While there is a similar vertical trend in the platform collections, these taxa were relatively rare and their abundances are likely underestimated due to the relatively shallow nature of the platform sampling (<23 m).

A possible explanation for the significantly higher subsurface plankton net densities (total catch) at the outer and mid-shelf platforms is the probable high predation pressures in the illuminated surface waters. The preflexion and early flexion larvae collected in passive plankton nets are less competent and generally less able to swim to avoid predators. Many larval fish predators were collected in platform samples, including larval and juvenile synodontids, carangids and scombrids. These visual predators could have higher feeding success at night in the illuminated surface waters vs. the less-illuminated subsurface waters. The relatively passive larval fishes, therefore, may be exposed to higher predation pressures in surface waters near platforms. A true test of this hypothesis would involve sampling planktonic fishes upstream, within and downstream of a platform to examine predator clearance rates. Unfortunately, this was not a logistically feasible option during the onsite platform sampling.

In this study, the only downstream samples collected were with light-traps. Of the taxa examined in these collections, there were some differences in distribution observed. Pelagic taxa such as *Caranx crysos* and *C. hippos/latus* at GC 18 (outer shelf), and *Euthynnus alletteratus* at GI 94(mid-shelf) and ST 54 (inner shelf) were collected primarily with light-traps in surface waters, generally downstream of the platform. *Synodus foetens*, in contrast, seemed to be common within the platform structure at GI 94. Overall, relatively few taxa were found solely in the off-platform light-trap samples: 4 genera at GC 18, 7 at GI 94, and 12 at ST 54. In all cases, these taxa comprised <1% of the off-platform light-trap total catch, with the exception of *Pomatomus saltatrix* at GC 18 (1.5%). Across all three platform sites, only the mullids were collected solely in off-platform samples. Since the distributions generally differed among taxa, one can only speculate as which factors were important in determining the distributions of these fishes. Fishes sampled within the platform may be very photopositive (e.g., synodontids and

blenniids) and may be responding partially to the illumination provided by the platform. Other fishes may maintain a position just off the platform's structure, thus balancing the advantages of increased feeding opportunities near the platform with the disadvantage of increased predation pressures. It is also possible that the distributions are related to other environmental or physical cues (i.e., increased turbulence and/or retention within the platform structure).

In general, taxon diversity and abundance of fish in light-traps was higher in surface waters, particularly within the platform structure. This result is noteworthy because the ambient light-field from the platform itself could have decreased the effectiveness (i.e., sampling efficiency) of the light-aggregating devices in the surface waters. A possible counter argument to that explanation, however, could be that the ambient light-field of the platform may have already drawn photopositive species to the surface waters prior to sampling. The surface trap's bright light was then able to fish in water with relatively elevated densities of larger and more photopositive fish than the subsurface waters (i.e., a fishing light-trap within a light-trap). With regards to differences in plankton net densities (Figure 4.1), the effect of the ambient light-field may have also increased surface catches of photopositive fish, or may have led to the higher densities in the subsurface collections due to decreased visual avoidance. With the exception of ST 54 (inner shelf) where there were only seven bottom net samples (Table 2.1), densities were generally higher (although not significantly so) in the subsurface nets. If the lights from the platform had the effect of drawing photopositive, and generally larger individuals to the surface waters, then these individuals would be better able to avoid a passively fishing gear at the surface. In contrast, a plankton net at depth would have the advantage of fishing in a less intense light field, resulting in decreased visual net avoidance.

In summary, densities of preflexion and flexion larvae collected in plankton nets were generally higher in subsurface waters, possibly a result of decreased predation pressures and decreased net avoidance in the less-illuminated deeper waters. Abundances of primarily larger postflexion larvae and juveniles collected in light-traps were higher in surface waters. Taxon-specific differences in spatial distributions of fishes in these surface waters were observed as well. The complex environment of the platforms necessitates a sampling protocol with multiple gear types and deployment strategies to account

for the varied responses (e.g., feeding, predator avoidance, light attraction/avoidance, depth preferences) of the larval and juvenile fishes being sampled.

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CHAPTER 5

THE EARLY LIFE HISTORY STAGES OF REEF-DEPENDENT AND REEF-ASSOCIATED FISHES COLLECTED AT THREE OIL AND GAS PLATFORMS

INTRODUCTION

Most fishes associated with reef environments have a pelagic larval stage, followed by a settlement, or transition, to a demersal adult phase (Leis 1991). Since most reef fishes are relatively sedentary as adults (Thresher 1984; Sale 1980), their planktonic stages are important in terms of dispersal and replenishment of reef fish populations, which are often patchily distributed (Sale 1980; Richards and Lindeman 1987; Carr 1991). Many studies have examined the relative importance of reef fish recruitment from external sources (i.e., adjacent or distant reef populations) vs. self-recruitment, with mixed results (Cowen and Castro 1994; Danilowicz 1997; Mullineaux and Mills 1997; Swearer et al. 1999). It is increasingly important, therefore, for recruitment studies to sample the full size-range of pelagic phases, from preflexion and early flexion larvae (local supply) to postflexion larvae and juveniles (potential settlers).

The rarity of reef fish larvae in the plankton (Leis 1991), however, can be a major hindrance to studies that attempt to address supply issues. Though most reef fishes are highly fecund, mortality during the pelagic phase approaches 100% (Leis 1991). Settlement to the reef site is equally precarious, as newly-settled postlarvae and juveniles can experience high predation pressures (i.e., the "wall of mouths" hypothesis) from resident adults (Emery 1973; Hamner et al. 1988). The pelagic- and settlement-phase predation gauntlets, combined with the patchy nature of suitable settlement habitat, can therefore result in relatively few surviving juveniles available for recruitment.

In examining the across-shelf larval and juvenile fish assemblages collected at oil and gas platforms in the northern Gulf of Mexico (Gulf), samples were collected within and downstream of platform structures with passive plankton nets and light-traps (Chapter 2). 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 (Chapter 3). The combined gears allow for the collection of a more complete range of available species, sizes and developmental stages. The sampling design utilized plankton net samples to provide estimates of nearby spawning (possibly at upstream platforms within the vicinity) and the overall larval fish supply to the platforms. Light-trap collections were used to provide estimates of the presettlement or settlement-sized fish that would represent potential recruits to the platforms. As expected, reef-associated and

reef-dependent taxa were relatively rare compared to other, more common taxa found in ichthyoplankton surveys in the northern Gulf (Chapter 2).

In this chapter I examine the relative abundances and size distributions of reef fish larvae and juveniles collected during the course of the study. In order to determine which life history stages were collected and how those specimens relate to supply and recruitment, size distributions of platform-collected reef fish larvae and juveniles are compared with literature-based sizes for hatchling, larval, postlarval and settlement-sized juvenile reef fishes. Also, in an effort to compare platform-collected fish abundances to continental shelf or "background" abundances, comparisons of reef-dependent and reef-associated fishes are made with nearby surveys from the Southeast Area Monitoring and Assessment Program (SEAMAP).

MATERIALS AND METHODS

Data collection and analyses focused on three oil and gas platforms in the northern Gulf. Three communities were characterized: a coastal assemblage (3-20 m depth), an offshore assemblage (20-60 m depth), and a bluewater/tropical assemblage (>60 m). Mobil's Green Canyon (GC) 18, which lies in about 230 m of water on the upper 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, but due to inclement weather, full moon collections were cancelled. Exxon's South Timbalier (ST) 54G, which lies in approximately 20 m of water on the inner shelf (28°50'01"N, 90°25'00"W), was sampled twice monthly over a 2-3 night period during new and full moons during April-September, 1997.

Sampling protocols are described in detail elsewhere (Chapter 2). In general, passive plankton nets (60-cm diameter; 333μm mesh dyed green) were used to collect ichthyoplankton at the three platform sites, both at depth (15-23 m for 10-20 min, set and retrieved closed) and near surface (1-2 m for 10-15 min) within the platform structure. Plankton net samples were standardized to number of fish per 100 m^3 (density). Quatrefoil light-traps were deployed for 10 minutes at depth and near surface within the platform structure. An additional light-trap was floated downstream (approximately 20 m) from the

platform for off-platform collections. Both the subsurface and off-platform light-traps were deployed with the light off until the sampling depth/location was reached, fished, and then retrieved with the light off. Light-trap samples were standardized to a catch-per-unit-effort (CPUE) of fish per 10 min.

While many fishes are found in association with natural and artificial reefs in the Gulf of Mexico, I followed the descriptions of Choat and Bellwood (1991) as a guide in defining reef-dependent and reef-associated fishes. Reef-dependent taxa are those that are associated with reef habitat for the duration of their adult life and include individuals from the families Chaetodontidae (butterflyfishes), Pomacanthidae (angelfishes), Acanthuridae (surgeonfishes), Scaridae (parrotfishes), Pomacentridae (damselfishes) and Labridae (wrasses). Reef-associated taxa are those commonly found in association with reef habitats and are often exploiting the resources of the reef, but they may occur in other habitats as well. While this definition is open to interpretation and may encompass many pelagic (e.g., Sphyraenidae, Rachycentridae, Scombridae, Carangidae) and benthic/demersal taxa (e.g., Gobiidae, Opistognathidae, Muraenidae, Synodontidae), I will limit the discussion to just a few, common families: Blenniidae (blennies), Lutjanidae (snappers), Serranidae (groupers and sea basses), and Holocentridae (squirrelfishes).

Reef fish larvae and juveniles were identified to the lowest possible taxonomic level and measured to the nearest millimeter with an ocular micrometer to determine notochord lengths (hatchling and preflexion larvae) and standard lengths (flexion, postflexion and juvenile fishes). In the event that the number of fish in a sample was greater than 50 for any single species, the largest, smallest and a random subsample of 50 individuals were measured. Also, damaged fishes were not measured and therefore not used in these analyses. Size distributions for the dominant reef-associated and reef-dependent taxa collected at the oil and gas platforms were plotted against known sizes for different early life history stages (hatchling, preflexion, flexion, postflexion and juvenile). Unfortunately, there is relatively little information on the identification of reef fish larvae and juveniles down to the genus or species level (Leis 1991), and even less information is available on species-specific size ranges of the different early life history stages. Size ranges for the different life-history stages, therefore, are at the family level and are compiled from numerous published studies (Table 5.1). Taxonomic richness (either at the family or genus/species level) is used in reference to the number of taxa collected.

Table 5.1. List of published literature used to compile size-at-stage data for selected taxa.

Family	References on Early Life History Stages
Reef-Dependent	
Pomacentridae	Brinley 1939; Shaw 1955; Cummings 1968; Thresher 1984; Potthoff et al. 1987; Robertson et al. 1988; Thorrold and Milicich 1990; Watson 1996g; Danilowicz 1997; Alshuth et al. 1998; Kavanagh et al. 2000; Wellington and Robertson 2001
Scaridae	Randall and Randall 1963; Bohlke and Chaplin 1968; Hardy 1978b; Richards and Leis 1984; Watson 1996c; Tolimieri 1998; Leis and Rennis 2000c
Chaetodontidae	Burgess 1978; Watson 1996a; Leis and Rennis 2000a
Labridae	Watson 1996b; Leis and Rennis 2000b
Reef-Associated	
Blenniidae	Hildebrand and Cable 1939; Wickler 1965; Peters 1981, 1985; Fahay 1983; Thresher 1984; Labelle and Nursall 1985, 1992; Watson 1996e; Cavalluzzi and Olney 1998; Watson 2000
Serranidae	Hildebrand and Schroeder 1928; Courtney 1967; Hoff 1970; Lipson and Moran 1974; Hardy 1978a; Kendall 1979; Baldwin 1990; Heemstra and Randall 1993; Watson 1996d; Baldwin et al. 2000a, b; Leis and Rennis 2000d; Mori and Leis 2000
Lutjanidae	Laroche 1977; Leis and Lee 1994; Riley et al. 1995; Watson and Brogan 1996; Clarke et al. 1997; Lindeman 1997; Drass et al. 2000; Leis and Rennis 2000e
Holocentridae	McKenney 1959; Jones and Kumaran 1962; Keene and Tighe 1984; Tyler et al. 1993; Watson 1996f; Leis and Rennis 2000f

Since no samples were collected further than 20 m from the platforms, true open ocean ("background") abundances of reef-dependent and reef-associated fishes at the time of sampling (and using similar gears) are not known. In an attempt to address this background abundance issue, SEAMAP data were acquired from the National Marine Fisheries Service (NMFS) for ichthyoplankton cruises during the same years, 1995-1997. Data were selected from SEAMAP sampling stations which were relatively close in both proximity (location on shelf) and water depth to the each platform (Table 5.2). In order to keep the comparisons similar in terms of seasonality, only SEAMAP samples collected from April-August were used in analyses. Oblique bongo net and neuston net samples were collected at the sampling stations using standard SEAMAP protocols (SEAMAP 2000). For SEAMAP samples,

Table 5.2. Location and maximum sampling depth range in meters (m) of oblique bongo tows for SEAMAP sampling stations (oblique bongo and neuston collections) used for comparison with platform data.

	Location	Maximum depth range (m)
Outer shelf	28.00 N 90.00 W	193-201
	28.00 N 90.50 W	†
	28.00 N 91.00 W	130-167
	28.00 N 91.50 W	†
	28.00 N 92.00 W	73-117
Mid-shelf	28.50 N 90.50 W	31-38
	28.50 N 91.00 W	23-33
Inner shelf	29.00 N 90.50 W	6-11
	29.00 N 91.00 W	6-7
	29.00 N 91.50 W	8-10

†No oblique bongo sample collected so only neuston net collections were used.

abundances were calculated as number of fish under 10 m^2 of seawater (fish/10 m^2) for reef-dependent and reef-associated families collected in oblique bongo tows (60 cm diameter frames with 333 µm mesh nets). Mean abundances were calculated from samples collected at selected outer shelf (n=21), mid-shelf (n=8) and inner shelf (n=12) sampling stations. For platform data, only paired, passive plankton net samples (surface and subsurface) were used in the calculation of abundances (fish/10 m^2):

$$[(N_1 + N_2)/(V_1 + V_2)] \times D \times 10$$

where N_1 = number of fish in surface sample
N_2 = number of fish in subsurface sample
V_1 = volume of water filtered in surface sample
V_2 = volume of water filtered in subsurface sample
D = total depth sampled

Since this calculation requires both subsurface and surface samples, the number of comparisons were limited due to one of these gears fouling (Chapter 2), particularly at the inner shelf (ST 54, n=7) and outer shelf (GC 18, n=14) sites. A nearly full complement of samples was available for comparison for the mid-shelf site (GI 94, n=161).

Similarly, the mean number of fish collected in SEAMAP neuston net (1x2 m opening with 948 µm mesh net) samples was calculated for outer shelf (n=25), mid-shelf (n=8) and inner shelf (n=12) stations. These values were compared to the mean number of fish collected in surface and off-platform light-trap samples (surface) collected at the outer shelf (n = 154), mid-shelf (n=319) and inner shelf

(n=146) platforms. No statistical comparisons were made due to the often large disparity in sampling effort between the SEAMAP and platform samples (i.e., larger volumes of water filtered in SEAMAP samples and, therefore, higher probabilities of encountering patches of larvae), as well as the difficulties in making meaningful comparisons among different sampling gears fished for different durations and during different times of the day (day vs. night). In addition, platform plankton net abundances are conservative estimates, since the multiplier D (total depth sampled in the equation above) was only 15-23 m and not the total depth of the water column as was the case for most SEAMAP data utilized.

RESULTS

Reef-dependent and reef-associated fishes were relatively uncommon in light-trap and plankton net collections at all three platforms (Table 5.3). Of the 5,057 fish collected at shelf break platform (125 plankton net collections; 319 light-trap collections), only 87 fish were reef-dependent fishes and 184 were reef-associated fishes, representing 1.7% and 3.6% of the total catch, respectively. Scarids dominated the

Table 5.3. Total number of fish and percent of reef-dependent and reef-associated fishes collected at each platform site. Numbers and percentages in parentheses represent values based on non-clupeiform data.

	Outer Shelf (GC 18)	Mid-Shelf (GI 94)	Inner Shelf (ST 54)
Total Number of fish	5, 057 (2, 063)	45, 754 (15, 550)	97, 697 (2, 882)
Reef-Dependent	1.7 % (4.2%)	0.4% (1.2%)	0.01% (0.3%)
Reef-Associated	3.6% (8.9%)	8.8% (26.0%)	0.2% (7.1%)

reef-dependent taxa collected (n=65), followed by pomacentrids (n=21) and chaetodontids (n=1). The most common reef-associated fishes were serranids (n=73), followed by lutjanids (n=49), blennies (n=41) and holocentrids (n=22). At the mid-shelf platform (GI 94), 45,754 fish were collected (plankton net collections, n=324; light-trap collections, n=474), of which 187 fish were reef-dependent (0.4%) and 4,045 were reef-associated fishes (8.8%). The most common reef-dependent fishes were pomacentrids (n=183), followed by labrids (n=3) and chaetodontids (n=1). Blennies (n=3,874) dominated the reef-associated taxa, followed by serranids (n=112), lutjanids (n=92) and holocentrids (n=12). At the inner

shelf platform (ST 54), 97,697 fish were collected (plankton net collections, n=89; light-trap collections, n=194), of which only 9 fish represented reef-dependent taxa (0.01%) and 206 represented reef-associated taxa (0.2%). The most common reef-dependent fishes were pomacentrids (n=7), labrids (n=1) and scarids (n=1). Blennies (n=187) dominated the reef-associated taxa, followed by lutjanids (n=18) and serranids (n=8). Two of the reef-dependent groups of fishes, the pomacanthids and the acanthurids, were not collected during the course of the study.

Reef-Dependent Fishes Collected and Size-at-Stage Literature

Pomacentridae (Damselfishes)

Damselfishes are among the most speciose of the reef fishes. Species accounts vary, but the numbers range from 225 species in approximately 25 genera (Thresher 1984; Lieske and Myers 1996; Alshuth et al. 1998) to approximately 321 species in approximately in 28 genera (Choat 1991; Allen 1991). Fourteen species (4 genera) occur in the Caribbean and Gulf of Mexico (Robins et al. 1986; Lieske and Myers 1996). Ten of these species (*Abudefduf saxatalis, Chromis cyanea, C. enchrysura, C. insolata, C. multilineata, C. scotti, Microspathodon chrysurus, Pomacentrus partitus, P. planifrons* and *P. variabilis*) have been observed on hard-bottom banks and other areas in the northcentral Gulf (Sonnier et al. 1976; Hoese and Moore 1977; Dennis and Bright 1988). Damselfishes, particularly juveniles, are common residents on artificial structures as well (Rooker et al. 1997). *Abudefduf saxatilis, A. taurus, C. multilineata, P. fuscus, P. partitus, P. planifrons*, and *P. variabilis* have been observed in association with oil and gas platforms. Off the Florida coast, *P. variabilis* are the most common pomacentrid observed at artificial structures, but others (*A. saxatilis, C. enchrysurus, C. scotti*, and *P. partitus*) are present as well (Hastings et al 1976).

Pomacentrids were among the most common reef-dependent taxa collected at the platforms. Among reef-dependent fishes, damselfishes ranked second in abundance at the shelf break site (n=21), and first in abundance at the mid-shelf (n=183) and inner shelf (n=7) sites. At the shelf break site (GC 18), only postflexion and juvenile *Pomacentrus* spp. (9-19 mm)were collected (Figure 5.1), most between 9-10 mm. These individuals were within the settlement size ranges (8.8-13.6 mm) described for five of the six western Atlantic species in the genus *Pomacentrus* (Wellington and Robertson 2001).

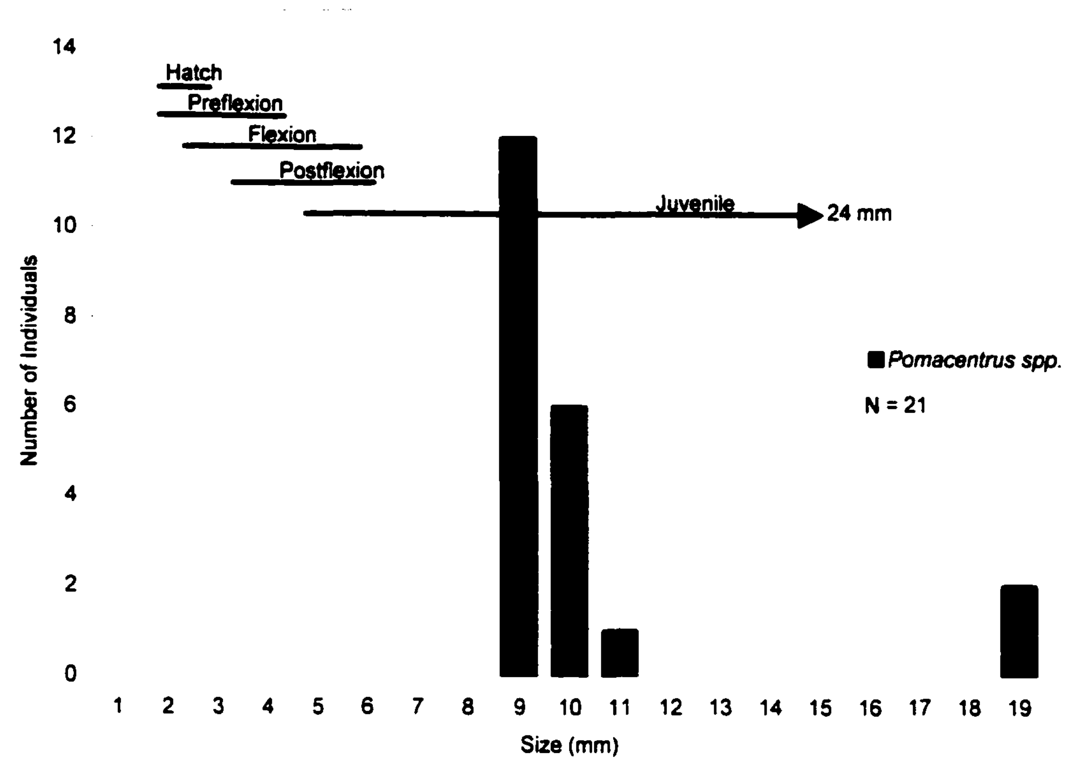

Figure 5.1. Size distribution of pomacentrids collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

At the mid-shelf site (GI 94), individuals were collected from a wider range of sizes (3.0-25.0 mm) and taxa (3 genera; Figure 5.2). *Pomacentrus* spp. (n=85) ranged from 4.0-16.0 mm in length and were mostly postflexion larvae and settlement-size juveniles (Wellington and Robertson 2001). Second in abundance at the mid-shelf site were *Chromis* spp. (n=84), which ranged in size from 3.0-25.0 mm. While there are five *Chromis* species in the Caribbean and Gulf, size-at-stage information is available for only one, *C. mulitlineata*, which has a hatchling size range of 2.09-2.45 mm and a relatively large settlement size range of 17.2-22.1 mm (Wellington and Robertson 2001). Most of the *Chromis* specimens collected at this site were in the postflexion/early juvenile stage. Seven *Abudefduf* spp. were collected, with a size range of 10.0-18.0 mm. Based on published size-at-stage data for the western Atlantic *A. saxatilis*, the individuals collected at the mid-shelf site were in the postflexion larvae (9.9-13.1 mm) and juvenile (17.1-19.0 mm) size ranges (Alshuth et al. 1998).

At the inner shelf site, only one *Pomacentrus* (10.0 mm) and six *Abudefduf* (12-15 mm) individuals were collected, and they represented postflexion larvae and settlement juvenile size classes (Alshuth et al. 1998; Wellington and Robertson 2001).

Scaridae (Parrotfishes)

Parrotfishes are a group of colorful herbivores common in shallow tropical and subtropical reef areas (Reeson 1983). There are approximately 60 species (10 genera) worldwide, with 14 of these (4 genera) occurring in Caribbean and Gulf waters (Robins et al. 1986; Bellwood 1994). Six species (*Scarus taeniopterus, Scarus vetula, Scarus croicensis, Sparisoma atomarium, Sparisoma aurofrenatum and Sparisoma viride*) have been described as occasional or rare inhabitants on natural hard-bottom reefs in the northern Gulf, generally in mid-shelf or inner shelf (<85 m) areas (Sonnier et al. 1976; Dennis and Bright 1988). Also, *Sparisoma aurofrenatum* and *S. viride* have been observed at oil and gas platforms off Louisiana (Rooker et al. 1997).

Sixty-five larval and juvenile scarids were collected at the shelf break platform (GC 18) in 1995 during the late summer (August) and fall months (October and November). At the inner shelf platform (ST 54), a single individual was collected in April 1997. No scarids were collected at the mid-shelf platform (GI 94). Sizes of individuals collected at the shelf break site ranged from 2.0-10.0 mm, with most of the larvae (67%) in the 2.3-3.0 mm size range (Figure 5.3). The individual collected at the

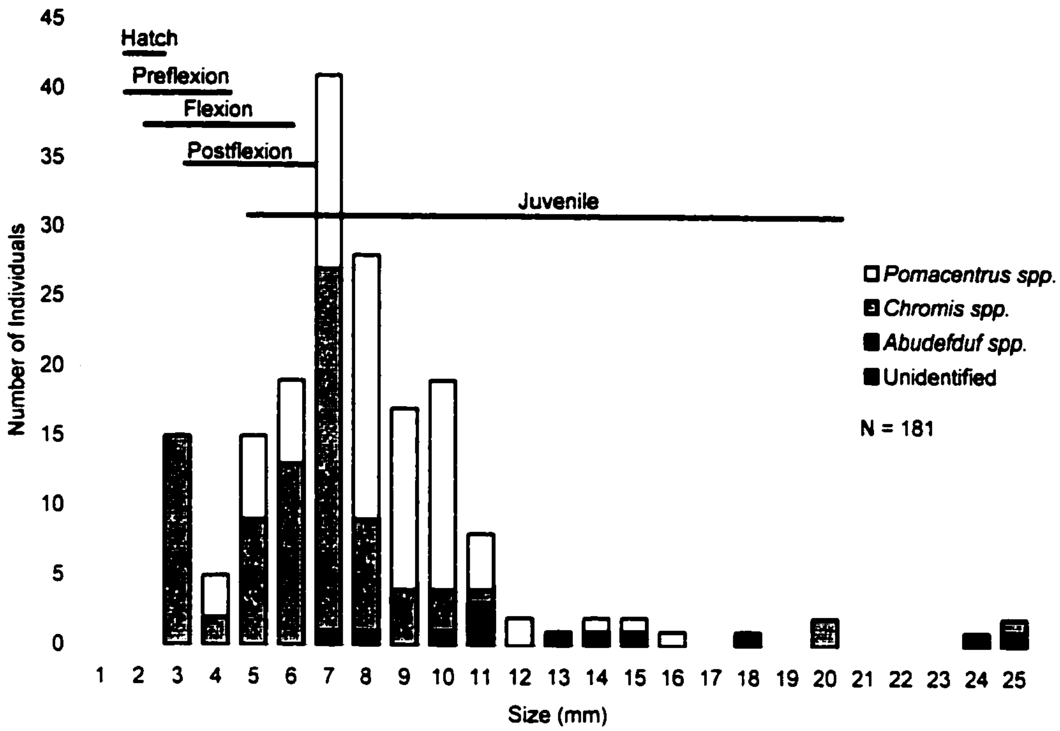

Figure 5.2. Size distribution of pomacentrids collected at the mid-shelf platform (GI 94). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

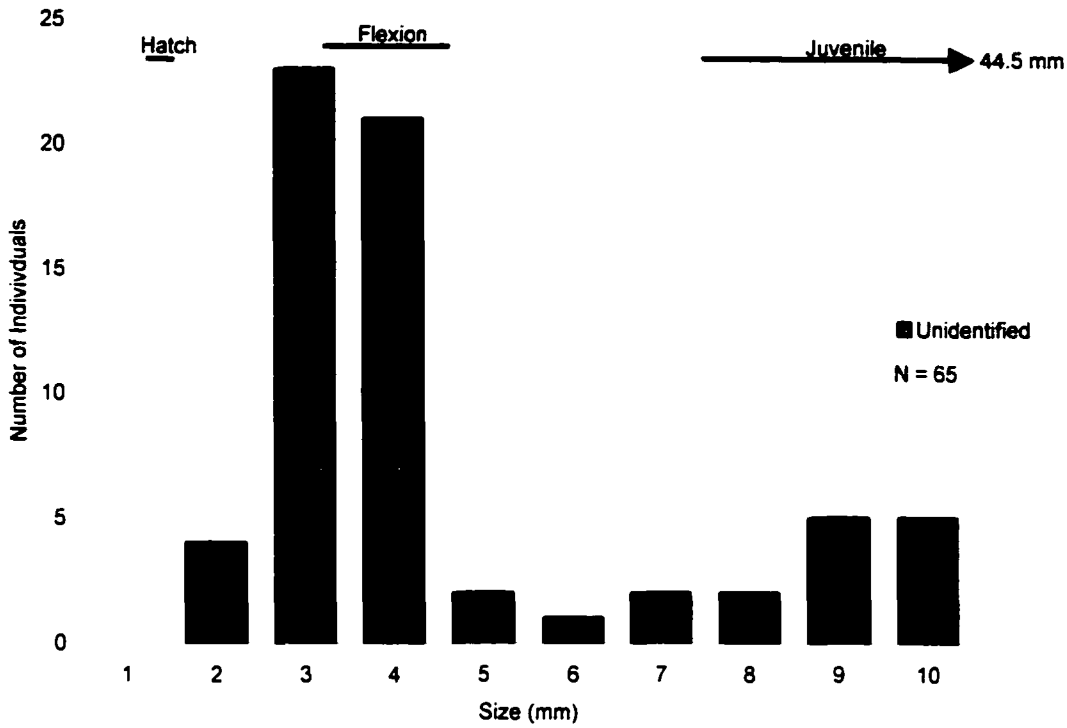

Figure 5.3. Size distribution of scarids collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

inner shelf platform was 11.0 mm.

Very little size-at-stage information is available for larval and juvenile parrotfishes, but previous studies indicate that settlement occurs at a relatively small size (Watson 1996c; Tolimieri 1998). The largest pelagic specimens collected in the Indo-Pacific, for example, range from 7.2-15.2 mm (Leis and Rennis 2000c). *Sparisoma viride*, a common Caribbean species, settle at 10 mm (Tolimieri 1998). Based on size-at-hatch information for Pacific taxa (1.6-1.7 mm), many of the scarids collected at the shelf break site were probably locally spawned, but several others were at least approaching settlement size (9-11 mm).

Labridae (Wrasses)

The family Labridae is one of the most speciose and diverse among reef fishes (Victor 1986). There are anywhere between 400-500 species worldwide in approximately 50-60 genera (Victor 1986; Choat and Bellwood 1991; Watson 1996). Twenty-one species occur in the Caribbean and Gulf, representing 10 genera (Robins et al. 1986; Robins et al. 1991). These fishes are among the most abundant reef-dependent taxa on natural and artificial habitats in the northern Gulf. Eleven taxa (*Bodianus pulchellus, B. rufus, Clepticus parrai, Halichoeres bivittatus, H. caudalis, H. garnoti, H. maculipinna, H. radiatus, Hemipteronotus spp., Lachnolaimus maximus*, and *Thalassoma bifasciatum*) have been reported from hard-bottom banks and other areas in the northwestern Gulf, primarily in shallower (inner and mid-shelf) waters (Sonnier et al. 1976; Hoese and Moore 1977; Dennis and Bright 1988). *Bodianus pulchellus, B. rufus* and *T. bifasciatum* are relatively common on oil and gas platforms, while *Clepticus parrai* have been observed at these structures in fewer numbers (Sonnier et al. 1976; Rooker et al. 1997). Rooker et al. (1997) noted that while labrids accounted for approximately 25% of the reef-dependent taxa at both their artificial and natural reefs, the species compositions differed. Both sites held high numbers of *T. bifasciatum*, for example, but more *Bodianus* spp. were found at platforms than at natural reefs. *Halichoeres* spp. were only located on the natural reefs. In the northeastern Gulf, *Halichoeres caudalis, H. bivittatus, Hemipteronotus novacula, L. maximus* and *T. bifasciatum* were found in association with artificial structures (Hastings et al. 1976).

Labrids were rare in collections at all platform sites. No wrasses were collected at the shelf break platform. Three labrids were collected at the mid-shelf platform (3.0, 10.0 and 13.0 mm

individuals) and only one individual was collected at the inner shelf site (15.0 mm). There is little size-at-stage information available for western Atlantic wrasses. Based on personal observations and information derived from Pacific specimens, most of the specimens are in the postflexion (4.0-21.0 mm) or juvenile (11.9-34.0 mm) size classes (Watson 1996b). Labrid hatchling sizes (Pacific taxa) range from 1.5-2.7 mm, while yolk-sac larvae range from 1.5-3.3 mm (Watson 1996b; Leis and Rennis 2000b). Based on these sizes, the smallest individual (3.0 mm, mid-shelf) is likely a result of local spawning.

Chaetodontidae (Butterflyfishes)

Butterflyfishes are small, warm-temperate and tropical fishes common around reefs and hard structures (Robins et al. 1986). There are 114 recognized species (10 genera), of which 6 species (1 genus) occur in the Gulf and Caribbean (Burgess 1978; Choat and Bellwood 1991). Adult *Chaetodon aculeatus*, *C. aya*, *C. ocellatus*, *C. sedentarius*, *C. capistratus* and *C. striatus* have all been observed on hard-bottom banks in the northern Gulf (Sonnier et al. 1976; Hoese and Moore 1977; Dennis and Bright 1988; Rooker et al. 1997). Several species have been observed in association with offshore platforms, including *C. sedentarius* and *C. striatus* off Louisiana (Sonnier et al. 1976; Rooker et al. 1997), and *C. ocellatus* and *C. sedentarius* off the Florida Gulf coast (Hastings et al. 1976). Since tagging experiments and other observations have demonstrated that butterflyfishes are very site specific (Bardach 1958; Aiken 1983; McBride and Able 1998), it is likely that adults on these sites are the result of juvenile settlement from the plankton rather than adult immigration.

Only two chaetodontids were collected during the course of this study: a 4.0 mm individual at the shelf break platform (GC 18) and a 4.0 mm individual at the mid-shelf platform (GI 94). Very little information is available on the early life history stages of these fishes. Based on a few described Pacific taxa, chaetodontid larvae hatch at approximately 1.4-1.9 mm, with flexion not occurring until approximately 4.0-5.3 mm (Watson 1996a; Leis and Rennis 2000a). Larger postflexion, "tholichthys" and pelagic juvenile individuals have been described as well, with a composite size range of 6.5-60 mm (Burgess 1978; Watson 1996a; Leis and Rennis 2000a). Based on observations in this study and the published size-at-stage descriptions, the two chaetodontids collected in this study were planktonic, early-flexion larvae. Little is known about the length of chaetodontid pelagic larval durations. Juveniles of several Atlantic and Caribbean taxa have been collected as far north as Cape Cod and Nova Scotia

(McBride and Able 1998), but no recently-spawned, preflexion larvae have been collected in these temperate waters. The individuals collected at these study sites are very likely from local spawning populations.

Pomacanthidae (Angelfishes)

Angelfishes are closely related to butterflyfishes and are also common coral reef inhabitants (Thresher 1984). There are 74 species (7 genera), of which only 6 species (3 genera) occur in the Gulf of Mexico and Caribbean (Hoese and Moore 1977; Aiken 1983). While not very abundant, all six species (*Centropyge argi, Holacanthus bermudensis, H. ciliaris, H. tricolor, Pomacanthus arcuatus, P. paru*) have been observed on hard-bottom banks in the northern Gulf (Sonnier et al. 1976; Hoese and Moore 1977; Dennis and Bright 1988). In addition, *H. ciliaris*, although rare, have been observed on offshore platforms in the northcentral Gulf (Hoese and Moore 1977), and *H. bermudensis* were observed at platforms surveyed in the northeastern Gulf (Hastings et al. 1976). Despite the occurrence of the adults on both natural and artificial reefs in the northern Gulf, no larvae and juveniles were collected during the course of the study.

Acanthuridae (Surgeonfishes)

Surgeonfishes are conspicuous herbivores on many shallow, tropical reefs (Thresher 1984; Choat 1991). There are approximately 76 species (6 genera) worldwide, and four of these occur in the northern Gulf, all in the genus *Acanthurus*. *Acanthurus bahianus, A. chirurgus*, and *A. coeruleus* have been observed on natural hard-bottoms in the northern Gulf, but the occurrences were relatively rare, and generally more common inshore at depths less than 85 m (Hoese and Moore 1977; Dennis and Bright 1988). Adult *A. chirurgus* and *A. coeruleus* were all reported from oil and gas platforms in the northcentral Gulf (Sonnier et al. 1976; Rooker et al. 1996), while *A. chirurgus* and *A. coeruleus* were reported off research platforms in the northeastern Gulf (Hastings et al. 1976). Despite the occurrence of the adults on both natural and artificial reefs in the northern Gulf, no larvae and juveniles were collected during the course of this study.

Reef-Associated Fishes Collected and Size-at-Stage Literature

Blenniidae (Combtooth Blennies)

Combtooth blennies are small, demersal fishes found in shallow reef and nearshore habitats (Robins et al 1986). There are approximately 345 species worldwide (53 genera), 15 of which (8 genera) occur in the Caribbean and Gulf (Robins 1986; Robins et al. 1991; Watson 1996e). While blennies have been reported from natural habitats in the northern Gulf (Robins et al. 1986; Raugh 1996), they are often underestimated or overlooked in surveys due to their small size and cryptic habits. Blennies commonly inhabit the barnacle shells attached to oil and gas platforms, and these habitats serve as spawning areas for these relatively sedentary and demersal spawning fishes (Gallaway 1980; Smith-Vaniz 1980; Gallaway et al. 1981; Peters 1981; Raugh 1996). *Ophioblennius atlanticus* and *Hypleurochilus geminatus* were reported as common on oil and gas platforms in the northern Gulf, but were relatively rare on adjacent natural reefs (Sonnier et al. 1976; Rooker et al. 1997). *Parablennius marmoreus* and *Hypsoblennius invemar* were also present on platforms in the northwestern Gulf, while *P. marmoreus* and *H. geminatus* were observed on platforms in the northeastern Gulf (Hastings et al. 1976; Raugh 1996; Rooker et al. 1997). Since blennies are sedentary and spend their entire adult existence at a single location, recruitment to a population is a result of juvenile settlement and not immigration of adults (Peters 1981).

Blennies were among the most dominant reef-associated fishes collected at the three platform sites. At the shelf break site (GC 18), blennies (n=41), primarily unidentified, preflexion individuals, ranked second in numerical dominance among reef-associated taxa (Figure 5.4). Eighty-five percent of the individuals collected were between 1.0-3.0 mm in length, indicative of local spawning. Two, early flexion *Hypsoblennius invemar* (4.0 mm) were collected at this site. While no published size-at-stage information is available for *H. invemar*, this flexion stage occurs in the same size range (4.0-5.0 mm) as that for a closely related species, *H. hentz* (Hildebrand and Cable 1939; Fahay 1983; Cavalluzzi and Olney 1998). Also, two relatively large (31.0 and 32.0 mm) *Ophioblennius atlanticus* juveniles were collected.

At the mid-shelf site (GI 94), blennies were the most abundant reef-associated taxa (n=3,874), dominated by *Hypsoblennius* spp. (n=1,285) and *Parablennius marmoreus* (n=1,153) individuals

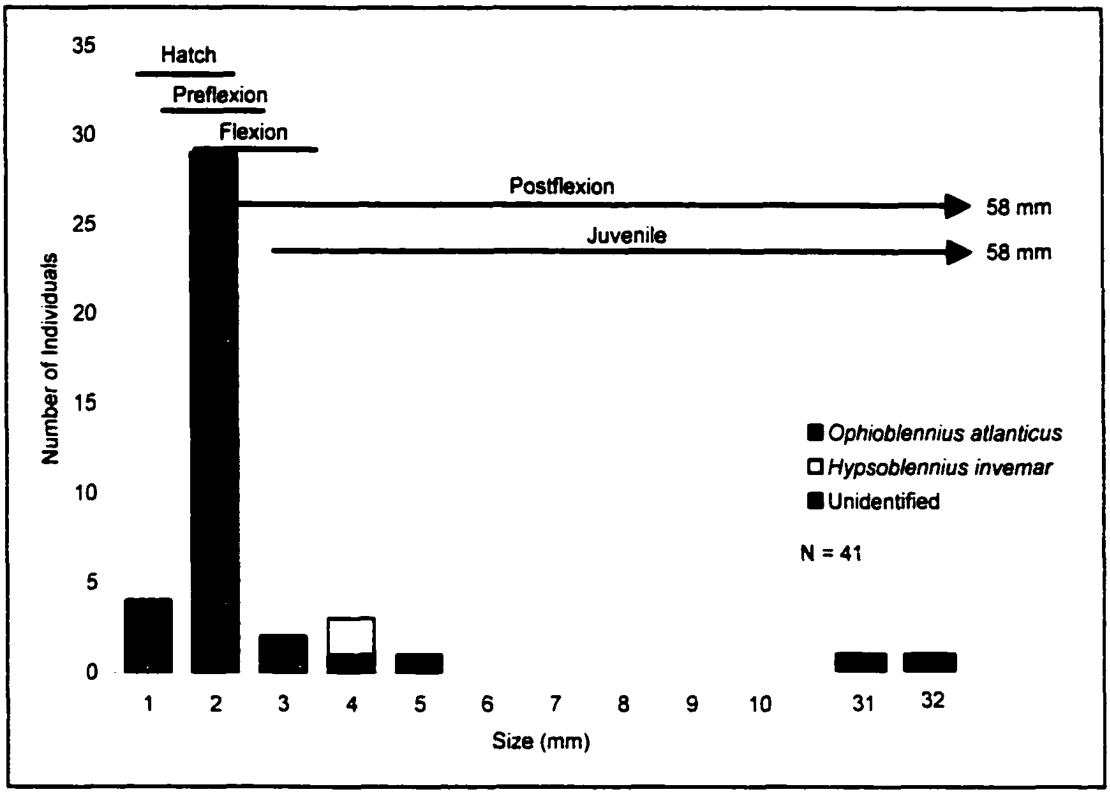

Figure 5.4. Size distribution of blennies collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. Note break in size scale. N = total number of fish measured.

(Figure 5.5). *Hypsoblennius* spp. individuals ranged from 3.0-14.0 mm and encompassed the published size ranges for all early life history stages. *Parablennius marmoreus* individuals generally encompassed a larger size range (4.0-23.0 mm), including many juveniles, but also included individuals from all early life history stages. *Scartella cristata* individuals (n=134) ranged from 4.0-16.0 mm in length and were primarily flexion and early postflexion larvae (approximately 81%). A few *Hypleurochilus multifilis* (n=18) individuals were collected at the mid-shelf site, most of which were flexion and early postflexion larvae. Many unidentified blennies, most of which were too small to identify (approximately 70% between 1.0-3.0 mm), were also collected. Overall, a wider range of sizes and taxa were present at the mid-shelf vs. the shelf break site.

At the inner shelf platform (ST 54), blennies (n=187) were once again the numerically dominant, reef-associated taxa (Figure 5.6). The most common individuals, *Scartella/Hypleurochilus* spp. (n=61), were identified as being of the same type, but due to identification limitations, could not be resolved as either *Scartella* species or *Hypleurochilus* species. While this type ranged from 3.0-15.0 mm in length, most of the individuals (84%) were small juveniles. Another species complex, *Hypsoblennius hentz/ionthas*, was second in abundance (n=49) and ranged in size from 2.0-14.0 mm, encompassing all early life history stages. *Hypsoblennius invemar* individuals were also collected, but at generally larger sizes (5.0-13.0 mm), and encompassed primarily postflexion and juvenile size classes. Only two *Parablennius marmoreus* individuals were collected (8.0 mm and 18.0 mm in length). Unidentified blennies were also collected (n=35), and represented primarily small, preflexion individuals.

Serranidae (Sea Perches, Groupers, Sea Basses and Soapfishes)

The family Serranidae is large and diverse, and includes sea perches, groupers, sea basses and soapfishes (Thresher 1984). Adult serranids range in size from 3 cm to approximately 3 m, and many are of great commercial and recreational fisheries value (Watson 1996d). There are anywhere from 350-450 species world-wide in approximately 62 genera (Bohlke and Chaplin 1993; Nelson 1994). Approximately 59 species (18-20 genera) are found in the Caribbean and Gulf (Robins et al. 1986; Robins et al. 1991). Many of these taxa are common in the northwestern Gulf, either on hard-bottom banks or in association with oil and gas platforms, and their distribution changes across the shelf with depth (Hoese and Moore 1977; Dennis and Bright 1988). Some taxa are primarily deep water fishes

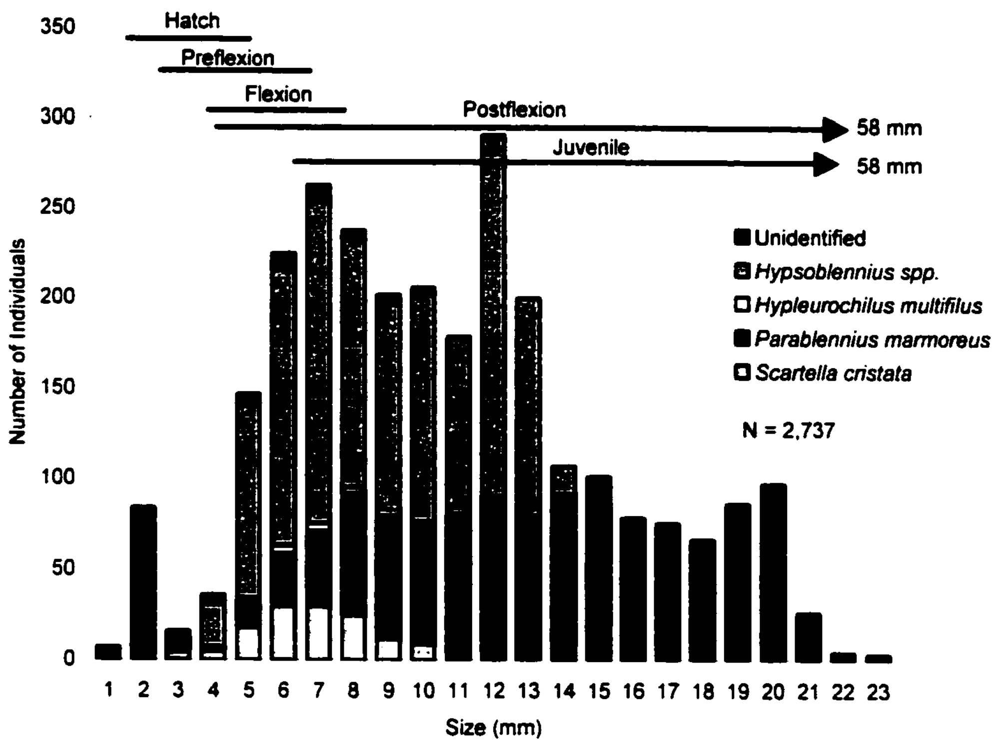

Figure 5.5. Size distribution of blennies collected at the mid-shelf platform (GI 94). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

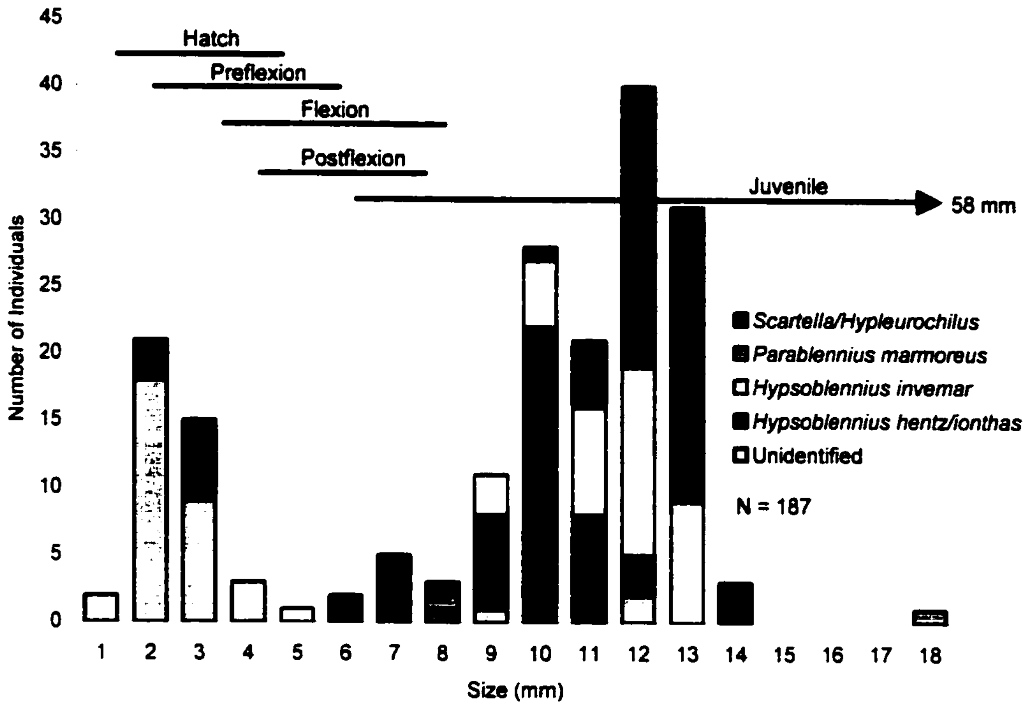

Figure 5.6. Size distribution of blennies collected at the inner shelf platform (ST 54). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

known to occur on outer shelf reefs, and include *Epinephelus flavolimbatus*, *E. niveata*, *E. striatus*, *Gonioplectrus hispanus*, *Hemanthias leptus*, *H. vivanus*, *Mycteroperca rubra*, *M. microlepis*, *Centropristis ocyurus*, and *Liopropoma rubre* (Sonnier et al. 1976; Dennis and Bright 1988; Hoese and Moore 1977). Other species are known primarily to occur on reefs on inner shelf and mid-shelf areas, including *Epinephelus adscensionis*, *E. cruentatus*, *E. guttatus*, *Liopropoma eukrines*, *Mycteroperca bonaci*, and *M. interstitialis* (Sonnier et al. 1976; Dennis and Bright 1988; Hoese and Moore 1977). The reefs and platforms off Texas and Louisiana also serve as habitat for tropical species whose distributions are otherwise limited to the Caribbean and southern Gulf waters. These fishes include *Epinephelus inermis*, *Epinephelus fulva*, *E. guttatus*, *Gonioplectrus hispanus*, *Holanthias martinicensis*, *Mycteroperca interstitialis*, *M. tigris*, *M. venenosa* and *Serranus annularis* (Hoese and Moore 1977; Dennis and Bright 1988). A number of species have also been observed in association with oil and gas platforms, including *Mycteroperca bonaci*, *M. interstitialis*, *M. microlepis*, *M. phenax*, *M. venenosa*, *Epinephelus adscencionis*, *E. cruentatus*, *E. fulvus*, *E. inermis*, *E. itajara*, *E. nigritus*, *Paranthias furcifer*, and *Rypticus maculatus* (Sonnier et al. 1976; Rooker et al. 1997; Stanley and Wilson 1997, 2000).

Serranid larvae and juveniles were collected at all three platforms. While it is difficult to identify serranids to the genus or species level, there are distinct differences between the subfamilies. Therefore, all larvae and juveniles were identified as anthiine, epinepheline, serranine, grammistine or liopropomatine fishes. With the exception of liopropomatines, individuals from all subfamilies were represented in the collections.

At the shelf break platform (GC 18), serranids (n=73) were the most dominant, reef-associated taxa collected (Figure 5.7). Epinephelines (n=31) and anthiines (n=30) were the most common serranids collected, followed by unidentified serranids (n=10) and grammistines (n=2). Epinephelines were either *Mycteroperca* spp. or *Epinephelus* spp. Anthiines included *Anthias nicholsi*, *Hemanthias vivanus* and *Protogrammus martinicensus*. All fishes ranged in size from 2.0-5.0 mm in length, with the exception of one 12.0 mm anthiine. Most of these individuals, therefore, are the result of local spawning events, and represent hatchling (1.2-2.5 mm), preflexion (2.5-5.2 mm) and flexion (3.3-6.0 mm) stage larvae (Hardy 1978a; Baldwin 1990; Heemstra and Randall 1993; Watson 1996d; Leis and Rennis 2000d; Baldwin et al.

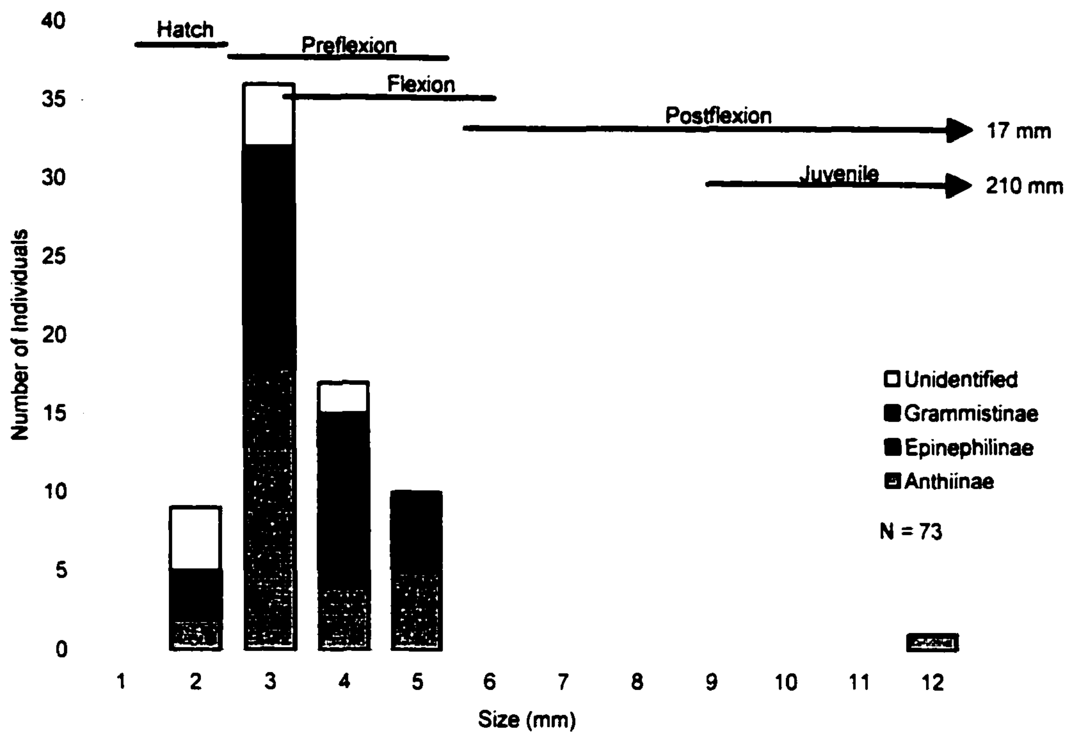

Figure 5.7. Size distribution of serranids collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

2000a, b). The larger, 12.0 mm anthiine was the only early juvenile collected (Watson 1996d; Leis and Rennis 2000d).

At the mid-shelf platform (GI 94), four serranid subfamilies were represented (Figure 5.8). Most were serranines (n=72), followed by anthiines (n=26), epinephelines (n=8) and grammistines (n=6). Little is known about serranine larvae, but based on a few Pacific species, transformation usually occurs around 11.0 mm (Watson 1996d). Approximately half of the serranine larvae were early juveniles (16.0-17.0 mm), while the others were preflexion, flexion and early postflexion sizes (3.0-9.0 mm). Similarly, approximately half of the anthiines were late postflexion and early juveniles (9.0-10.0 mm), while the other half were preflexion and flexion-stage larvae (3.0-6.0 mm). Although few in number, a wide range of sizes was observed for epinephelines, including preflexion and flexion larvae (3.0-5.0 mm), as well as postflexion larvae (9.0-10.0 mm) and juveniles (16.0-22.0 mm). Grammistines were represented in the samples by two preflexion larvae (3.0-4.0 mm) and four early postflexion larvae (7.0-8.0 mm).

Relatively few serranids were collected at the inner shelf platform (Figure 5.9). Eight unidentified serranids, including preflexion and early flexion larvae (2.0-5.0 mm) and one, postflexion specimen (15.0 mm) were collected.

Lutjanidae (Snappers)

Snappers are common residents in many reef and shallow coastal areas and many species are targeted by recreational and commercial fishing efforts (Allen 1985). There are between 92-103 species worldwide in 17 recognized genera (Allen 1985; Leis and Rennis 2000e). Eighteen of these species (6 genera) occur in the Caribbean and Gulf (Allen 1985; Robins et al. 1991), with several species being fairly common in the northern Gulf. *Lutjanus campechanus*, a deep water species, is a common resident on both natural and artificial reefs in the northern Gulf (Sonnier et al. 1976; Allen 1985; Dennis and Bright 1988; Stanley and Wilson 1990, 1997, 2000; Rooker et al. 1997). *Rhomboplites aurorubens* is another resident of moderately deep waters, and has also been observed on natural reefs and platforms, primarily along the mid-shelf (Sonnier et al. 1976; Allen 1985; Dennis and Bright 1988). *Pristipomoides aquilonaris* another common resident of hard-bottom banks on the mid- and outer shelf (Hoese and Moore 1977). Other, more tropical snapper species are less common in the northern Gulf. *Lutjanus*

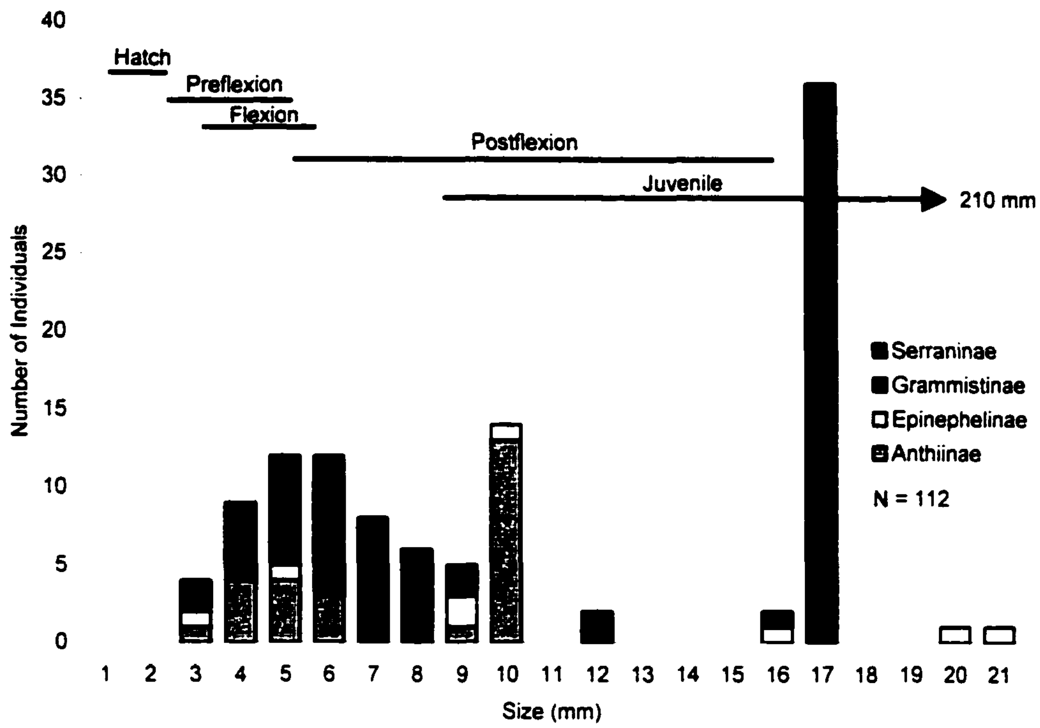

Figure 5.8. Size distribution of serranids collected at the mid-shelf platform (GI 94). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

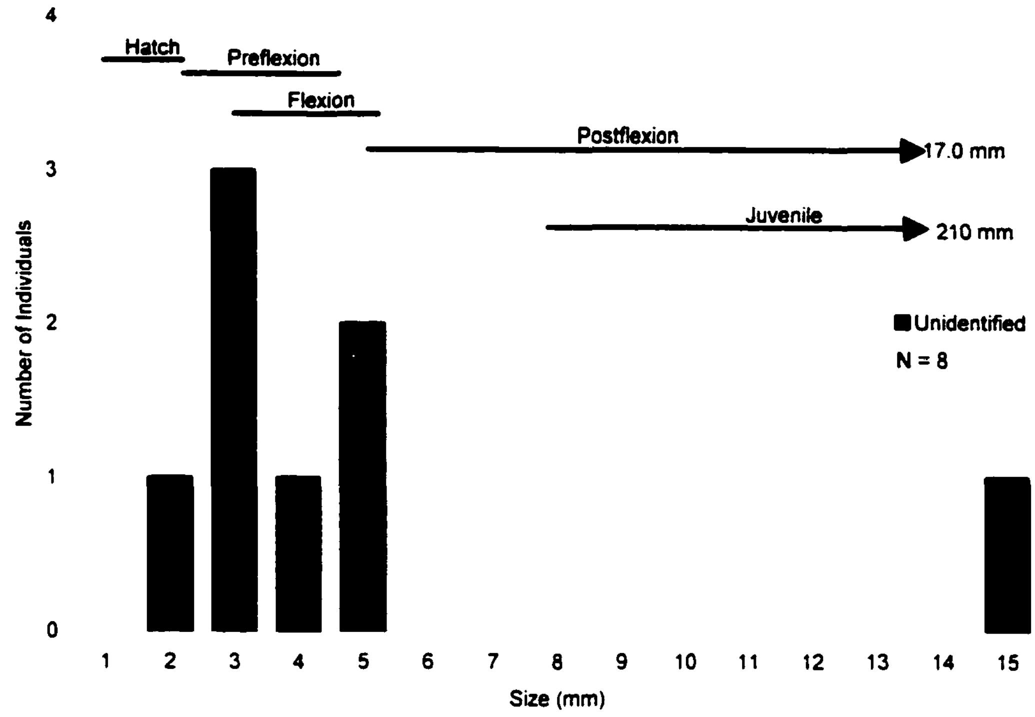

Figure 5.9. Size distribution of serranids collected at the inner shelf platform (ST 54). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

apodus, L. griseus, L. jocu, L. synagris, L. cyanopterus and *Ocyurus chrysurus* are relatively rare, but have been observed on natural banks in the northwestern Gulf (Sonnier et al. 1976; Dennis and Bright 1988). Similarly, some snappers (e.g., *L. cyanopterus, L. griseus, O. chrysurus*) have been observed in association with platforms in the northern Gulf (Hastings et al. 1976; Sonnier et al. 1976; Stanley and Wilson 1997, 2000).

Lutjanids were relatively common, reef-associated taxa at all three platforms sampled. At the shelf break platform (GC 18), 34 *Pristipomoides aquilonaris* individuals were collected, and other than one 40.0 mm juvenile, all were between 2.0-6.0 mm in length (Figure 5.10). Based on published studies, these individuals were representative of preflexion (3.2-4.7 mm), flexion (3.7-5.2 mm) and postflexion (5.0-42.4 mm) stages (Leis and Lee 1994). Leis and Lee (1994) have noted that *P. aquilonaris*, as well as other *Pristipomoides* species, may remain pelagic until relatively large sizes. Unidentified lutjanids (n=24) were collected as well, and included a group of small, preflexion and flexion-sized individuals (2.0-5.0 mm) and a group of larger, postflexion larvae and possibly early juveniles (13.0-16.0 mm).

At the mid-shelf platform, two groups of lutjanids were collected. *Lutjanus* spp. (n=62) were dominant and ranged in size from 3.0-11.0 mm in length (Figure 5.11). Based on previous studies on the early life history stages of several *Lutjanus* species, these individuals were representative of preflexion (2.6-5.5 mm), flexion (3.8-6.2 mm) and early postflexion (5.0-14.8 mm) stages (Watson and Brogan 1996; Clarke et al. 1997; Drass et al. 2000). Two size groupings of *Rhomboplites aurorubens* (3.0-12.0 mm and 20.0-25.0 mm) were also collected at the mid-shelf platform. The smaller sizes are representative of early preflexion (approximately 3.0-4.7 mm), flexion (approximately 4.7-5.0 mm), postflexion (5.0-8.3 mm) and early juvenile (8.3-10.9 mm) individuals (Laroche 1977). The second grouping consisted of small, presettlement juveniles.

At the inner shelf site (ST 54), few lutjanids were collected (n=18), but they represented the second most abundant reef-associated taxa (Figure 5.12). Six *Rhomboplites aurorubens* individuals were collected, including one postflexion larvae (10.0 mm) and five juveniles (19.0-29.0 mm). Four *Lutjanus campechanus* specimens were collected, including one postflexion larva (6.0 mm) and three, early juveniles (23.0-24.0 mm; Drass et al. 2000). Eight unidentified snapper larvae and juveniles were also collected and ranged in size from 2.0-21.0 mm.

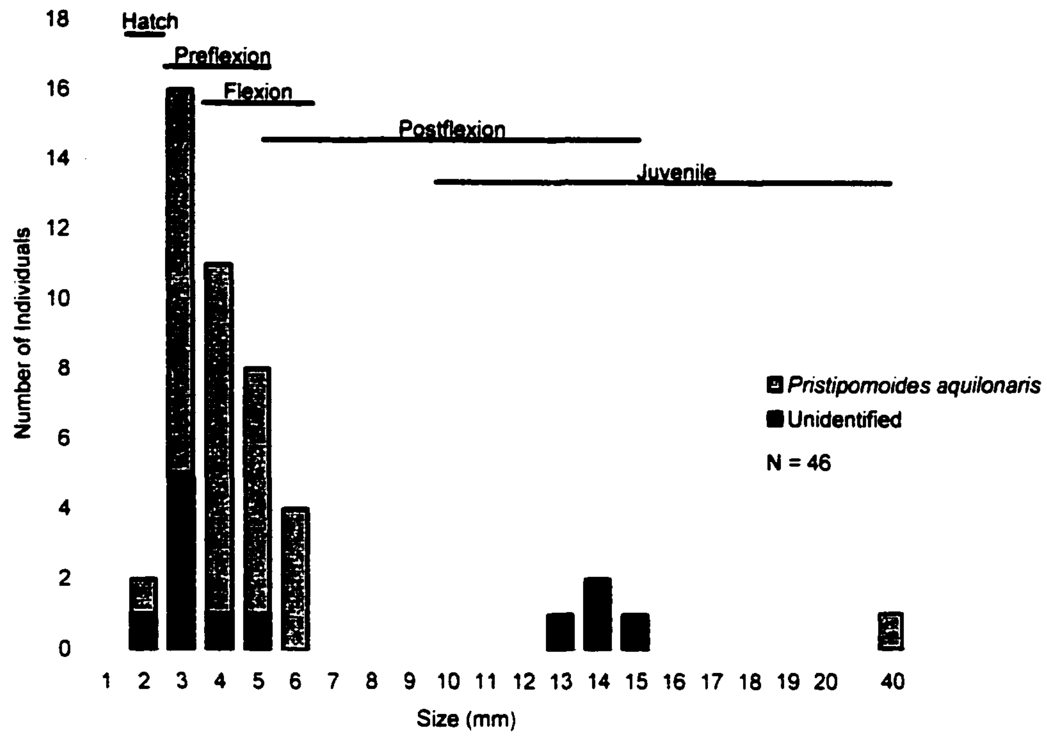

Figure 5.10. Size distribution of lutjanids collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured. Note break in size scale.

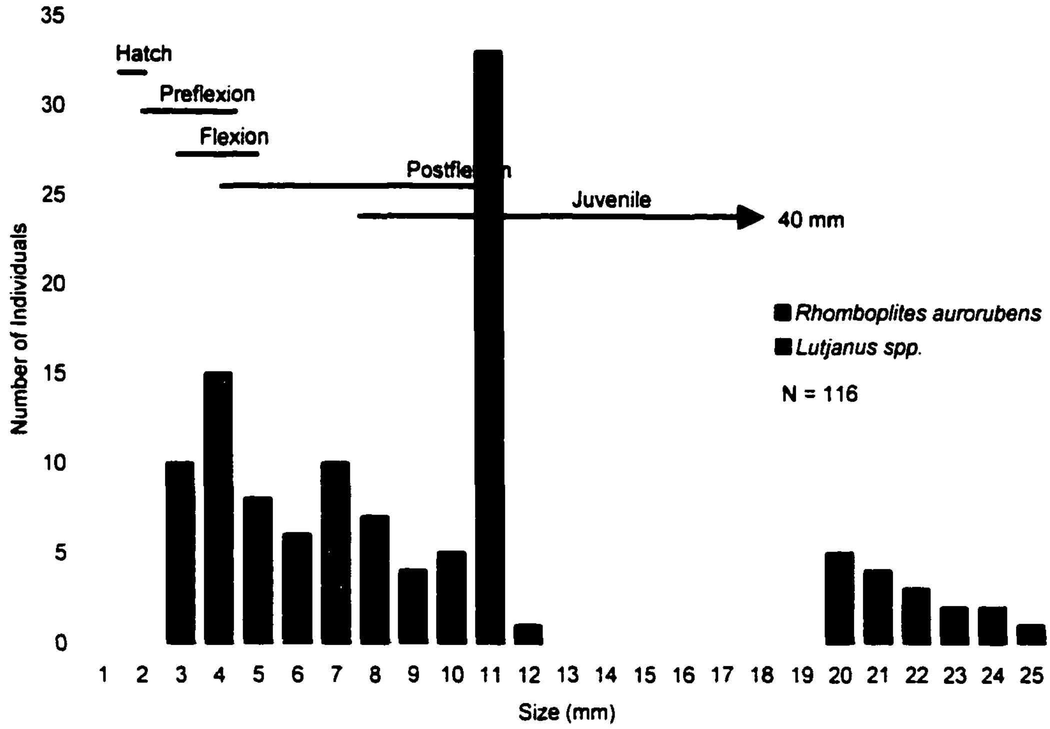

Figure 5.11. Size distribution of lutjanids collected at the mid-shelf platform (GI 94). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

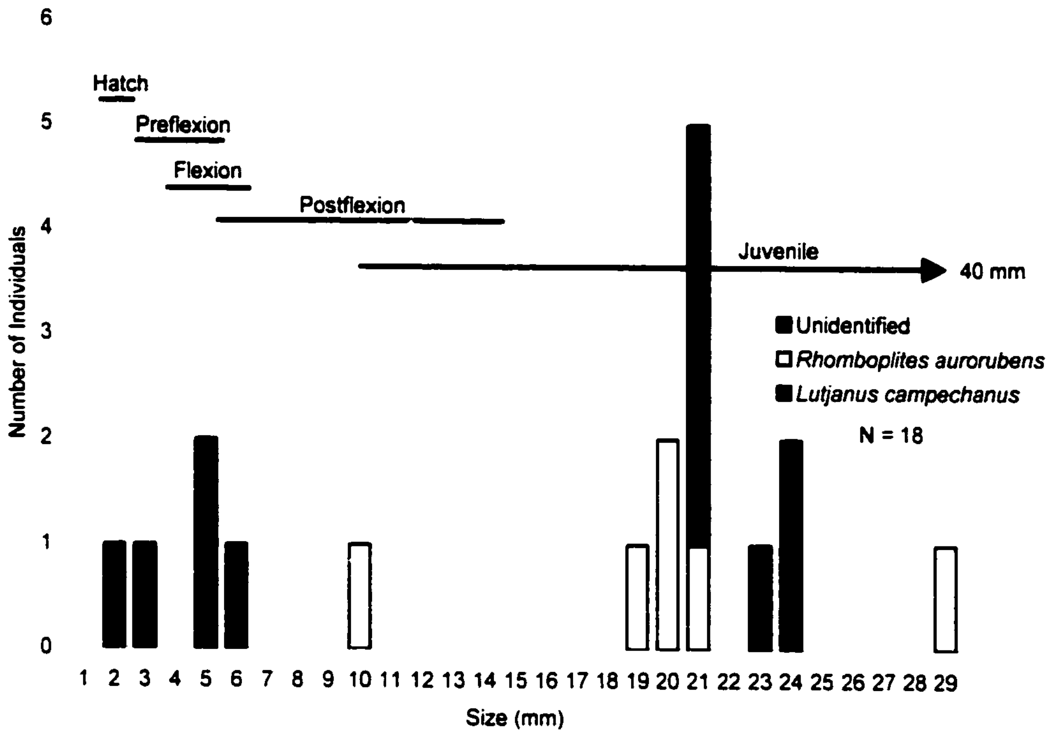

Figure 5.12. Size distribution of lutjanids collected at the inner shelf platform (ST 54). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

Holocentridae (Squirrelfishes)

Squirrelfishes are relatively small, nocturnal fishes that occupy the crevices of rocky ledges and reefs during the day (Robins et al. 1986; Wyatt 1976). World-wide, there are approximately 65 species (8 genera), of which 11 (4 genera) occur in the Gulf and Caribbean (Robins et al. 1986; Robins et al. 1991). *Holocentrus ascensionis* and *Myripristis jacobus* are the most common species found in association with natural banks in the northwestern Gulf, but other species (*H. marianus, H. poco, H. rufus, H. vexillarius,* and *Plectrypops retrospinis*) have been observed as well (Sonnier et al. 1976; Hoese and Moore 1977; Dennis and Bright 1988). In contrast, few squirrelfish (*Holocentrus* spp. and *H. marianus*) have been reported in association with oil and gas platforms (Stanley and Wilson 1991; Rooker et al. 1997). Interestingly, holocentrids have a protracted pelagic existence, which includes a unique, postlarval "rhynchichthys" stage (McKenney 1959; Wyatt 1976; Tyler et al. 1993). This extended pelagic phase culminates for most species with settlement at approximately 30-50 mm (Tyler et al. 1993). However, at least two, common western Atlantic species (*Holocentrus ascensionis* and *H. rufus*) have an even longer pelagic existence before settlement in a prejuvenile, "meeki" stage (Tyler et al. 1993).

Larval and juvenile holocentrids were collected at the shelf break (GC 18) and mid-shelf (GI 94) platforms only. At the shelf break platform, 25 holocentrids from a relatively wide range of sizes (2.0-37.0 mm) were collected (Figure 5.13). Approximately 40% of the holocentrids collected were pre-rhynchichthys stage larvae (2.0-9.0 mm) and included preflexion, flexion and postflexion stages. No information is known about the hatchling sizes of squirrelfishes, but McKenney (1959) reported the collection of a 1.8 mm *Holocentrus vexillarius* with some yolk remaining. It is probable, therefore, that some of the holocentrid larvae (i.e., 2.0-4.0 mm individuals) are the result of local spawning. Other, relatively large rhynchichthys and juvenile individuals were collected (9.0-37.0 mm) as well, but no meeki holocentrids were represented. These larger individuals were identified as *H. vexillarius* (n=9), *H. poco* (n=3) and *H. rufus* (n=1). *Holocentrus vexillarius* individuals (20.0-33.0 mm) ranged from late rhynchichthys stages to early settled juveniles (McKenney 1959). All *H. poco* individuals were post-rhynchichthys individuals. The single *H. rufus* specimen collected (25.0 mm) was a pelagic, rhynchichthys (Tyler et al. 1993).

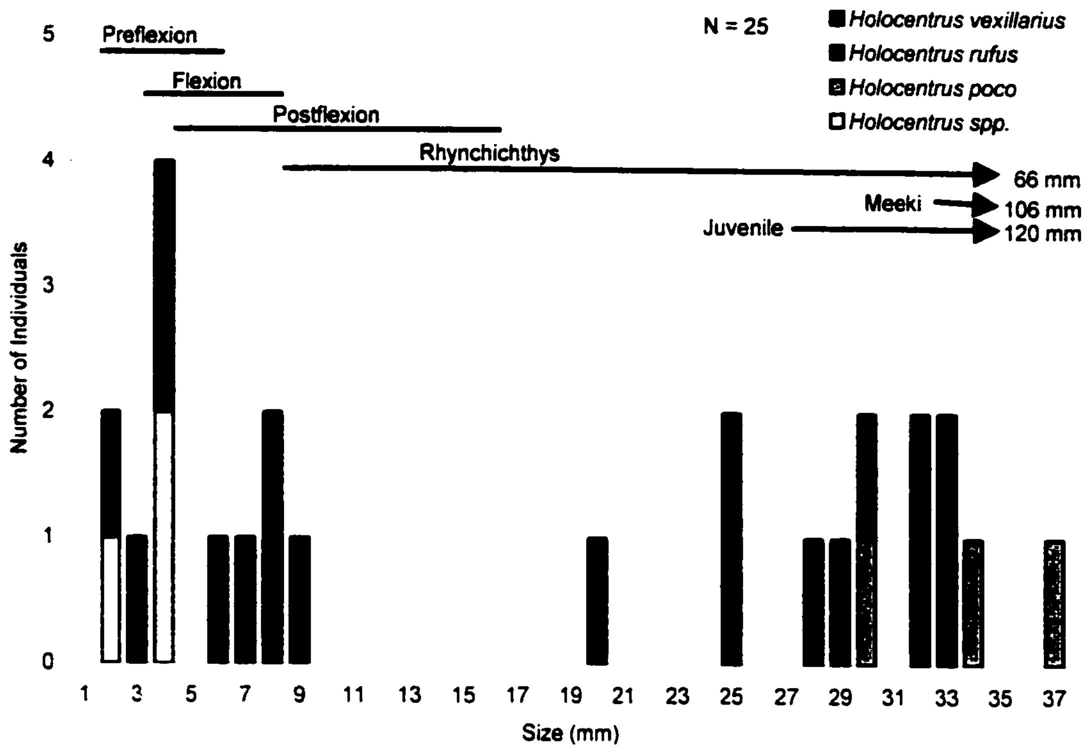

Figure 5.13. Size distribution of holocentrids collected at the outer shelf platform (GC 18). Lines above the bars denote the size ranges for different early life history stages based on published literature. N = total number of fish measured.

Twelve holocentrids were collected at the mid-shelf platform (GI 94), primarily smaller preflexion, flexion and postflexion *Holocentrus* spp (3.0-10.0 mm; Figure 5.14). One 36.0 mm *H. vexillarius* juvenile was also collected. No holocentrid early life history stages were collected at the inner shelf site (ST 54).

SEAMAP Comparisons: 60-cm, Oblique Bongo Tows vs. 60-cm, Passive Plankton Collections

Several trends were evident in the comparisons of reef fish abundances collected in the passive plankton nets vs. SEAMAP oblique bongo tows. Across the shelf, pomacanthids were absent in both the platform plankton net collections and the SEAMAP bongo samples analyzed, and acanthurids were only collected in SEAMAP collections on the outer shelf in relatively low abundances (Table 5.4).

In the outer shelf comparisons, reef-dependent pomacentrids, labrids and scarids were present in SEAMAP samples, but not in platform samples (Table 5.4). Only chaetodontids were present at the platforms and absent in SEAMAP bongo tows. However, at the outer shelf platforms reef-associated taxa were generally more abundant, with the exception of serranids. In general, abundances within both data sets were relatively low, with the exception of serranids (72.3 fish/m^2) collected in SEAMAP bongo tows. At the platforms, the most abundant taxa were lutjanids (8.2 fish/m^2).

In the mid-shelf comparisons, both reef-dependent and reef-associated fishes were generally more abundant at the platform locations than in the SEAMAP samples (Table 5.4). No reef-dependent taxa were present in the SEAMAP bongo collections, but chaetodontids, pomacentrids and labrids were collected at the platforms, though at relatively low abundances. Similar to the outer shelf comparisons, reef-associated taxa were more abundant at the platform sites than in the SEAMAP bongo collections, again with the exception of the serranids. Serranids were the most abundant reef-associated taxa in SEAMAP bongo tows (5.6 fish/m^2), although abundances were considerably lower than in the outer shelf samples. Blenniids were the most abundant reef-associated taxa in the platform samples (17.6 fish/m^2). In the inner shelf comparisons, very few reef-associated and reef-dependent fishes were collected (Table 5.4). No reef-dependent taxa were collected in SEAMAP samples at the inner shelf sites, while only scarids were present (0.5 fish/m^2) at the platforms. Blenniids were the most abundant reef-associated fishes collected, but again abundances were very low both in the SEAMAP (0.7 fish/m^2) and platform (1.2 fish/m^2) collections.

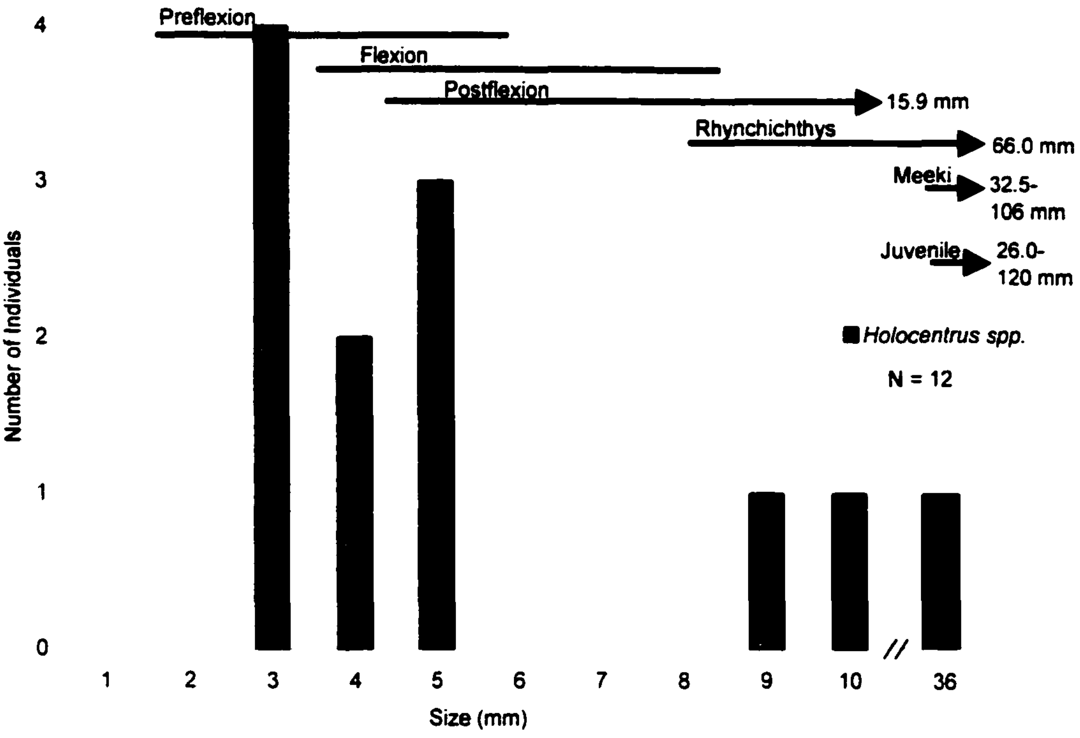

Figure 5.14. Size distribution of holocentrids collected at the mid-shelf platform (GI 94). Lines above the bars denote the size ranges for different early life history stages based on published literature. Note break in size scale. N = total number of fish measured.

Table 5.4. Mean abundance (fish/m^2) and standard deviation (SD) for reef fish collected at selected SEAMAP ichtyoplankton sampling stations (oblique bongo tows) and at three oil and gas platforms (passive plankton net, subsurface and surface) across the continental shelf.

	Outer Shelf		Mid-shelf		Inner Shelf	
	SEAMAP† Mean (SD)	GC 18‡ Mean (SD)	SEAMAP† Mean (SD)	GI 94‡ Mean (SD)	SEAMAP† Mean (SD)	ST 54‡ Mean (SD)
Reef-dependent						
Chaetodontidae	0 (0)	0.8 (0.7)	0 (0)	<0.1 (0.5)	0 (0)	0 (0)
Pomacanthidae	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Pomacentridae	1.3 (4.0)	0 (0)	0 (0)	1.1 (6.7)	0 (0)	0 (0)
Labridae	4.4 (7.2)	0 (0)	0 (0)	<0.1 (0.8)	0 (0)	0 (0)
Acanthuridae	0.3 (1.5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Scaridae	1.6 (3.7)	0 (0)	0 (0)	0 (0)	0 (0)	0.5 (1.3)
Reef-associated						
Holocentridae	0.3 (1.2)	0.6 (1.5)	0 (0)	0.3 (1.7)	0 (0)	0 (0)
Serranidae	72.3 (83.2)	3.0 (3.9)	5.6 (5.0)	1.2 (3.4)	0.2 (0.7)	0 (0)
Lutjanidae	3.2 (5.1)	8.2 (12.6)	1.9 (5.4)	2.1 (6.7)	0 (0)	0 (0)
Blenniidae	0 (0)	4.1 (13.3)	3.2 (5.4)	17.6 (19.3)	0.7 (2.0)	1.2 (2.4)

†Means calculated for five outer shelf (n=21 samples), two mid-shelf (n=8) and three inner shelf (n=12) SEAMAP sampling stations (1995-1997).
‡Means calculated for paired (subsurface and surface), passive plankton net samples collected at GC 18 (n=14), GI 94 (n=161) and ST 54 (n=7).

SEAMAP Comparisons: 1 x 2 m Neuston Tows vs. Light-trap Collections

Similar trends were observed in comparisons between SEAMAP neuston tows and platform light-trap collections. Overall, pomacanthids and acanthurids were absent in both SEAMAP and platform samples (Table 5.5). Chaetodontids were absent in all light-trap collections, while scarids and holocentrids were not collected in neuston tows.

In the outer shelf comparisons, reef-dependent taxa were rare (Table 5.5). Pomacentrids and labrids were present in SEAMAP neuston tows, and pomacentrids and scarids were present in light-trap samples, but all mean abundances were low (<1 fish/sample). As a group, reef-associated fish were generally more common, but abundances were still generally low. Serranids were the most abundant reef-associated taxa collected in neuston tows (1.7 fish/sample).

In the mid-shelf comparisons, reef-dependent fishes were nearly absent in SEAMAP collections (Table 5.5). Only chaetodontids occurred in small numbers (0.1 fish/sample). Pomacentrids and labrids were the only reef-dependent fishes collected in light-trap samples at the mid-shelf platform. Blenniids and lutjanids were the only reef-associated fishes present in SEAMAP neuston samples at the mid-shelf stations. Serranids, which were the most dominant taxa in the SEAMAP bongo samples at these stations, were absent in the neuston collections. They were, however, present in platform light-trap collections. The most common reef-associated fishes in the platform light-trap samples were blenniids (11.2 fish/sample). Holocentrids, serranids and lutjanids were collected in light-traps, but abundances were very low (approximately 0.1 fish/sample).

In the inner shelf comparisons, reef-dependent fishes were absent in SEAMAP neuston collections and were virtually absent in platform light-trap samples (Table 5.5). Only pomacentrids were present in low numbers (<0.1 fish/sample) in the platform light-trap samples. Reef-associated taxa were also rare in both data sets. Blenniids (0.6 fish/sample) and lutjanids (0.3 fish/sample) were collected in SEAMAP neuston nets. Abundances of blenniids, lutjanids and serranids were low in platform light-trap samples as well.

DISCUSSION

Due to the demersal and relatively sedentary nature of most adult reef fishes, it is generally believed that reef fish populations are maintained, in part, by the continuous settlement of pelagic larvae

Table 5.5. Mean number (fish/sample) and standard deviation (SD) of reef fish collected at selected SEAMAP ichtyoplankton sampling stations (neuston tows) and at three oil and gas platforms (light-traps, surface and off-platform) across the continental shelf.

	Outer Shelf		Mid-shelf		Inner Shelf	
	SEAMAP† Mean (SD)	GC 18‡ Mean (SD)	SEAMAP† Mean (SD)	GI 94‡ Mean (SD)	SEAMAP† Mean (SD)	ST 54‡ Mean (SD)
Reef-dependent						
Chaetodontidae	0 (0)	0 (0)	0.1 (0.4)	0 (0)	0 (0)	0 (0)
Pomacanthidae	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Pomacentridae	0.2 (1.0)	0.1 (1.0)	0 (0)	0.5 (1.9)	0 (0)	<0.1 (0.4)
Labridae	<0.1 (0.2)	0 (0)	0 (0)	<0.1 (0.1)	0 (0)	0 (0)
Acanthuridae	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Scaridae	0 (0)	<0.1 (0.3)	0 (0)	0 (0)	0 (0)	0 (0)
Reef-associated						
Holocentridae	0 (0)	0.1 (0.5)	0 (0)	<0.1 (0.1)	0 (0)	0 (0)
Serranidae	1.7 (5.6)	<0.1 (0.2)	0 (0)	0.1 (0.4)	0 (0)	<0.1 (0.1)
Lutjanidae	0.2 (0.7)	<0.1 (0.2)	0.9 (2.1)	0.1 (0.3)	0.3 (0.6)	<0.1 (0.1)
Blenniidae	0.4 (1.6)	0.1 (1.4)	1.0 (1.4)	11.2 (31.1)	0.6 (1.0)	1.0 (3.5)

†Means calculated for five outer shelf (n=25 samples), two mid-shelf (n=8) and three inner shelf (n=12) SEAMAP sampling stations (1995-1997).
‡Means calculated for light-trap (surface and off-platform) samples collected at GC 18 (n=154), GI 94 (n=319) and ST 54 (n=146).

(Leis 1991). One of the proposed benefits of artificial reefs (e.g., oil and gas platforms), is that they may contribute to increased production by providing additional spawning habitat for adults, as well as settlement habitat for juveniles, and/or additional habitat which is otherwise limited for sub-adults and adults. By examining the different early life history stages, it is possible to infer if the reef fish collected were spawned locally (very small or young larvae) or if they are potential settlers to a reef or platform environment (juveniles). McGowan (1985), for example, used the sizes of larval fish collected near the Flower Garden Banks (outer shelf, northwestern Gulf) and adjacent oil platforms to infer local spawning events. He determined, based on the collection of small, preflexion individuals, that a number of reef fish were actively spawning in the vicinity, including apogonids, acanthurids, labrids, scarids, lutjanids, serranids and pomacentrids. Although fish were sampled just above the reef environment, juveniles were not collected, probably due to the nature of the sampling gear (bongo nets), which targeted smaller larvae (McGowan 1985).

A similar approach was taken in this study, in conjunction with an extensive literature search on the sizes of the early life history stages of reef fish, from likely adults to be encountered in the study area. In doing so, a number of fishes have been identified as having local spawning populations relative to the platforms sampled. At the outer shelf platform, there is evidence of local spawning by chaetodontids, scarids, holocentrids, serranids, lutjanids and blenniids. Relatively small, preflexion chaetodontids, pomacentrids, and labrids, as well as holocentrids, serranids, lutjanids and blenniids were also collected at the mid-shelf platform. At the inshore platform, evidence of local spawning events was found only for serranids, lutjanids and blenniids. While examining the size-at-stage information for these fishes gives an indication of local spawning populations, it does not give information on the source of the larvae, i.e., whether they were spawned from populations inhabiting natural reef or artificial reef environments. Since adult reef fishes are found in association with both habitat types, it is possible that the pool of larval fishes sampled is a result of spawning efforts of adults in both environments. The platforms do not equal the natural reefs and hard bottoms in terms of measurable hard-bottom surface area Gulf-wide (i.e., 0.4% of "total reef habitat"; Gallaway 1998). However, along the platform transect in this study (just west of the Mississippi River Delta and within its historical sedimentary plume), the proponderance of platforms

vs. natural reefs, particularly in the mid- and inner shelf environments, would appear to statistically increase their probable significance as spawning sites for adults, and thus sources of larvae.

Knowledge of the spawning habits of some adult reef fishes may give insight into the importance of oil and gas platforms as artificial reefs. While most reef-associated and reef-dependent fishes are broadcast spawners, some fishes lay demersal eggs on the reef substrate. Blenniids, for example, were relatively common among the reef fishes collected at the platforms, and these fishes lay demersal eggs on the hard substrate of reefs (Thresher 1984; Cowen and Sponaugle 1997). Blenniids are small, cryptic, reef-associated demersal fishes and are, therefore, particularly well-adapted to the platform environments. They are one of the most abundant species on platforms and typically inhabit dead barnacle shells (Workman and Jones 1979; Gallaway and Lewbel 1982). These shells provide suitable habitat for blenniid spawning and egg deposition, which occurs in small crevices (Smith-Vaniz 1980; Gallaway et al. 1981; Thresher 1984). Large numbers of preflexion blennies were collected at all platforms, a strong indication that the platforms may be the source of small larvae.

Pomacentrids are reef-dependent fishes that also deposit demersal eggs (Thresher 1984), and adults and juveniles are commonly found in association with oil and gas platforms. At least one species (*Abudefduf saxatilis*) has been observed guarding nests on an oil and gas platform structure (Scarborough-Bull and Kendall 1994). While larger, postflexion larvae and juveniles were present at all platforms, preflexion pomacentrids were only collected at the mid-shelf platform. With the lack of preflexion larvae at the outer and inner shelf platforms, it is difficult to conclude how important the platforms may be to pomacentrid spawning and reproduction. In any event, it may be that the platforms serve a different function in the life history of these fishes in the northern Gulf. Rooker et al. (1997) noted that pomacentrids (and blenniids) are shallow water reef species and the depths of natural reefs in the northern Gulf (>20 m) may inhibit their colonization of these habitats. The authors noted increased abundances of adult *A. saxatilis* on the Flower Garden Banks shortly after the deployment of mooring buoys above the site. These buoys supported large numbers of juvenile *A. saxatilis*, which the authors postulated resulted in a subsequent increase colonization of the Flower Garden Banks by this species. In addition, *A. saxatilis*, which were once considered transients in the northwestern Gulf, have recently established permanent populations in this area along the near-surface supports of oil and gas platforms

(Dennis and Bright 1988). The collection of relatively large numbers of pomacentrid juveniles at these platforms supports this notion of near-surface, artificial structures serving as important habitat for juveniles.

The other reef-dependent and reef-associated taxa of interest in this study are typical of most marine fishes in that pelagic eggs are released and fertilized (Cowen and Sponaugle 1997). Most of the reef-dependent fishes were absent or rare (e.g., chaetodontids, pomacanthids, labrids and acanthurids), with the exception of scarids, which were relatively common at the outer shelf platform. Many of these scarids were preflexion and early flexion larvae, indicative of a local spawning population. Of particular interest is the rarity of labrid larvae at the platform sites. Labrids are often the dominant taxa on natural and artificial reefs in the northern Gulf (Dennis and Bright 1988; Rooker et al. 1997), including several species common in temperate environments (e.g., *Halichoeres bivittatus* and *Lachnolaimus maximus*). It is difficult to hypothesize why labrids and other reef-dependent larvae and juveniles were not more common in the platform samples or within the oil fields. Recruitment events for these taxa can be extremely episodic (Choat et al. 1993; Rooker et al. 1996), with most of the reef fish replenishment occurring over the course of 1-3 nights (Thorrold et al. 1994; Rooker et al. 1996). Labrids, for example, can have acyclic spawning patterns, as well as settlement during quarter moon phases (Thorrold et al. 1994). The pelagic larval durations for labrids can also vary greatly, potentially allowing for asynchronous settlement events (Victor 1986). Pelagic larval durations for two common platform residents, *Bodianus pulchellus* and *Thalassoma bifasciatum*, range from 32-51 days and 38-78 days, respectively (Victor 1986). Although peak times of settlement and recruitment (new and full moon periods) were targeted, it is possible that settlement peaks were missed during the course of the study's 2-3 day sampling trips, or that settlement events were temporally spread out over long periods of time, decreasing the chances of sampling patchily distributed taxa in larger numbers.

Several characteristics unique to oil and gas platforms as artificial habitats may influence the frequency or magnitude of settlement events. For example, platforms always provide shallow water, hard substrate/habitat regardless of the water depth or location on the continental shelf. This may be particularly important for many reef fishes settling from the plankton, particularly since many of the natural hardbottom and reefs are relatively deep compared to reefs in the eastern Gulf and Caribbean.

The chances of a potential settler encountering a platform vs. a natural habitat are relatively high, since most ichthyoplankton and pelagic juveniles are found in the upper water column. For example, several studies have documented the presence of reef fish larvae and juveniles in pelagic drift algae communities, including reef-dependent (pomacentrids and labrids) and reef-associated (serranids, lutjanids, blenniids, holocentrids, mullids, priacanthids and lobotids) fishes (Bortone et al. 1977; Kingsford 1992; Franks et al. 2001). Since floating *Sargassum* mats are not uncommon in the northern Gulf, it is possible that these algal patches may serve as vectors of recruitment for some fishes as they move along the surface, perhaps encountering platforms. Another important aspect of the platforms may be the large light-field associated with the structure at night. Many reef fish juveniles are attracted to light (Doherty 1987) and it is possible that the platforms may aggregate juveniles and draw them towards the artificial habitat. Munday et al. (1998) used light-aggregation devices (modified light-traps) to enhance settlement above small patch reefs. The authors determined that greater numbers and species of juveniles settled on light-enhanced reefs vs. control reefs (no lights) or surface buoy-enhanced reefs (see Rooker et al. 1997 discussion above).

Reef-associated fishes, particularly blenniids, serranids and lutjanids, were generally more common in the platform samples. This result is not surprising, since many of these fishes are common in temperate as well as tropical environments (Hoese and Moore 1977). Their occurrence should be higher relative to reef-dependent taxa that are more restricted by both environmental (i.e., temperature tolerances) and habitat (reef) requirements. At the shelf break platform, most of the serranids collected were preflexion and flexion larvae, indicative of local spawning events. Unfortunately, the inability to confidently identify many of these early life history stages to species limits comparisons with known adult distributions across the shelf. For example, epinephelines were either *Mycteroperca* spp. or *Epinephelus* spp., which represent 10-12 and 7-8 possible species, respectively. When identifications were possible, however, larval and juvenile data generally agreed with adult across-shelf distributions. Anthiines were believed to be mostly *Hemanthias vivanus* and *Protogrammus martinicensus*, both of which occur on deep, offshore reef environments (Hoese and Moore, 1977). In contrast, most of the serranids collected at the mid-shelf platform were serranines (sea basses), including many juveniles. Again, most of these could only be identified to the genus level: *Centropristis* spp. (3 species),

Diplectrum spp. (2 species) and *Serranus* spp. (4 species). Many of these fishes, however, are relatively common along the mid-shelf and inner shelf environments (Hoese and Moore 1977).

Similar patterns were observed with lutjanids, of which several were identified to the species level. Many preflexion *Pristipomoides aquilonaris* larvae were collected at the outer shelf platform. These lutjanids are among the most common fishes associated with mid- and outer shelf hard-bottom areas (Hoese and Moore 1977). Across-shelf collections of *Rhomboplites aurorubens* (mid- and inner shelf platforms) and *Lutjanus campechanus* (inner shelf platform) were also in agreement with known adult distributions.

Overall, across-shelf distribution patterns in reef-dependent and reef-associated larval and juvenile distributions were as expected. What remains problematic, however, is why the early life history stages of these fishes are so rare in the plankton when compared with other marine fishes. A number of studies have investigated the relative abundances of different larval fishes in the Gulf, including reef-dependent and reef-associated fishes (Ditty 1986; Kelley et al. 1990, 1993; McGowan 1985). In general, these taxa are among the rarest in the ichthyoplankton, especially compared to common coastal or oceanic pelagics or demersal fishes (e.g., Clupeidae, Engraulidae, Carangidae, Sciaenidae).

The estimates of "background" plankton abundances (SEAMAP data) appeared relatively similar to the abundances at the platforms sampled. Although no statistical tests could be run to rigorously support this conclusion, there were relatively few order of magnitude differences in comparisons of taxa collected within or immediately downstream of platforms vs. SEAMAP surveys. For the outer shelf comparisons, the largest differences were between serranids, where abundances were higher in the SEAMAP surveys than at the platforms, particularly in the bongo net samples. At the mid-shelf, blenniids were found to be generally more abundant in association with the platform. Similar to the results at the platforms, SEAMAP surveys generally collected more reef-associated fishes than reef-dependent species.

While high on-site predation rates may help explain the rarity of reef fish larvae at platforms, it is difficult to determine why they are relatively rare in the Gulf-wide, open water ichthyoplankton assemblage. Some reef fish larvae have been reported as rare even in the eastern Gulf and Caribbean, where more natural reef habitat is available and many of these fishes are abundant as adults (Richards

1984; Limouzy-Paris et al. 1994). For example, Richards (1984) surveyed the Caribbean Sea (109 oblique bongo samples) and collected very few larvae (<13 individuals) of such common reef fishes as holocentrids, lutjanids, chaetodontids, pomacentrids, mullids and blenniids. In terms of the relative abundances of reef fishes, the results of this study are in general agreement with previous surveys. Reef-dependent and reef-associated fishes made up a relatively small percentage of the total ichthyoplankton assemblage at each of the platforms. What does appear interesting at the platforms, however, is the presence of a full spectrum of sizes and developmental stages which may not be as well represented (abiet at very low densities) elsewhere.

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CHAPTER 6

POTENTIAL IMPACTS OF OIL AND GAS PLATFORMS ON LARVAL AND JUVENILE ASSEMBLAGES IN THE NORTHERN GULF OF MEXICO

SUMMARY

This study, along with a companion project addressing different questions (Tolan 2001), represents the first comprehensive look at the ichthyoplankton and juvenile fish assemblages collected within oil and gas platforms in the Gulf of Mexico (Gulf), and to my knowledge, the world. It is also a first (yet preliminary) attempt at comparing such assemblages across different depth zones and geographical regions. It is apparent that a diverse assemblage of recently-spawned larvae, postlarval and juvenile fishes occurs in the waters within and immediately downstream of platforms, and that these structures may be important to reef fish population dynamics. Based on the results of this study, three obvious conclusions stand out: the peak in taxonomic richness and diversity at the mid-shelf platform (GI 94); the relatively low abundance of reef-associated and reef-dependent postlarvae and juveniles present at the platforms (as is the case with shelf-wide ichthyoplankton surveys); and the presence, albeit in low abundances, of recently-spawned, preflexion, flexion, postflexion and juvenile reef-dependent and reef-associated species at platforms.

Mid-Shelf Peak in Taxonomic Richness and Diversity

In general, while reef-associated and reef-dependent taxa were collected at all platform sites, taxonomic richness and diversity was highest at GI 94 (mid-shelf). Due to the pelagic nature of most reef-dependent eggs and larvae, dispersal in the oceanic environment plays a large role in the eventual settlement and recruitment of postlarvae and juveniles to adult environments. While some studies have determined mechanisms of larval retention in reef environments (Swearer et al. 1999; Cowen et al. 2000), it is widely believed that recruitment is variable and dependent, in part, on the supply from nearby, upstream reefs (Sale 1980; Richards and Lindeman 1987; Doherty and Williams 1988; Doherty 1991). In the northern Gulf, most oil and gas platforms are concentrated along the inner and mid-shelf region, where 93% of the structures are located in water depths ranging from 0-75 m (Grace Hawayek, Minerals Management Service, New Orleans Office, pers. com.). At GI 94, which was the mid-shelf platform (60 m depth), the proximity to the high density of surrounding platforms may have created generally favorable conditions for the recruitment of reef taxa. The presence, proximity and concentration of upstream reefs (natural or artificial) and spawning habitats is known to play an important role in the eventual makeup of the pre-adult assemblages.

At GC 18 (shelf break), the relatively low abundance of reef fish larvae and juveniles may likewise be due to a combination of depth (> 200m), distance from other natural/artificial reefs, and oligotrophic, open ocean waters devoid of possible recruits. Similarly, the close proximity of ST 54 (inner shelf) to the coastal boundary current and hydrologic interactions with the Mississippi River plume (e.g., low salinity and high turbidity), along with its shallow water depth (20 m) which makes it more susceptible to rapid cooling during winter cold fronts, may result in fluctuating conditions generally unfavorable for most reef-associated or reef-dependent fishes, but more suitable for estuarine and coastal pelagic taxa, which dominated the collections. Previous research on the adult assemblages associated with the sampling sites (Stanley and Wilson 2000) involving hydroacoustical and underwater video surveys utilizing remote controlled vehicles have shown similar results, with the highest taxonomic richness, particularly among reef-dependent taxa, occurring at GI 94 (mid-shelf). Adult biomasses were significantly higher at GI 94 as well. Mean adult densities at GI 94 were approximately 15-17 times higher than at ST 54 (inner shelf) and GC 18 (Stanley and Wilson 2000).

Rarity of Reef-Associated and Reef-Dependent Larvae and Juveniles

The fact that relatively few individuals of reef-dependent and reef-associated taxa were collected, particularly lutjanid and serranid specimens, is not surprising for several reasons. First of all, due to the high mortality rates experienced by pelagic larvae prior to settlement (approaching 100%), reef-dependent juveniles are relatively rare in general (Leis 1991). This, coupled with potentially high predation rates at the settlement site itself (see below), may result in very low abundance of early life stages available for capture. Secondly, recruitment events for these taxa can be extremely episodic (Choat et al. 1993; Rooker et al. 1996), with most of the reef fish replenishment occurring over the course of 1-3 nights (Thorrold et al. 1994; Rooker et al. 1996). Although peak times of settlement and recruitment (new and full moon periods) were targeted for 2-3 night periods, it is still very possible that settlement peaks were missed during the course of the study. Finally, although light-traps were used as a means of collecting larger postlarvae and juveniles, light-aggregation devices can be very taxon-selective. While some reef-dependent taxa, such as pomacentrids, have been collected in large numbers, few research efforts have been able to collect many lutjanids or serranids with light-aggregation devices (Dennis et al. 1991; Choat et al. 1993; Brogan 1994; Rooker et al. 1996; Hernandez and Lindquist 1999).

A popular justification for artificial reefs is that they increase fish populations by improving recruitment (Bohnsack et al. 1994). The occurrence of extremely large numbers of postlarvae and newly-settled juveniles on new reefs, which are devoid of high numbers of adults, suggests that there is a pool of opportunistic surplus larvae (Bohnsack et al. 1994). Numerous observations on the subsequent, rapid disappearance of these newly-settled juveniles, however, support the "wall of mouths hypothesis" (Emery 1973; Hamner et al. 1988) and the "limited shelter hypothesis" (Shulman 1985; Hixon and Beets 1989), which state that for postlarval reef fish, the time of settlement, especially in the absence of suitable shelter, is characterized by exceedingly high predation-mortality rates by the larger, predominately carnivorous resident population, many of which are conspecifics. Thus, the presence of presettlement postlarvae and postsettlement juveniles may often be "displaced" from the most favorable reef habitat by this intensive, on-site, adult predation (Frederick 1997).

While much of the evidence for the "wall of mouths" and related hypotheses has been collected from natural reefs, there is some supporting evidence from oil and gas platform studies. Scarborough-Bull and Kendall (1994) studied juvenile recruitment and colonization on three offshore oil and gas platforms that were converted to artificial reefs. Two platforms were explosively toppled and had virtually all of their resident fish community lethally concussed. These sites subsequently served as recruitment sites for juveniles/immature reef fish. A third rig was toppled during a hurricane and experienced minimum impact to its adult fish communities and did not serve as a recruitment site, i.e., virtually all fish observed were adults (Scarborough-Bull and Kendall 1994).

It is with this paradigm in mind (increased production by improving recruitment) that light-traps were used within the sampling design in an effort to collect settlement-stage postlarvae and juveniles. The presence of these larger, more competent individuals could provide indirect evidence for the nursery area/refuge function of the petroleum platforms. The adult populations of reef fish at the sites are well-known. Stanley and Wilson (2000) have documented reef-dependent adults at the outer shelf platform (GC 18: *Epinephelus inermis, Mycteroperca phenax, Paranthias furcifer, Pristipomoides aquilonaris, Balistes capriscus*), the mid-shelf platform (GI 94: *Epinephelus fulvus, E. inermis, Mycteroperca bonaci, M. microlepis, M. phenax, M. venenosa, P. furcifer, Lutjanus campechanus, L. griseus, Rhomboplites aurorubens, B. capriscus*) and the inner shelf platform (ST 54: *Epinephelus adscensionis, L.*

campechanus, L. griseus, B. capriscus). However, few reef-dependent, settlement-size postlarvae and juveniles were collected, mostly pomacentrids and blenniids.

The abundance of postlarval and juvenile synodontids and scombrids near the platforms suggests that even the early life stage predatory field is probably high, i.e., postlarvae/juvenile predation on other postlarvae and juveniles, plus cannibalism. Most synodontids and scombrids are piscivorous as early as the postlarval stage (Naughton and Saloman 1981; Uchida 1981; Sweatman 1984; Thresher et al. 1986). Larvae and juveniles of synodontids were frequently collected in the light-trap samples (as were scombrids to a lesser extent) and were observed preying on other organisms retained in the cod end. Small, cryptic species such as synodontids are often overlooked in surveys and, therefore, their abundances are usually unknown. The presence of a large population of synodontids may have a major impact on fish community dynamics, since they prey directly on postlarvae and juveniles of many commercially- and recreationally-important species (Thresher et al. 1986). Observations on piscivory by a synodontid suggest that new recruits can face a 65% annual chance of predation from just a single species of lizardfish (Sweatman 1984). The high numbers of piscivorous juveniles collected in this study, primarily with light-traps, indicate that predation is important in determining local reef assemblages.

Full Range of Early Life History Stages of Reef-Dependent and Reef-Associated Fishes

A functional attribute often credited to artificial reefs is that they increase fish production by increasing the available habitat for adult nesting or spawning (Grossman et al. 1997). While this study did not examine adult spawning activity or pelagic egg densities, smaller, yolk-sac and preflexion larvae were present in the plankton net collections. At the outer shelf platform (GC 18), for example, preflexion blenniids, holocentrids, serranids, lutjanids, and scarids were collected, suggesting nearby spawning or local supply. Similarly, reef-dependent/associated, preflexion individuals were collected at the mid-shelf platform, GI 94 (pomacentrids, blenniids, holocentrids, lutjanids, and serranids), and at the inner shelf platform, ST 54 (blenniids and lutjanids). While the passive plankton net collections do not necessarily reflect platform-association, they do provide an indication of local supply. Since preflexion, reef-dependent larvae were collected, it is likely that they were locally spawned at either natural or artificial habitats nearby. Platforms are more abundant on the mid- and inner shelf, increasing their potential importance. At the shelf break platform, the number of possible upstream spawning sites is very much

restricted when compared to the mid-shelf platform (with the most possible adjacent, upstream sites) or even the inner shelf site.

With the limited amount of hard-substrate habitat available in the northcentral Gulf of Mexico, the addition of artificial habitats (platforms) may increase the chances of finding suitable settlement habitat, particularly where they are most dense (mid- and inner shelf). The available natural hard-bottom habitats in the Gulf are widely scattered and relatively deep, particularly for many reef-dependent taxa accustomed to shallow water habitats. The chances of encountering a platform in the northern Gulf (especially west of the Mississippi River Delta) is probably relatively high compared to those of encountering a natural reef or hard-bottom. Also, since most larval and juvenile fishes are in the upper water column, the encounter rate is potentially enhanced by the vertical nature of platform structures. Platforms may not equal natural hard-bottom banks in terms of settlement area or suitable porosity/rugosity, but they potentially serve as a settlement site for fishes that otherwise might be "lost" from the system.

MANAGEMENT IMPLICTIONS

From a management perspective, fish early life history data from a cross-shelf study of petroleum platforms could provide information useful in deciding the future placement of artificial structures (Shinn and Wicklund 1989) and in determining whether or not the platforms serve as refugia for reef species (Steimle and Meier 1997). While oil and gas platforms may be very suitable habitat for adult fishes, the physical meso- and micro-structure of these artificial reefs may not be ideal for settling postlarvae and juveniles. Previous studies have shown that smaller reefs tend to hold a greater cumulative numbers of total and resident species, higher fish densities, and more settlers (Bohnsack et al. 1994). The higher carrying capacity and settlement success of smaller reefs is probably a function of their: 1) greater edge effect (higher ratio of perimeter to reef area; Bohnsack et al. 1994); 2) lower vertical relief which often favors juvenile over adult reef fish (West et al. 1994); and 3) greater porosity or availability of small shelter holes ($\leq$ a few cm), which has been repeatedly shown to be important for post-settlement survival (Shulman 1985; Hixon and Beets 1989; West et al. 1994). Petroleum platforms, in contrast, are large reefs and are generally characterized as having a higher profile (high vertical relief), less complexity, and lower porosity than natural reefs.

I believe the lack of structural complexity of platforms, combined with the high predation pressures (see above) results in a habitat that is not very suitable for a settling juvenile. The "wall of mouths" predation pressure is enhanced by the large constant light fields associated with platforms that allow for additional nocturnal surface feeding by visual predators. Some opportunistic settlement events undoubtedly occur, as evident by the presence of settlement-sized juveniles at the platforms and by the presence of sedentary, reef-dependent adult species (e.g., chaetodontids and labrids). However, I believe the major value of oil and gas platforms as artificial habitat lies in their increased carrying capacity for adult fishes and potential as spawning habitat. The vertical structure of the platform, while unique, is not as important for most larval and juvenile fishes.

FUTURE CONSIDERATIONS

This study represents one of the first intensive investigations of the relationships between larval and juvenile fishes and oil and gas platforms. It is apparent that much has yet to be learned about the role platforms may play as habitat for early life stages of fishes, particularly reef-associated and reef-dependent fishes. One aspect that should be investigated further is the near-bottom vertical structure of the platforms. Logistically, this study was limited in its sampling scope to the surface and near-surface waters (15-23 m depth as determined by the first level of structural cross members). While some taxa may settle in relatively shallow waters and remain on a platform's upper support structures as adults (e.g., pomacentrids, chaetodontids and blenniids), others are more demersal as adults and probably recruit to the bottom support structures and pilings (e.g., serranids and lutjanids) as late-stage juveniles or even sub-adults. In addition, any low-relief benthic modification that may result from platform placement/construction (e.g., foundational bottom hardening, shell pads) or subsequent production (e.g., bottom oil or gas distributional pipelines) may also represent potentially valuable recruitment habitat. This platform-related, benthic sphere of influence may be further enhanced by the no trawling halo that is enforced immediately adjacent to all platforms. Future investigations should attempt to sample the deeper hard-bottom habitat provided by platforms.

Another important consideration in artificial reef studies is the degree to which organisms associated with the hard substrate habitat interact with pelagic species and contribute to off-reef production (Lindberg 1997). The scombrids, for example, are pelagic but often structure-associated, and

the juveniles are competent swimmers and highly piscivorous. If these juveniles, which were relatively abundant in the collections, are actively feeding in association with the platforms, then they, and similar taxa (e.g., carangids) could serve as an important trophic link between the reef and pelagic environments. Blennies, for example, could be an important link between production at the platforms and pelagic, transient predators. These fishes are structure-dependent and are attracted to the numerous habitats created by the biofouling community (e.g., barnacles) on the platform legs and cross members, as well as the to the associated zooplankton food resources (Gallaway 1981; Bohnsack and Sutherland 1985). Some blennies have been cited as important components of the diets of fishes such as Archosargus probatocephalus (Gallaway 1980) and Seriola rivoliana (Gallaway and Martin 1980).

The importance of platform primary and secondary production in different trophic pathways could be elucidated with the use of stable isotopes analyses (Thomas and Cahoon 1993). Since the sessile invertebrates (and associated meiofauna and macrofauna) on platforms represent "vertical benthos", it is likely there is a distinct platform isotopic signature in the fishes that utilize these food resources. Predatory taxa such as carangids and scombrids with more generalized habitat requirements may be attracted to the concentrations of zooplankton and forage fish that are dependent on the platforms (Keenan et al. in press). The use of stable isotope analyses could help to determine the relative contribution of platform vs. off-platform food resources in these trophic pathways.

A major problem for managing reef resources is the incomplete understanding of the interactions between recruitment and habitat structure. Although habitat space may ultimately be limiting, many reef fish populations are not at the carrying capacity of their environment and changes in abundance may be controlled by settlement from the plankton or by early postsettlement mortality. Virtually nothing is known about the relationship between offshore petroleum platforms and the early life history stages of fishes anywhere in the world. These findings, therefore, represent an important first step towards this aspect of artificial reef research.

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VITA

Frank Joseph Hernandez, Jr. was born on April 2, 1971 in New Roads, Louisiana. He is the son of Frank J. Hernandez, Sr. and Mary A. Hernandez (deceased), and the brother of Phyllis Jarreau and Amy Hernandez. Frank grew up in Baton Rouge where he attended Scotlandville Magnet High School, graduating in 1989. After a year at the University of Southwestern Louisiana, Frank transferred to Louisiana State University where he completed a bachelor of science degree in Zoology, graduating in 1993. He then moved "north" to pursue a master of science degree in Marine Biology at the University of North Carolina at Wilmington. Under the direction of Dr. David G. Lindquist, Frank discovered the world of ichthyoplankton and completed a thesis which compared the efficiency of different ichthyoplankton sampling gears. He graduated in 1996 and worked for Dr. Lindquist on miscellaneous projects until 1997. Frank returned to LSU in 1997 to continue his graduate studies in the Department of Oceanography and Coastal Sciences under the direction of Dr. Richard F. Shaw. His research has focused on the relationships between larval and juvenile fishes and artificial habitats, particularly petroleum platforms, in the northcentral Gulf of Mexico. He is currently looking forward to a post-doctoral research position at the NOAA lab in Beaufort, North Carolina. Frank will receive the Doctor of Philosophy degree in Oceanography and Coastal Sciences (minor in Experimental Statistics) in December 2001.

DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Frank Joseph Hernandez, Jr.

Major Field: Oceanography and Coastal Sciences

Title of Dissertation: The Across-Shelf Distribution of Larval, Postlarval and Juvenile Fishes Collected at Oil and Gas Platforms and a Coastal Jetty Off Louisiana West of the Mississippi River Delta

Approved:

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Major Professor and Chairman

Dean of the Graduate School

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October 24, 2001